NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

STANDARD SPECIFICATIONS FOR ROADS AND STRUCTURES

JANUARY 2024

FOREWORD

This publication has been prepared to provide a compilation of standard requirements used by the North Carolina Department of Transportation for construction contracts.

When this publication, entitled *Standard Specifications for Roads and Structures*, dated January 2024, is incorporated by reference into the Department's construction bid proposals or contracts; it is made a part of that document and shall be known as the *Standard Specifications*. The requirements stated herein may be revised or amended from time to time by supplemental specifications, by standard special provisions which are unique to a select group of projects or by project special provisions which are unique to the specific bid proposal or contract.

Working titles have a masculine gender, such as workman, workmen and foreman. Pronouns such as he, his, and him are used in the *Standard Specifications* for the sake of brevity and are intended to refer to persons of either sex or corporate entities.

Reference by title and date will be made to the governing provisions in the contract.

GENERAL INFORMATION

For general questions about this publication, please contact the Contract Standards and Development Unit at specs@ncdot.gov or (919) 707-6900.

ORDERING INFORMATION

Copies of the *Standard Specifications* and the *Roadway Standard Drawings* may be purchased through the Contract Standards and Development Unit:

North Carolina Department of Transportation
Contract Standards and Development Unit – Manual Distribution
1591 Mail Service Center
Raleigh, NC 27699-1591
Telephone: (919) 707-6944
Website: http://www.ncdot.gov/

The order form is available at https://connect.ncdot.gov/letting/Pages/Order-Publications.aspx.

Electronic copies of the *Standard Specifications* and the *Roadway Standard Drawings* are available for download on the Contract Standards and Development Unit's website at https://connect.ncdot.gov/resources/Specifications/Pages/default.aspx.

TABLE OF CONTENTS

DIVISION 5 – SUBGRADE, BASES AND SHOULDERS

DIVISION 6 – ASPHALT PAVEMENTS

DIVISION 7 – CONCRETE PAVEMENTS AND SHOULDERS

DIVISION 8 – INCIDENTALS

DIVISION 9 – SIGNING

DIVISION 10 – MATERIALS

DIVISION 11 – WORK ZONE TRAFFIC CONTROL

DIVISION 12 – PAVEMENT MARKINGS, MARKERS AND DELINEATION

DIVISION 14 – LIGHTING

DIVISION 15 – UTILITY CONSTRUCTION

DIVISION 16 – EROSION CONTROL AND ROADSIDE DEVELOPMENT

DIVISION 17 – SIGNALS AND INTELLIGENT TRANSPORTATION SYSTEMS

DIVISION 1
GENERAL REQUIREMENTS

SECTION 101
DEFINITIONS OF TERMS

101-1 GENERAL

Whenever the terms defined in this section are used in the contract, in any of the contract documents, or in the plans, the intended meaning of such terms shall be as defined in this section.

101-2 ABBREVIATIONS

AASHTO _____ American Association of State Highway and Transportation Officials
ABC _____ Aggregate Base Course
ACI _____ American Concrete Institute
AFAD _____ Automated Flagger Assistance Device
AISC _____ American Institute of Steel Construction
AMS-STD-595_ Aerospace Material Specification Standard Number 595
ANSI _____ American National Standards Institute
APL _____ Approved Products List
ASC _____ Approved Supplier Certification
ASB _____ Aggregate Shoulder Borrow
ASME _____ American Society of Mechanical Engineers
ASTM _____ American Society for Testing and Materials
AWG _____ American Wire Gauge
AWS _____ American Welding Society
AWWA _____ American Water Works Association
AWPA _____ American Wood-Preservers' Association
CAPWAP _____ CAse Pile Wave Analysis Program
CFR _____ Code of Federal Regulations
CIE _____ International Commission on Illumination
CIP _____ Cast in Place
CRSI _____ Concrete Reinforcing Steel Institute
CS _____ Corrugated Steel
CSI _____ Cumulative Straightedge Index
CSL _____ Crosshole Sonic Logging
EIA/TIA _____ Electronics Industries Alliance/Telecommunications Industry Association
ESAL _____ Equivalent Single Axle Load
FHWA _____ Federal Highway Administration, U.S. Department of Transportation
HDPE _____ High Density Polyethylene
HMA _____ Hot Mix Asphalt
ID _____ Identification
IES _____ Illuminating Engineering Society
IRI _____ International Roughness Index
IMSA _____ International Municipal Signal Association
JMF _____ Job Mix Formula
LED _____ Light Emitting Diode
LL _____ Liquid Limit
LLC _____ Limited Liability Company
LRFD _____ Load and Resistance Factor Design
MIL _____ Military Standard
MRAS _____ Manufactured Waste Reclaimed Asphalt Shingles

MRI _____ Mean Roughness Index
MTV _____ Material Transfer Vehicle
MUTCD _____ Manual on Uniform Traffic Control Devices and the North Carolina Supplement thereto
NCAC _____ North Carolina Administrative Code
NCDEQ _____ North Carolina Department of Environmental Quality
NCDOT _____ North Carolina Department of Transportation
NCGS _____ North Carolina General Statutes
NEC _____ National Electrical Code
NEMA _____ National Electrical Manufacturers Association
NESC _____ National Electrical Safety Code
OGFC _____ Open-Graded Friction Course
OSHA _____ Occupational Safety and Health Administration
OTDR _____ Optical Time Domain Reflectometer
PPV _____ Peak Particle Velocity
PADC _____ Permeable Asphalt Drainage Course
PDA _____ Pile Driver Analyzer
PDF _____ Portable Document Format
PI _____ Plasticity Index (Material), Public Information Plan (Traffic Management)
PIT _____ Pile Integrity Testing
POC _____ Purchase Order Contract
PMEM _____ Polymer-Modified Emulsion Membrane
PRAS _____ Post Consumer Reclaimed Asphalt Shingles
PVC _____ Polyvinyl Chloride
PVCO _____ Molecularly Oriented Polyvinyl Chloride
QA _____ Quality Assurance
QC _____ Quality Control
QMS _____ Quality Management System
QPL _____ Qualified Products List
RAP _____ Reclaimed Asphalt Pavement
RAS _____ Reclaimed Asphalt Shingles
RUS _____ Rural Utilities Service
SCM _____ Supplementary Cementitious Material
SCTE _____ Society of Cable Telecommunications Engineers
SDS _____ Safety Data Sheets
SMFO _____ Single Mode Fiber Optic (Cable or Connector)
SSPC _____ Society of Protective Coatings
SWG _____ Steel Wire Gauge
STIP _____ State Transportation Improvement Plan
TMP _____ Traffic Management Plan
TO _____ Transportation Operations Plan
TSR _____ Tensile Strength Ratio
TTC _____ Temporary Traffic Control Plan
TTF _____ Temperature-Time Factor
UBWC _____ Ultra-thin Bonded Wearing Course
UL _____ Underwriters' Laboratories, Inc.
USACE _____ U.S. Army Corps of Engineers
UST _____ Underground Storage Tank
UV _____ Ultraviolet
VEP _____ Value Engineering Proposal
VMA _____ Voids in Mineral Aggregate
VTM _____ Voids in Total Mix
WBS _____ Work Balance Sheet
WTAT _____ Wet Track Abrasion Test
WMA _____ Warm Mix Asphalt

TABLE 101-1
MEASUREMENT SYMBOLS

Symbol	Unit Name	Symbol	Unit Name
"	Inch, Inches	lb	Pound, Pounds
%	Percent	lbf	Pound(s) Force
±	Plus or Minus	nm	Nanometer(s)
°	Degree, Degrees	mcd/lux/m^2	Millicandellas per Lux per Square Meter
>	Greater Than	mg-cm	Milligram-Centimeter
≥	Greater Than or Equal to	mg/sf	Milligram per Square Foot
<	Less Than	mm	Millimeter, Millimeters
≤	Less Than or Equal to	mph	Mile(s) per Hour
µ	Micro	oz	Ounce, Ounces
A, amp	Ampere, Amperes	pcf	Pounds per Cubic Foot
cf	Cubic Foot, Cubic Feet	ppm	Parts per Million
cu.in.	Cubic Inch, Cubic Inches	psf	Pounds per Square Foot
cy	Cubic Yard, Cubic Yards	psi	Pounds per Square Inch
dB	Decibel, Decibels	qt	Quart, Quarts
F	Fahrenheit	rpm	Rotations per Minute
ft	Foot, Feet	sec	Second, Seconds
ft-lb	Foot-Pounds	sf	Square Foot, Square Feet
gal	Gallon, Gallons	SFS	Saybolt Furol Seconds
gpm	Gallon(s) per Minute	sq.in.	Square Inch, Square Inches
$G_{mm}@N_{ini}$	Maximum Specific Gravity at Initial Number of Gyrations	sy	Square Yard, Square Yards
hr	Hour, Hours	tsf	Tons per Square Foot
Hz	Hertz	V, VAC, VDC	Voltage, Volts of Alternating Current, Volts of Direct Current
J	Joule, Joules	vpm	Vibrations per Minute
kbps	Kilobit per Second	W	Watt, Watts
ksi	Kips per Square Inch	Yd	Yard, Yards

101-3 DEFINITIONS

ACT OF GOD: Events in nature so extraordinary that the history of climate variations and other conditions in the particular locality affords no reasonable warning of them.

ADDITIONAL WORK: Additional work is that which results from a change or alteration to the contract and for which there are existing contract unit prices.

ADVERTISEMENT: The public advertisement inviting bids for the construction of specific projects.

AMOUNT BID: The amount bid for a particular item of work in a proposal.

ARTICLE: A primary numbered subdivision of a section of the *Standard Specifications*. An article may be subdivided into subarticles.

AWARD: The decision of the Department of Transportation to accept the bid of the lowest responsible responsive bidder for work that is subject to the furnishing of payment and performance bonds and such other conditions as may be otherwise provided by law, the proposal and these *Standard Specifications*.

BASE COURSE: That portion of the pavement structure of planned thickness placed immediately below the pavement or surface course.

BID (OR PROPOSAL): *Paper Bid:* The offer of a bidder on the proposal furnished by the Department to perform the work and to furnish the labor and materials at the prices quoted. *Electronic Bid:* The electronic offer of a bidder via the approved electronic bidding software to the Department to perform the work and to furnish the labor and materials at the prices quoted.

BID BOND OR BID DEPOSIT: The security furnished by the bidder with his bid as guaranty that he will furnish the required bonds and execute such documents as may be required if his bid is accepted.

BIDDER: An individual, partnership, firm, corporation, LLC or joint venture formally submitting a bid for the work contemplated.

BOARD OR BOARD OF TRANSPORTATION: The Board created by the provisions of NCGS § 143B-350 for formulating policies for the Department of Transportation and awarding all transportation construction contracts.

BRIDGE: A structure including supports, erected over a depression or an obstruction such as water, highway or railway, and having a track or passage way for carrying traffic or other moving loads and having a length measured along the center of the roadway of more than 20 ft between undercopings of end supports, spring lines of arches or between extreme ends of openings for multiple reinforced concrete box structures.

BRIDGE LENGTH: The length of a bridge structure is the overall length measured along the line of survey stationing back to back of backwalls of abutments, if present, otherwise end to end of the bridge floor.

BRIDGE WIDTH: The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs, guard timbers or face of parapets, or in the case of multiple heights of curbs, between the bottoms of the lower risers.

CALENDAR DAY: A day shown on the calendar beginning and ending at midnight.

CHIEF ENGINEER: The Chief Engineer, Division of Highways, North Carolina Department of Transportation acting directly or through his duly authorized representatives.

COMPLETION DATE: That date established as set forth in the contract or as revised by authorized extensions, by which it is required that the work set forth in the contract be satisfactorily completed. When observation periods are required by the *Standard Specifications*, they are not a part of the work to be completed by the completion date or intermediate contract times stated in the contract unless otherwise noted.

CONSTRUCTION EASEMENT: A right owned by the Department of Transportation in a parcel of land owned by a third party outside the highway right of way for containing construction that exceeds the right of way.

CONTRACT: The executed agreement between the Department and the successful bidder, covering the performance of and compensation for the work.

The term contract is all inclusive with reference to all written and electronic agreements affecting a contractual relationship and all documents referred to therein. The contract shall include, but not be limited to, the proposal, the printed contract form and attachments, contract bonds, plans, *Standard Specifications* and supplemental specifications, standard special provisions and project special provisions contained in the proposal and all executed supplemental agreements. All references to contracts shall include electronic agreements and printed paper agreements. These may include, but not be limited to, the electronic bid bond, Non-Collusion Certification, Debarment Certification, Gift Ban Certification and award limits.

The contract shall constitute one instrument.

CONTRACT ITEM: A specifically described unit of work for which a unit or lump sum price is provided in the contract. Synonymous with Pay Item.

CONTRACT LUMP SUM PRICE: The amount bid for a lump sum item that has been submitted by the Contractor in his proposal.

CONTRACT PAYMENT BOND: A bond furnished by the Contractor and his corporate surety securing the payment of those furnishing labor, materials and supplies for the construction of the project.

CONTRACT PERFORMANCE BOND: A bond furnished by the Contractor and his corporate surety guaranteeing the performance of the contract.

CONTRACT TIME: The number of calendar days inclusive between the date of availability and the completion date, said dates being established as set forth in the special provisions, including authorized extensions to the completion date.

CONTRACT UNIT PRICE: The unit bid price for a unit item that has been submitted by the Contractor in his proposal.

CONTRACTOR: The successful bidder to whom the contract has been awarded, and who has executed the contract and furnished acceptable contract bonds. The Prime Contractor is the Bidder or Purchase Order (PO) Prime Contractor.

CULVERT: Any structure not classified as a bridge that provides an opening under the roadway.

CURRENT CONTROLLING OPERATION OR OPERATIONS: Any operation or operations, as determined by the Engineer, that if delayed would delay the completion of the project.

DATE OF AVAILABILITY: That date, established as set forth in the special provisions, by which it is anticipated that sufficient work sites within the project limits will be available for the Contractor to begin his controlling operations that are not otherwise limited by moratoriums, listed third party conflicts, or by weather conditions.

DEPARTMENT or DEPARTMENT OF TRANSPORTATION: A principal department of the Executive Branch that performs the functions of planning, design, construction and maintenance of an integrated statewide transportation system.

DIVISION OF HIGHWAYS: The division of the Department of Transportation that, under the direction of the Secretary of Transportation, carries out state highway planning, design, construction and maintenance functions assigned to the Department of Transportation.

DRAINAGE EASEMENT: A right, owned by the Department of Transportation, in a parcel of land owned by a third party outside the highway right of way, to construct and maintain ditches, channels, or structures for directing the course and flow of water outside the highway right of way.

EASEMENT: A property right to use or control real property of another.

ENGINEER: The Chief Engineer of the North Carolina Department of Transportation, acting directly or through a duly authorized representative, such representative acting within the scope of particular assigned duties or authority.

EQUIPMENT: All machinery and equipment, together with the necessary supplies, tools and apparatus for upkeep and maintenance, all of which are necessary for the proper construction and acceptable completion of the work.

EXTRA WORK: Work found necessary or desirable to fully complete the work as contemplated in the contract for which payment is not provided for by the contract unit or lump sum prices in the original contract. Extra work shall not be work that in the terms of the

contract is incidental to work for which there is a contract price or work that payment is included in some other contract unit or lump sum price.

FINAL ACCEPTANCE DATE: That date on which all work set forth in the contract and work modified by the Engineer is satisfactorily completed excluding any observation periods not specifically made a part of the work by the specifications or special provisions.

FINAL ESTIMATE: The document that contains a final statement of all quantities and total dollar amount for each item of work performed during the life of the contract including any adjustments to those amounts made under the terms of the contract. The final statement will be titled The Final Estimate and will be the document used to document final payment to the Contractor. Receipt of this document by the Contractor will begin the time frame for filing of a verified claim with the Department as provided for in NCGS § 136-29.

FINAL ESTIMATE ASSEMBLY: As constructed plans and other project records that establish the final statement of quantities to be paid and document work performed on the project.

FORCE ACCOUNT NOTICE: A written notice to the Contractor that extra work ordered by the Engineer will be paid as force account work.

FORCE ACCOUNT WORK: Work that is paid in accordance with Article 109-3 or on the basis of the force account formula provided in the contract.

HIGHWAY: A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way. Synonymous with Road and Street.

HOUR: One of the 24 equal parts of a day.

INSPECTOR: The authorized representative of the Engineer assigned to make a detailed inspection of any or all portions of the work and materials.

INTERMEDIATE COMPLETION DATE: That date established as set forth in the special provisions or as revised by authorized extensions, by which date it is required that the portion of work set forth in the contract be satisfactorily completed.

INTERMEDIATE COMPLETION TIME: The time established as set forth in the special provisions or as revised by authorized extensions, by which it is required that the portion of work set forth in the contract be satisfactorily completed.

INTERMEDIATE CONTRACT TIME (DAYS): The number of calendar days inclusive between the date of availability and the intermediate completion date, said days being established as set forth in the special provisions, or as revised by authorized extensions, by which it is required that a portion of that work set forth in the contract be satisfactorily completed.

INTERMEDIATE CONTRACT TIME (HOURS): The number of hours inclusive between the time of availability and the intermediate completion time, said times being established as set forth in the special provisions, including authorized extensions to the intermediate completion time.

INVERT: The lowest point in the internal cross section of a pipe or other culvert.

INVITATION TO BID: The notification that bids will be received for the construction of specific projects.

LABORATORY: The testing laboratory of the Department of Transportation or any other testing laboratory that may be designated or approved by the Engineer.

LOCAL TRAFFIC: Traffic that must use the facility under construction to reach its destination.

MAJOR AND MINOR CONTRACT ITEMS: Major contract items are listed as such in the project special provisions. All other original contract items and extra work shall be considered as minor items.

MATERIALS: Any substances that may be incorporated into the construction of the project.

MEDIAN: The center section of a divided highway that separates the traffic lanes in one direction from the traffic lanes in the opposite direction.

MOBILIZATION: The work described in Article 800-1.

PAVEMENT STRUCTURE: The combination of base and surface courses placed on a subgrade to support the traffic load and distribute it to the roadbed.

PAY ITEM: Synonymous with Contract Item.

PLANS: The approved plans, profiles, typical roadway sections, appropriate standard drawings, supplemental plans and working drawings, or exact reproductions thereof, that show the location, dimensions and details of the work to be done and that are a part of the contract.

PREBID CONFERENCE: A conference held before bids are accepted on a project at which representatives of the Department will provide information and accept and answer questions from interested parties.

PROJECT: The work specified under the contract.

PROJECT SPECIAL PROVISIONS: Special provisions peculiar to the project and not otherwise thoroughly or appropriately set forth in the *Standard Specifications* or plans.

PROPOSAL: The electronic or paper document provided by the Department that the bidder uses to develop his electronic or paper offer to perform the work at designated bid prices.

PURCHASE ORDER (PO) PRIME CONTRACTOR: A Bidder that can bid on any Division Let Contract.

RIGHT OF WAY: The land area shown in the plans as right of way to be furnished by the Department of Transportation within which the project is to be constructed.

ROAD: Synonymous with Highway and Street.

ROADBED: The graded portion of a highway usually considered as the area between the intersections of top and side slopes, upon which the base course, surface course, shoulders and medians are constructed.

ROADSIDE: A general term denoting the area within the limits of the right of way adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may be considered roadside.

ROADWAY: The portion of a highway within limits of construction.

SECTION: A numbered chapter of the *Standard Specifications*.

SHOULDER: The portion of the roadway adjacent to the traveled way for accommodation of stopped vehicles, for emergency use and for lateral support of base and surface courses.

SIDEWALK: That portion of the roadway primarily constructed for pedestrian traffic.

SKEW ANGLE: The angle between the centerline of the project and the centerline of a pipe, culvert, bridge pier, bent, abutment, or other drainage feature, measured to the right of the project centerline facing in the direction of progressing stations.

SPECIAL PROVISIONS: Project special provisions and standard special provisions taken together as one body of special provisions.

SPECIFICATIONS: The general term comprising all the directions, provisions and requirements contained or referred to in the *Standard Specifications*, including the supplemental specifications, together with such additional directions, provisions and requirements that may be added or adopted as special provisions.

STANDARD DRAWINGS: The general term comprising all the directions, provisions and requirements contained or referred to in the book entitled *Roadway Standard Drawings* and in any subsequent revisions or additions to such book that are issued as Detail Drawings.

STANDARD SPECIAL PROVISIONS: Special directions or requirements not otherwise thoroughly or appropriately set forth in the standard specifications and that are peculiar to a selected group of projects.

STANDARD SPECIFICATIONS: The general term comprising all the directions, provisions and requirements contained or referred to in this book entitled *Standard Specifications for Roads and Structures* and in any subsequent revisions or additions to such book that are issued as supplemental specifications.

STATE: The State of North Carolina.

STATION: A station, when used as a term of measurement, will be 100 linear feet measured horizontally. When used as a location, it will be a designated point on the project.

STREET: Synonymous with Highway and Road.

SUBCONTRACTOR: An individual, partnership, firm, joint venture, LLC or corporation to whom the Contractor, with the written consent of the Engineer, sublets any part of the contract.

SUBGRADE: That portion of the roadbed prepared as a foundation for the pavement structure including curb and gutter. On portions of projects that do not include the construction of a base course or pavement, the presence of the subgrade will not be recognized during the life of such contract.

SUBSTRUCTURE: All of that part of the structure below the bearings of simple and continuous spans, spans, skew back of arches and tops of footings of rigid frames, together with the backwalls and wingwalls.

SUCCESSFUL BIDDER: The bidder awarded a contract.

SUPERINTENDENT: The representative of the Contractor authorized to supervise and direct the construction for the Contractor and to receive and fulfill directions from the Engineer.

SUPERSTRUCTURE: All of the part of the structure exclusive of the substructure.

SUPPLEMENTAL AGREEMENT: A written agreement between the Contractor and the Department of Transportation covering amendments to the contract.

SUPPLEMENTAL SPECIFICATIONS: Specifications, regulations, standards, manuals or codes referenced in the contract or general revisions or additions to this book of standard specifications that are issued under the title of supplemental specifications. Supplemental specifications shall be considered part of the *Standard Specifications*.

SURETY: A corporate bonding company furnishing the bid bond or furnishing the contract payment and performance bonds.

TEMPORARY CONSTRUCTION EASEMENT: A temporary right, owned by the Department of Transportation, in a parcel of land owned by a third party outside the highway right of way, for the use of the Department of Transportation during the construction and that reverts to the third party on completion of construction.

THROUGH TRAFFIC: Traffic that can reach its destination by a route or routes other than the facility under construction.

TIME OF AVAILABILITY: That time established as set forth in the special provisions, by which it is anticipated that sufficient work sites within the project limits will be available for the Contractor to begin his controlling operations.

TOTAL AMOUNT BID: Same as total price bid. The total amount bid will be considered to be the correct sum total obtained by adding together the amounts bid for every item in the proposal other than items that are authorized alternates to those items for which an amount bid has been established.

UNBALANCED BID: A bid that includes any unbalanced bid price.

UNBALANCED BID PRICE: A unit or lump sum bid price that does not reflect reasonable actual costs that the bidder anticipates for the performance of the item in question along with a reasonable proportionate share of the bidder's anticipated profit, overhead costs and other indirect costs.

WORK: Work shall mean the furnishing of all labor, materials, equipment and incidentals necessary or convenient to the successful completion of the project, or any part, portion or phase thereof, and the carrying out of all duties and obligations imposed by the contract.

WORKING DRAWINGS: Stress sheets, shop drawings, erection drawings, falsework drawings, cofferdam drawings, catalog cuts, or any other supplementary drawings or similar data that the Contractor is required to submit to the Engineer for review or approval.

SECTION 102
BIDDING REQUIREMENTS AND CONDITIONS

102-1 INVITATION TO BID

After the advertisement has been made, an Invitation to Bid will be made available on the Department's website to interested parties, informing them that bids will be received for the construction of specific projects. Such invitations will indicate the contract identification number, length, locations and descriptions; a general summary of the items and approximate quantities of work to be performed; and the time and place for the public opening and reading of the bids received. Information concerning the cost and availability of plans and proposals will be indicated in the Invitation to Bid.

All projects will be advertised in daily newspapers throughout the state before the bid opening.

102-2 CONTRACTOR PREQUALIFICATION

Contractors desiring to perform work on Department projects shall prequalify with the Department. Upon prequalification, contractors will be placed on the Department's Prequalified Contractors' List on the Directory of Firms. The requirements for prequalification are as follows:

(A) Bidder Prequalification

(1) Applicant shall submit a completed Department Prequalification Application and *Bidder Experience Questionnaire*, along with any additional supporting information requested by the Department, as noted in the application and experience questionnaire package. Additional requirements for prequalification may be set forth in the bid proposal.

(2) Applicant shall demonstrate that he has sufficient ability and experience in related transportation construction projects to perform the work specified in the Department's contracts, including the type and dollar value of previous contracts.

(3) Applicant shall demonstrate a history of successful performance and completion of projects in a timely manner, subject to contract time adjustments.

(4) Applicant shall demonstrate the financial ability to furnish bonds as specified in NCGS § 44A-26 and any other relevant statutes.

(5) Applicant shall demonstrate sufficient and readily available equipment to perform transportation construction contracts in a timely manner.

(6) Applicant shall demonstrate sufficient available experienced personnel to perform transportation construction contracts. The identities and qualifications of both management and labor work force shall be provided.

(7) Applicant shall provide names and addresses of persons for whom the firm has performed related work. Responses from the references shall be on Department forms and shall be received by the Department before evaluating the request for prequalification.

(8) Applicant shall provide any information requested concerning the corporate and operational management structure of the company, the identity of persons or entities owning stock or other equity interest in the company, and the relationship between the applicant and any other company prequalified or applying for prequalification with the Department.

(9) Applicant shall demonstrate, at the time of application for prequalification, the financial capacity to successfully complete projects containing the work types they so designate.

(10) Applicant shall provide further information as may be required to determine that the firm is a responsible bidder.

(11) Applicant shall submit a completed *Pre-Bid Non-Collusion Certification*, *Debarment Certification* and *Gift Ban Certification* in accordance with Article 102-9. These forms can be found on the Department's website.

(12) Applicant shall submit a completed *Safety Index Rating Form* with the Questionnaire and annually thereafter in accordance with Subarticle 102-2(D).

Bidders shall renew annually and shall requalify every 3 years in accordance with Subarticle 102-2(E).

The *Bidder Experience Questionnaire* shall be completed in its entirety and signed by an officer of the firm. The officer's signature shall be notarized. In addition to submitting the *Bidder Experience Questionnaire*, the prospective bidder shall submit supporting information in a format of his choosing to address the requirements listed above.

Prospective bidders shall obtain prequalification approval at least two business days prior to any letting in which they intend to submit a bid. It is recommended that the prospective bidder file all required statements and documents with the State Prequalifications Engineer no less than 4 weeks before a given letting. A bid shall not be opened unless all prequalification requirements have been met by the bidder and have been found acceptable by the Engineer.

(B) Purchase Order (PO) Prime Contractor Prequalification

Contractors who have been approved to be placed on the Prequalified Bidders' List as noted above may perform work for the Department as a Purchase Order (PO) Prime Contractor and need not apply further. However, Purchase Order (PO) Prime Contractors will not be placed on the Prequalified Bidders' List unless they submit through the prequalification process described above.

(1) Applicant shall submit a completed Department Prequalification Application along with any additional supporting information requested by the Department, as noted in the application. Additional requirements for prequalification may be in the bid proposal.

(2) Applicant shall demonstrate that it has sufficient ability and experience in related transportation construction projects to perform the work specified in Department contracts, including the type and dollar value of previous contracts.

(3) Applicant shall demonstrate a history of successful performance and completion of projects in a timely manner, subject to contract time adjustments.

(4) Applicant shall demonstrate sufficient and readily available equipment to perform transportation construction contracts in a timely manner.

(5) Applicant shall provide further information as may be required to determine that the firm is a responsible contractor.

(6) Applicant shall submit a completed *Pre-Bid Non-Collusion Certification*, *Debarment Certification* and *Gift Ban Certification* in accordance with Article 102-9. These forms can be found on the Department's website.

(7) Applicant shall submit a completed *Safety Index Rating Form* with the application and annually thereafter in accordance with Subarticle 102-2(D).

Purchase Order (PO) Prime Contractors shall renew annually and requalify every 3 years in accordance with Subarticle 102-2(E).

The application shall be completed in its entirety and signed by an officer of the firm. The officer's signature shall be notarized. In addition to submitting the application, the firm shall submit supporting information in a format of his choosing to address the requirements listed above.

Prospective Purchase Order (PO) Prime Contractors shall obtain prequalification approval at least two business days prior to any letting in which they intend to submit a bid. It is recommended that the applicant file all required statements and documents with the State Prequalifications Engineer no less than 4 weeks before a given bid opening for their bid to be considered. A bid shall not be opened unless all prequalification requirements have been met by the applicant and have been found acceptable by the Engineer.

(C) Subcontractor Prequalification

Contractors who have been approved to be placed on the Prequalified Bidders' List or the Purchase Order (PO) Prime Contractor's List as noted above may perform work for the Department as a subcontractor and need not apply further. However, subcontractors will not be placed on the Prequalified Bidders' List or the Purchase Order (PO) Prime Contractor's List unless they submit through the prequalification process described above.

(1) Applicant shall submit a completed Department Prequalification Application along with any additional supporting information requested by the Department, as noted in the application. Additional requirements for prequalification may be in the bid proposal.

(2) Applicant shall demonstrate sufficient ability and experience in related transportation construction projects to perform the work specified in Department contracts, including the type of previous contracts.

(3) Applicant shall demonstrate sufficient and readily available equipment to perform transportation construction contracts in a timely manner.

(4) Applicant shall submit a completed *Safety Index Rating Form* with the Subcontractor Application and annually thereafter in accordance with Subarticle 102-2(D).

(5) Applicant shall provide further information as may be required.

Subcontractors shall renew annually and shall requalify every 3 years in accordance with Subarticle 102-2(E).

The Subcontractor Application shall be completed in its entirety. In addition to submitting the Subcontractor Application, the prospective subcontractor shall submit supporting information in a format of their choosing to address the requirements listed above.

The subcontractor shall file all required statements and documents with the State Prequalifications Engineer no less than 4 weeks before beginning work. A subcontractor will not be allowed to begin work until all prequalification requirements have been met by the subcontractor and have been found acceptable by the Engineer.

(D) Safety Index

The Department will conduct a review of each firm's safety index. To be prequalified, each firm shall maintain a satisfactory safety index. An overall safety index of at least 60 is considered satisfactory. An index between 60 and 69 may be considered marginal results in an in-depth safety audit of a firm's safety practices and may result in one or more of the sanctions listed below as a result of a failing Safety Index. An overall safety index equal to or less than 59 is considered unsatisfactory and will prohibit prequalification of new firms.

A score of 59 or less for renewing or requalifying firms will result in disciplinary action pursuant to Subarticles 102-2(D)(1) through 102-2(D)(4). The Engineer may require the Contractor to state in writing the reason for the unsatisfactory rating and produce such supporting data as may be necessary to evaluate the circumstances surrounding the rating. When the Contractor cannot provide justification to raise the unsatisfactory safety index, the Engineer may invoke one or more of the following sanctions:

(1) Removal of the firm from the Prequalified Contractors' List,

(2) Placement of the firm on probation for up to 2 years,

(3) Auditing of the firm's safety practices and

(4) Giving a written warning to correct any safety deficiencies.

Firms not approved or disqualified to bid or perform subcontract work due to an unsatisfactory safety index will not be approved or reinstated to bid or perform subcontract work until they can provide adequate evidence that all safety deficiencies have been corrected to the satisfaction of the Engineer.

(E) Renewal and Requalification

Renewal of firms shall occur annually on or before the firm's anniversary date. Renewal shall consist of submitting an updated application. Bids of firms who fail to submit these documents by their anniversary date will be deemed non-responsive and not considered for award. The Engineer may review performance related issues when considering firms for renewal. Subcontractors who fail to submit these documents by their anniversary date will not be allowed to begin work on any new contracts until these documents are received and approved by the Engineer.

Requalifying of firms shall occur every 3 years. Requalifying shall consist of submitting an updated application. Bids of firms who fail to submit these documents by their anniversary date will be deemed non-responsive and not considered for award. The Engineer may review performance related issues when considering firms for

requalification. Subcontractors who fail to submit these documents by their anniversary date will not be allowed to begin work on any new contracts until these documents are received and approved by the Engineer.

It is recommended that the renewing or requalifying firm file all required statements and documents with the State Prequalifications Engineer no less than 4 weeks before a given letting for their bid to be considered. Following the anniversary date, a bid will not be opened unless all renewal or requalification requirements have been met by the bidder and have been found acceptable by the Engineer. Following the anniversary date, a subcontractor may not begin any new work unless all renewal or requalification requirements have been met by the firm and have been found acceptable by the Engineer.

102-3 PROPOSALS AND INTERESTED PARTIES LIST

On Department projects advertised the prospective bidder shall sign up on the *Interested Parties List* no later than one business day prior to the Letting day of that project, for which he intends to submit a bid. There is no cost for signing up on the *Interested Parties List* that can be found on the Department's website at connect.ncdot.gov/letting.

The proposal will state the location of the contemplated construction and show a schedule of contract items with the approximate quantity of each of these items for which bid prices are invited. It will set forth the date and time for the opening of bids. The proposal will include any special provisions or requirements that vary from, or are not contained in, the plans or *Standard Specifications.*

The plans, *Standard Specifications* and other documents designated in the proposal shall be considered a part of the proposal whether or not attached.

The names and identity of corporations, firms, partnerships, individuals, LLCs or joint ventures who have requested plans or proposals for the purposes of bidding shall be made public.

(A) Paper Bids

The proposal will include the printed contract forms and signature sheets for execution by both parties to the contract. In the event the bidder is awarded the contract, execution of the bid by the bidder is considered the same as execution of the contract.

All papers bound with the proposal are necessary parts thereof and shall not be detached, taken apart or altered.

(B) Electronic Bids

The bidder shall bid in accordance with Subarticle 102-8(B).

102-4 COMBINATION BIDS

If the Department so elects, proposals may be issued for projects in combination or separately, so that bids may be submitted either on the combination or on separate units of the combination. The right is reserved to make awards on combination bids or separate bids to the best advantage of the Department. No combination bids, other than those specified by the Department in the proposal will be considered.

102-5 INTERPRETATION OF QUANTITIES IN PROPOSAL

The quantities appearing in the proposal are approximations only and are to be used solely for the comparison of bids. Payment to the Contractor will be made in accordance with the contract.

When revisions in the plans are made by the Engineer that affect the quantities shown for lump sum items, adjustment in compensation may be made under the provisions of Articles 104-3 or 104-7.

102-6 EXAMINATION OF PLANS, SPECIFICATIONS, CONTRACT AND SITE OF WORK

The bidder shall carefully examine the site of the work contemplated, the plans and specifications, and the proposals and contracts therefor. The submission of a bid shall be conclusive evidence that the bidder has investigated and is satisfied as to the conditions to be encountered; the character, quality and scope of work to be performed; the quantities of materials to be furnished; and the conditions and requirements of the proposal, plans and contract under which his bid is offered.

A bidder or contractor shall prior to bidding, make such independent investigation and examination as to conditions to be encountered in the performance of the work and with respect to possible local material sources, the quality and quantity of material available from such property, and the type and extent of processing that may be required to produce material conforming to the contract.

102-7 SUBSURFACE INVESTIGATION REPORT

If a subsurface investigation report is available on a project, an electronic copy is available on-line with the project letting files.

The subsurface report and the subsurface investigation on which it is based were made for study, planning and design and not for construction or pay purposes. The various field boring logs, rock cores and soil test data available may be reviewed or inspected. Contact the Geotechnical Engineering Unit to set up an appointment in the appropriate Regional office. The subsurface investigation report, the field boring logs, rock cores, and soil test data are not part of the contract.

General soil and rock strata descriptions and indicated boundaries are based on a geotechnical interpretation of available subsurface data and do not necessarily reflect the actual subsurface conditions between borings or between sampled strata within the borehole. The laboratory sample data and the in-place test data can be relied on only to the degree of reliability inherent in the standard test method. The observed water levels or soil moisture conditions indicated in the subsurface investigations are as recorded at the time of the investigation. These water levels or soil moisture conditions may vary considerably with time according to climatic conditions including temperature, precipitation and wind, as well as other nonclimatic factors.

Details shown in the subsurface investigation report are preliminary only and the final design details may be different. For bidding and construction purposes, refer to the contract for final design information on this project. The Department does not warrant or guarantee the sufficiency or accuracy of the investigation made, nor the interpretations made or opinions of the Department as to the type of materials and conditions that may be encountered. The bidder or contractor shall make independent subsurface investigations, as to conditions to be encountered on this project. The Contractor assumes all risks for any discrepancies between the subsurface information and the actual conditions encountered and expressly agrees that NCDOT is not liable for any such variances and shall have no claim for additional compensation or for an extension of time for any reason resulting from the actual conditions encountered at the site differing from those indicated in the subsurface investigation.

102-8 PREPARATION AND SUBMISSION OF BIDS

Prior to submitting a bid on a project, the bidder shall sign up on the *Interested Parties List* in conformance with Article 102-3. The bidder shall submit a unit or lump sum price for every item in the proposal other than items that are authorized alternates to those items for which a bid price has been submitted.

An amount bid shall be entered in the proposal for every item on which a unit price has been submitted. In the case of lump sum items, the price shall be written in figures in the Amount Bid column in the proposal.

The bid shall not contain any unauthorized additions, deletions or conditional bids.

The bidder shall not add any provision reserving the right to accept or reject an award or to enter into a contract pursuant to an award.

The bid shall not be an unbalanced bid.

(A) Paper Bids

(1) The proposal provided by the Department shall be used and shall not be taken apart or altered. The bid shall be submitted on the same proposal that has been furnished to the bidder by the Department.

The bid shall be accompanied by a bid bond on the form furnished by the Department or by a bid deposit. The bid bond shall be completely and properly executed in accordance with Article 102-10. The bid deposit shall be a certified check or cashier's check in accordance with Article 102-10.

(2) All entries including signatures shall be written in ink.

(3) The unit prices shall be rounded off by the bidder to contain no more than 4 decimal places.

(4) An amount bid shall be entered in the proposal for every item on which a unit price has been submitted. The amount bid for each item other than lump sum items shall be determined by multiplying each unit bid price by the quantity for that item and shall be written in figures in the Amount Bid column in the proposal.

(5) In the case of lump sum items, the price shall be written in figures in the Amount Bid column in the proposal.

(6) The total amount bid shall be written in figures in the proper place in the proposal. The total amount bid shall be determined by adding the amounts bid for each item.

(7) Changes in any entry shall be made by marking through the entry in ink and making the correct entry adjacent thereto in ink. A representative of the bidder shall initial the change in ink.

(8) Subarticle 103-2(A) will apply to Paper Bidding.

(9) The bidder shall provide a Non-Collusion Certification, Debarment Certification and Gift Ban Certification in accordance with Articles 102-2 and 102-9.

(10) Bids will be opened and read publicly in accordance with Article 102-13.

(11) The Contractor shall submit a fully executed Execution of Contract, signature sheet and payment and performance bonds within 14 calendar days of receipt of award letter in accordance with Article 102-10.

(12) The bid shall be properly executed. To constitute proper execution, the bid shall be executed in strict compliance with the following:

(a) If a bid is by an individual, it shall show the name of the individual and shall be signed by the individual with the word *Individually* appearing under the signature. If the individual operates under a firm name, the bid shall be signed in the name of the individual doing business under the firm name.

(b) If the bid is by a corporation, the President, Vice President, or Assistant Vice President shall execute it in the name of the corporation. The Secretary or Assistant Secretary shall attest it. The seal of the corporation shall be affixed. If the bid is executed on behalf of a corporation in any other manner than as above, a certified copy of the minutes of the Board of Directors of said corporation authorizing the manner and style of execution and the authority of the person executing shall be attached to the bid or shall be on file with the Department.

(c) If the bid is made by a partnership, it shall be executed in the name of the partnership by one of the general partners.

(d) If the bid is made by a limited liability company, it shall be signed by the manager, member or authorized agent and notarized.

(e) If the bid is a joint venture, it shall be executed by each member of the joint venturers in the appropriate manner set out above. In addition, the execution by the joint venturers shall appear below their names.

(f) The bid execution shall be notarized by a notary public whose commission is in effect on the date of execution. Such notarization shall be applicable to the bid.

(13) The bid shall be placed in a sealed envelope and shall have been delivered to and received by the Department before the time specified in the Invitation to Bid.

(B) Electronic Bids

The Department will not be responsible if a bidder cannot submit his bid via the approved electronic bidding software. Claims will not be accepted for such failure.

(1) Obtain an account and valid Digital Signature to bid electronically.

(2) Subarticle 103-2(B) will apply to Electronic Bidding.

(3) The bid shall be accompanied by an electronic bid bond or by a bid deposit. The bid bond shall be completely and properly executed in accordance with Article 102-10. The bid deposit shall be a certified check or cashier check in accordance with Article 102-10.

(4) The bidder shall provide a Non-Collusion Certification, Debarment Certification and Gift Ban Certification in accordance with Articles 102-2 and 102-9.

(5) All addenda and attachments will be considered part of the bid.

(6) All bids shall be submitted with an electronically affixed digital signature. Affixing a digital ID to the bid shall be the equivalent of signing before a notary public.

(7) By submitting an electronic bid, the bidder certifies that he has read, understands, accepts, acknowledges and agrees to comply with all statements, conditions and specifications in the electronic bid submittal.

(8) Bids will be decrypted, opened, printed to paper and read publicly in accordance with Article 102-13.

(9) The Contractor shall submit a fully executed Execution of Contract, signature sheet and payment and performance bonds within 14 calendar days of receipt of award letter in accordance with Article 102-10.

102-9 NON-COLLUSION CERTIFICATION, DEBARMENT CERTIFICATION AND GIFT BAN CERTIFICATION

(A) General

Prime Contractors and lower tier participants in each transaction involving public funds shall execute a Non-Collusion Certification, Debarment Certification and Gift Ban Certification. Transactions that require certifications from lower tier participants are:

(1) Transactions between a Prime Contractor and a person, other than for a procurement contract, for goods or services, regardless of type.

(2) Procurement contracts for goods and services, between a prime contractor and a person, regardless of type, expected to equal or exceed the Federal small purchase threshold fixed at 10 U.S.C. 3205 under a prime contract.

(3) Procurement contracts for goods or services between a prime contractor and a person, regardless of the amount, under which that person will have a critical influence on or substantive control over the transaction. Such persons include, but are not limited to, bid estimators and contract managers.

The certifications for both the Prime Contractor and the lower tier participants shall be on a form furnished by the Department to comply with Federal Highway Administration requirements, as published in 49 CFR Part 29. The Prime Contractor is responsible for obtaining the certifications from the lower tier participants and is responsible for keeping them as part of the contract records.

(B) Non-Collusion Certification

In compliance with applicable Federal and State laws and regulations, each and every bidder shall furnish the Department with a form certifying that the bidder has not entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with his bid on the project. The certification shall conclusively indicate that the bidder intends to do the work with its own bona fide employees or subcontractors and is not bidding for the benefit of another contractor.

(C) Debarment Certification

In compliance with applicable Federal and State laws and regulations, each and every bidder shall furnish the Department with a debarment certification, stating that he is not debarred, or if he is debarred, an explanation shall be included. The explanation will not necessarily result in denial of participation in a contract. Failure to furnish a certification or an explanation will be grounds for rejection of a bid. If the prequalified bidder's status changes, he shall immediately submit a new fully executed debarment certification with an explanation of the change.

Failure to have a fully executed *Non-Collusion Certification*, *Debarment Certification* and *Gift Ban Certification* on file in the Contractual Services Office before submitting bids will cause those bids to be non-responsive.

(1) Paper Bid

Execution of Bid, *Non-Collusion Certification*, *Debarment Certification* and *Gift Ban Certification* forms will be included in the proposal as part of the signature sheets. Execution of the signature sheets will constitute *Execution of the Bid*, *Non-Collusion Certification*, *Debarment Certification* and *Gift Ban Certification*.

(2) Electronic Bids

The prequalified bidder shall have a fully executed *Non-Collusion Certification*, *Debarment Certification* and *Gift Ban Certification* on file in the Contractual Services Office before submitting his bid. Forms may be downloaded from the Department's website.

The bidder shall provide a *Debarment Certification* in the electronic bid submittal. If a bidder cannot provide the *Debarment Certification* required, he shall provide an explanation in the electronic submittal.

Within 14 calendar days after notice of award is received by him, the successful bidder shall submit a fully executed *Execution of Contract*, *Non-Collusion Certification*, *Debarment Certification* and *Gift Ban Certification* signature sheet.

102-10 BID BOND OR BID DEPOSIT

Each bid shall be accompanied by a corporate bid bond or a bid deposit of a certified or cashier's check in the amount of at least 5% of the total amount bid for the contract. When a bid is secured by a bid deposit, the execution of a bid bond will not be required.

If the bidder has failed to meet all conditions of the bid bond and the Department has not received the amount due under the bid bond, the bidder may be disqualified from further bidding as provided in Article 102-15.

No bid will be considered or accepted unless accompanied by one of the foregoing securities. The bid bond shall be executed by a corporate surety licensed to do business in North Carolina. The certified check or cashier's check shall be drawn on a bank or trust company insured by the Federal Deposit Insurance Corporation. Both shall be made payable to the Department of Transportation in an amount of at least 5% of the total amount bid for the contract. The condition of the bid bond or bid deposit is: the Principal shall not withdraw its bid within 60 days after the opening of same and, if the Department shall award a contract to the Principal, the Principal shall, within 14 calendar days after the notice of award is received by him, give payment and performance bonds with good and sufficient surety as required for the faithful performance of the contract and for the protection of all persons supplying labor and materials in the prosecution of the work. In the event of the failure of the Principal to give such payment and performance bonds as required, then the amount of the bid bond shall be immediately paid to the Department as liquidated damages, or, in the case of a bid deposit, the deposit shall be forfeited to the Department.

Withdrawal of a bid due to a mistake made in the preparation of the bid, where permitted by Article 103-3, shall not constitute withdrawal of a bid as cause for payment of the bid bond or forfeiture of the bid deposit.

When a bid is secured by a bid bond, the bid bond shall be on the form furnished by the Department. The bid bond shall be executed by both the bidder and a corporate surety licensed under the laws of North Carolina to write such bonds. The execution by the bidder shall be in the same manner as required by Article 102-8 for the proper execution of the bid. The execution by the corporate surety shall be the same as is provided for by Subarticle 102-8(A)(8)(b), for the execution of the bid by a corporation. The seal of the corporate surety shall be affixed to the bid bond. The *bid bond form* furnished is for execution of the corporate surety by a General Agent or Attorney in Fact. A certified copy of the Power of Attorney shall be attached if the bid bond is executed by a General Agent or Attorney in Fact. The Power of Attorney shall contain a certification that the Power of Attorney is still in full force and effect as of the date of the execution of the bid bond by the General Agent or Attorney in Fact. If the bid bond is executed by the corporate surety, the President, Vice President or Assistant Vice President, and attested to by the Secretary or Assistant Secretary, then the *bid bond form* furnished shall be modified for such execution, instead of execution by the Attorney in Fact or the General Agent.

An electronic corporate surety bid bond for at least 5% of the total amount bid shall accompany each electronic bid, or the Contractor may submit a certified check or cashier's check instead of an electronic bid bond. The certified check or cashier's check shall be for at least 5% of the total amount bid, shall be received by 5:00 p.m. the last business day before the bid letting and shall be delivered to the Contract Officer at the address shown in the Invitation to Bid.

Contact a bond management company to acquire the necessary service to submit an electronic bid bond that is compatible with the Department's approved electronic bidding software.

102-11 DELIVERY OF BIDS

Paper Bids shall be delivered before the time and place specified in the contract. Bids received after such time will not be accepted and will be returned to the bidder unopened.

Electronic Bids shall be submitted via approved Department electronic bidding software in accordance with Article 102-8.

102-12 WITHDRAWAL OR REVISION OF BIDS

(A) Paper Bid

A bidder may, without prejudice to himself, withdraw a paper bid after it has been delivered to the Department, provided the request for such withdrawal is made, in writing, to the Contract Officer before the date and time set for the opening of bids. The bidder may then submit a revised bid provided it is received before the time set for opening of bids.

Only those persons authorized to sign bids under the provisions of Subarticle 102-8(A)(8) shall be recognized as being qualified to withdraw a bid.

(B) Electronic Bid

An electronic bid may be changed and resubmitted as many times as desired before the advertised bid opening time specified in the Invitation to Bid. The latest time stamped electronically submitted bid before the advertised bid opening time will constitute the bid.

Withdrawal of a bid after the date and time set for the opening of bids will be permitted only in accordance with Article 103-3.

102-13 RECEIPT AND OPENING OF BIDS

A bid will be received and opened from any bidder who:

(A) Is prequalified in accordance with the provisions of Article 102-2 and

(B) Has delivered the bid to the place indicated in the contract before the time indicated in the Invitation to Bid.

(1) Paper Bids will be opened and read publicly at the time and place indicated in the Invitation to Bid.

(2) Electronic Bids will be decrypted, opened, printed to paper and read publicly at the time and place specified in the Invitation to Bid.

Bidders, their authorized agents and other interested parties are invited to be present.

A bid received from a bidder who has not complied with the above requirements will under no circumstances be considered for award.

In the event of technical difficulties or adverse weather conditions, the Department reserves the right to postpone the reading of bids past the advertised bid opening time and date.

102-14 REJECTION OF BIDS

Any bid submitted that fails to comply with any of the requirements of Articles 102-8, 102-9 and 102-10 shall be considered irregular and may be rejected.

Irregularities due to apparent clerical errors and omissions may be waived in accordance with Article 103-2.

Any bid including any unit or lump sum bid price that is unbalanced to the potential detriment of the Department will be considered irregular and may be rejected. In the event the Board determines it is in the best public interest to accept such irregular bid, it may award the contract based on such bid subject to Subarticle 109-4(C).

All bidders shall comply with all applicable laws regulating the practice of general contracting as contained in Chapter 87 of the General Statutes of North Carolina, except where waived by the Department by project special provision for certain specialty work. Bidders shall comply with all other applicable laws regulating the practices of electrical, plumbing, heating and air conditioning and refrigeration contracting as contained in Chapter 87 of the General Statutes of North Carolina.

(A) State Funded Projects

The bidder shall be licensed by the North Carolina Licensing Board for General Contractors where the bid is $30,000 or more. Bids received from bidders not meeting this requirement will be considered non-responsive and will not be considered for award.

(B) Federal Aid Projects

The bidder is not required to be licensed by the North Carolina Licensing Board for General Contractors to place a bid of $30,000 or more. However, a project may not be awarded until the bidder provides evidence that the appropriate General Contractor license has been obtained. The license shall be obtained within 60 days of bid opening or the project may be awarded to another bidder or all bids rejected. No contract time extension will be considered for delays associated with obtaining a license.

The right to reject any and all bids shall be reserved to the Department.

102-15 DISQUALIFICATION OF CONTRACTORS OR SUBCONTRACTORS

Any one of the following causes may be justification for disqualifying a Contractor from further bidding, or a Subcontractor from performing work, until he has applied for and has been requalified in accordance with Article 102-2 as applicable:

(A) Unsatisfactory progress in accordance with Article 108-8.

(B) Being declared in default in accordance with Article 108-9.

(C) Uncompleted contracts which, in the judgment of the Engineer, might hinder or prevent the timely completion of additional work if awarded.

(D) Failure to comply with prequalification requirements.

(E) The submission of more than one bid for the same contract by individuals, partnerships, joint ventures, LLCs or corporations whom the Department determines are under sufficient common ownership and management control to warrant the firms be considered a single entity.

(F) Evidence of collusion among bidders. Each participant in such collusion will be disqualified.

(G) Failure to furnish a Non-Collusion Certification, Debarment Certification or Gift Ban Certification upon request.

(H) Failure to comply with Article 108-6.

(I) Failure to comply with a written order of the Engineer as provided in Article 105-1, if in the judgment of the Engineer, such failure is of sufficient magnitude to warrant disqualification.

(J) Failure to satisfy the Minority, Women or Disadvantaged Business Enterprise requirements of the project special provisions.

(K) The Department has not received the amount due under a forfeited bid bond or under the terms of a performance bond.

(L) Failure to submit the documents required by Article 109-10 within 60 days after request by the Engineer.

(M) Failure to return overpayments as directed by the Engineer.

(N) Failure to maintain a satisfactory safety index as required by Article 102-2.

(O) Failure to restrict a former Department employee as prohibited by Article 108-5.

(P) False information submitted on any application, statement, certification, reports, records or reproduction.

(Q) Conviction of any employee of the company, of any applicable state or federal law, may be fully imputed to the business firm with which he is or was associated or by whom he was employed or with the knowledge or approval of the business firm or there after ratified by it.

(R) Being debarred from performing work with other Federal, State and city agencies.

(S) Failure to perform guaranty work within the terms of the contract.

(T) Failure to make prompt payment in accordance with Article 109-4.

Upon a determination that a contractor or subcontractor should be disqualified for one or more of the reasons listed above, the Department may, at its discretion, remove all entities which are considered as a single entity as described in Subarticle 102-15(E).

SECTION 103
AWARD AND EXECUTION OF CONTRACT

103-1 CONSIDERATION OF BIDS

After the bids are opened and read, they will be compared on the basis of the summation of the products of the quantities shown in the bid schedule by the unit bid prices. The results of such comparisons will be immediately available to the public. In the event of errors, omissions, or discrepancies in the bid prices, corrections to the bid prices will be made in accordance with Article 103-2. Such corrected bid prices will be used for the comparison and consideration of bids.

The right is reserved to reject any or all bids, to waive technicalities, to request the low bidder to submit an up-to-date financial and operating statement, to advertise for new bids or to proceed to do the work otherwise, if in the judgment of the Department, the best interests of the State will be promoted thereby.

103-2 CORRECTION OF BID ERRORS

The provisions of this article shall apply in waiving irregularities and correcting apparent clerical errors and omissions in the unit bid price and the amount bid for bid items.

(A) Paper Bid

(1) Omitted Unit Bid Price--Amount Bid Completed--Quantity Bid on is One Unit

In the case of a bid item for which the amount bid is completed, but the unit bid price is omitted and the quantity shown in the proposal for the bid item is only one unit, the unit bid price shall be deemed to be the same as the amount bid for that bid item and shall constitute the contract unit price for that bid item.

(2) Omitted Unit Bid Price--Amount Bid Completed--Quantity Bid on is More Than One Unit

In the case of a bid item for which the amount bid is completed (extension of the unit bid price by the quantity) but the unit bid price is omitted and the quantity shown in the proposal for the bid item is more than one unit, the unit bid price shall be deemed to be the amount derived by dividing the amount bid for that item by the quantity shown in the proposal for that bid item and shall constitute the contract unit price for that bid item.

(3) Discrepancy in the Unit Bid Price and the Amount Bid

In the case of a bid item in which there is a discrepancy between the unit bid price and the extension for the bid item (amount bid), the unit bid price shall govern.

As an exception to the above, on bids for contracts not funded with any federal funds, the extension for the bid item (amount bid) shall govern when the discrepancy consists of an obvious clerical mistake in the unit bid price consisting of the

misplacement of a decimal point. The correction to the unit bid price will be made only when the following two conditions are met:

(a) The corrected unit bid price multiplied by the quantity equals the amount bid for the bid item.

(b) The corrected unit bid price is closer to the average of the Engineer's estimate and the individual bids for the contract item than the uncorrected unit bid price.

(4) Omitted Unit Bid Price and Omitted Amount Bid--Deemed Zero Bid

(a) State Funded Projects

In the case of omission of the unit bid price and the omission of the amount bid for any one item except Mobilization and, in the case of the omission of the amount bid where a lump sum price is called for, the amount bid and the unit bid price shall be deemed to be zero where the value of the omitted amount bid is 1% or less of the total amount bid for the entire project (excluding the omitted item). The value of the omitted amount bid will be derived by determining the average of the Engineer's estimate and the individual bids for that contract item.

Where the unit bid price is deemed to be zero as provided in this subarticle, such zero unit bid price shall constitute the contract unit price for the affected bid item.

Where the amount bid for a lump sum bid item is deemed to be zero except Mobilization, as provided in this subarticle, such zero amount bid shall constitute the contract lump sum price for that bid item.

In the case of omission of the amount bid for Mobilization, the bid shall be deemed irregular and may be rejected.

(b) Federally Funded Projects

In the case of omission of the unit bid price and the omission of the amount bid for any one item and, in the case of the omission of the amount bid where a lump sum price is called for, the bid will be considered nonresponsive and will not be considered for award.

(5) Unit Bid Prices Containing More Than Four Decimal Places

In the case of a Bid Item for which the amount bid contains more than 4 decimal places for the Unit Bid Price, only the whole number and the first 4 decimal places shall constitute the Contract Unit Price for that Bid Item.

(6) Do not enter zero (0) in any unit price field unless zero is the intended bid for that item. Zero will be considered a valid bid. However, where zeros are entered for items that are authorized alternates to those items for which a non-zero bid price has been submitted, zeros will be deemed invalid.

(7) When the proposal allows alternate bids, the bidder shall submit a unit or lump sum price for every item in the proposal other than items that are authorized alternates to those items for which a bid price has been submitted. Where the bidder submits a unit price other than zero for all items of an authorized alternate, the Department will determine the lowest total price based on the alternate bid.

(B) Electronic Bids

(1) Enter a unit price in schedule of items. Totals will be generated automatically.

(2) Data incorrectly entered may not be recognized, and the bid item may remain blank until entered correctly.

(3) Enter no more than 4 decimal places for unit price.

(4) Do not enter zero (0) in any unit price field unless zero is the intended bid for that item. Zero will be considered a valid bid. However, where zeros are entered for items that are authorized alternates to those items for which a non-zero bid price has been submitted, zeros will be deemed invalid.

(5) When the proposal allows alternate bids, the bidder shall submit a unit or lump sum price for every item in the proposal other than items that are authorized alternates to those items for which a bid price has been submitted. Where the bidder submits a unit price other than zero for all items of an authorized alternate, the Department will determine the lowest total price based on the alternate bid.

(6) Omitted Unit Bid Price and Omitted Amount Bid--Deemed Zero Bid

(a) State Funded Projects

In the case of omission of the unit bid price and the omission of the amount bid for any one item except Mobilization and, in the case of the omission of the amount bid where a lump sum price is called for, the amount bid and the unit bid price shall be deemed to be zero where the value of the omitted amount bid is 1% or less of the total amount bid for the entire project (excluding the omitted item). The value of the omitted amount bid will be derived by determining the average of the Engineer's estimate and the individual bids for that contract item.

Where the unit bid price is deemed to be zero as provided in this subarticle, such zero unit bid price shall constitute the contract unit price for the affected bid item.

Where the amount bid for a lump sum bid item is deemed to be zero except Mobilization, as provided in this subarticle, such zero amount bid shall constitute the contract lump sum price for that bid item.

In the case of omission of the amount bid for Mobilization, the bid shall be deemed irregular and may be rejected.

(b) Federally Funded Projects

In the case of omission of the unit bid price and the omission of the amount bid for any one item and, in the case of the omission of the amount bid where a lump sum price is called for, the bid will be considered nonresponsive and will not be considered for award.

103-3 WITHDRAWAL OF BIDS—MISTAKE

(A) Criteria for Withdrawal of Bid

The Department of Transportation may allow a bidder submitting a bid pursuant to NCGS § 136-28.1 for construction or repair work to withdraw his bid after the scheduled time of bid opening upon a determination that:

(1) A mistake was in fact made in the preparation of the bid.

(2) The mistake in the bid is of a clerical or mathematical nature and not one of bad judgment, carelessness in inspecting the work site or in reading the contract.

(3) The mistake is found to be made in good faith and was not deliberate or by reason of gross negligence.

(4) The amount of the error or mistake is equal to or greater than 3% of the total amount bid.

(5) The notice of mistake and request for withdrawal of the bid by reason of the mistake is communicated to the Engineer within 48 hours after the scheduled time of bid opening. Upon proper notification of a mistake and request for withdrawal of bid,

the bidder shall submit within 48 hours written notice of mistake accompanied by copies of bid preparation information to the Engineer. The notification of a mistake, request for withdrawal of bid and copies of bid preparation information shall be submitted to the State Contract Officer or Engineer.

(6) The Department will not be prejudiced or damaged except for the loss of the bid.

(B) Hearing by the Engineer

If a bidder files a notice of mistake along with a request to withdraw his bid, the Engineer will promptly hold a hearing thereon. The Engineer will give to the requesting bidder reasonable notice of the time and place of any such hearing. The bidder may appear at the hearing and present the original working papers, documents or materials used in the preparation of the bid sought to be withdrawn, together with other facts and arguments in support of his request to withdraw his bid. The bidder shall be required to present a written affidavit that the documents presented are the original, unaltered documents used in the preparation of the bid.

(C) Action by Chief Engineer

A determination may be made by the Chief Engineer that the bidder meets the criteria for withdrawal of the bid as set forth in Subarticle 103-3(A) upon presentation of clear and convincing evidence by the bidder. The Engineer will present his findings to the Chief Engineer for action on the bidder's request. The Engineer will advise the bidder of the Chief Engineer’s decision before the Department's consideration of award.

(D) Bid Bond

If a bid mistake is made and a request to withdraw the bid is made, the bid bond shall continue in full force and effect until there is a determination by the Chief Engineer that the conditions in Subarticle 103-3(A) have been met. The effect of the refusal of the Contractor to give payment and performance bonds within 14 calendar days after the notice of award is received by him, if award has been made by the Department after consideration and denial of the Contractor's request to withdraw his bid, shall be governed by the terms and conditions of the bid bond.

103-4 AWARD OF CONTRACT

(A) General

The lowest responsible bidder will be notified by letter that his bid has been accepted and that he has been awarded the contract. This letter shall constitute the notice of award. Where award is to be made, the notice of award will be issued within 60 days after the opening of bids; except with the consent of the lowest responsible bidder, the decision to award or execute the contract may be delayed for as long a time as may be agreed upon by the Department and such bidder. In the absence of such agreement, the lowest responsible bidder may withdraw his bid at the expiration of the 60 days without penalty if no notice of award has been issued.

Award of a contract involving any unbalanced bid price may be made in accordance with Article 102-14.

(B) Award Limits

A bidder who desires to bid on more than one project on which bids are to be opened in the same letting and who desires to avoid receiving an award of more projects than he is equipped to handle, may bid on any number of projects but may limit the total amount of work awarded to him on selected projects by completing the form *Award Limits on Multiple Projects* for each project subject to the award limit. In the event that a bidder is the lowest responsible bidder on projects subject to the award limit and the value of such projects is more than the award limit established by such bidder, the Department will not award such bidder projects from among those subject to the award limit which have

a total value exceeding the award limit. The projects to be awarded to the bidder will be those projects on which award will result in the lowest total cost to the Department.

In determining the lowest total cost to the Department, the options of rejecting a bid or readvertising for new bids may be considered.

All bids submitted without the properly executed form *Award Limits on Multiple Projects* will not be subject to the award limit. In the event that there is a discrepancy between the completed award limit forms submitted by the same bidder for the different projects in a letting, the Department reserves the right to declare all such award limit forms invalid or to make such interpretation of the discrepancy as may be in the best interests of the Department. However, the presence of such discrepancy shall not be reason for declaring any bid irregular nor shall it invalidate the conditions of his bid bond or bid deposit.

Where a prequalified Contractor bids individually (as opposed to a Joint Venture) on one or more projects and bids on one of more projects as part of a Joint Venture, such individual bidder and such Joint Venture will be considered separate bidders in applying the provisions of this article.

(1) Paper Bids

This form will be bound within each proposal. This form will not be effective unless the amount is filled in and the form is properly signed.

(2) Electronic Bids

This form is located in the electronic submittal file. The bidder shall click on yes or no to indicate whether or not the bidder desires to limit the award.

103-5 CANCELLATION OF AWARD

The Department reserves the right to rescind the award of a contract for any reason at any time before the receipt of the properly executed contract bonds from the successful bidder.

103-6 RETURN OF BID BOND OR BID DEPOSIT

Checks that have been furnished as a bid deposit by all bidders, other than the 3 lowest responsible bidders, will be retained not more than 10 calendar days after the date of opening of bids. After the expiration of such period, the checks that were furnished as a bid deposit will be returned to all bidders other than the 3 lowest responsible bidders.

Checks that have been furnished as a bid deposit by the 3 lowest responsible bidders will be retained until after the contract bonds have been furnished by the successful bidder at which time the checks that were furnished as a bid deposit will be returned to the 3 lowest responsible bidders.

Paper bid bonds will be retained by the Department until the contract bonds are furnished by the successful bidder after which all such bid bonds will be destroyed unless the individual *bid bond form* contains a note requesting that it be returned to the bidder or the Surety.

103-7 CONTRACT BONDS

The successful bidder, within 14 calendar days after the notice of award is received by him, shall provide the Department with a contract payment bond and a contract performance bond each in an amount equal to 100% of the amount of the contract. All bonds shall be in conformance with NCGS § 44A-33. The corporate surety furnishing the bonds shall be authorized to do business in the State.

103-8 EXECUTION OF CONTRACT

As soon as possible following receipt of the properly executed contract bonds, the Department will complete the execution of the contract, retain the original contract and return one copy of the contract to the Contractor.

103-9 FAILURE TO FURNISH CONTRACT BONDS

The successful bidder's failure to file acceptable bonds within 14 calendar days after the notice of award is received by him shall be just cause for the forfeiture of the bid bond or bid deposit and rescinding the award of the contract. Award may then be made to the next lowest responsible bidder or the work may be readvertised and constructed under contract or otherwise, as the Department may decide.

SECTION 104
SCOPE OF WORK

104-1 INTENT OF CONTRACT

The intent of the contract is to prescribe the work or improvements that the Contractor undertakes to perform, in full compliance with the contract. In case the method of construction or character of any part of the work is not covered by the plans, these specifications shall apply. The Contractor shall perform all work in accordance with the lines, grades, typical sections, dimensions and other data shown in the plans, or that may be modified by written orders and shall do such additional, extra and incidental work as may be considered necessary to complete the work to the full intent of the plans and specifications. Unless otherwise provided in the contract, the Contractor shall furnish all implements, machinery, equipment, tools, materials, supplies, transportation and labor necessary for the prosecution and completion of the work.

104-2 SUPPLEMENTAL AGREEMENTS

Whenever it is necessary to make amendments to the contract to satisfactorily complete the proposed construction or to provide authorized time extensions, the Engineer shall have the authority to enter into a supplemental agreement covering such amendments.

Supplemental agreements shall become a part of the contract when executed by the Engineer and an authorized representative of the Contractor. The Contractor shall file with the Engineer a copy of the name or names of his representatives who are authorized to sign supplemental agreements.

104-3 ALTERATIONS OF PLANS OR DETAILS OF CONSTRUCTION

The Engineer reserves the right to make, at any time during the progress of the work, such alterations in the plans or in the details of construction as may be found necessary or desirable. Under no circumstances will an alteration involve work beyond the termini of the proposed construction except as may be necessary to satisfactorily complete the project. Such alterations shall not invalidate the contract nor release the Surety, and the Contractor agrees to perform the work as altered at his contract unit or lump sum prices the same as if it had been a part of the original contract except as otherwise herein provided.

An adjustment in the affected contract unit or lump sum prices due to alterations in the plans or details of construction that impacts the controlling operation and materially changes the character of the work and the cost of performing the work will be made by the Engineer only as provided in this article.

If the Engineer makes an alteration in the plans or details of construction, which he determines will materially change the character of the work and the cost of performing the work, an adjustment will be made and the contract modified in writing accordingly. The Contractor will be paid for performing the affected work in accordance with Subarticle 104-8(A).

When the Contractor is required to perform work that is, in his opinion, an alteration in the plans or details of construction that materially changes the character of the work and the cost of performing the work, he shall notify the Engineer in writing before performing such work. The Engineer will investigate and, based upon his determination, one of the following will occur:

(A) If the Engineer determines that the affected work is an alteration of the plans or details of construction that materially changes the character of the work and the cost of performing the work, the Contractor will be notified in writing by the Engineer and compensation will be made in accordance with Subarticle 104-8(A).

(B) If the Engineer determines that the work is not such an alteration in the plans or details of construction that materially changes the character of the work and the cost of performing the work, he will notify the Contractor in writing of his determination. If the Contractor, upon receipt of the Engineer's written determination, still intends to file a claim for additional compensation by reason of such alteration, he shall notify the Engineer in writing of such intent before beginning any of the alleged altered work, and the provisions of Subarticle 104-8(B) shall be strictly adhered to.

No contract adjustment will be allowed under this article for any effects caused on unaltered work.

If the Contractor elects to file a written claim or requests an extension of contract time, it shall be submitted on the *Contractor Claim Submittal Form* available through the Construction Unit on the Department's website.

104-4 SUSPENSIONS OF WORK ORDERED BY THE ENGINEER

(A) Suspensions of the Work Ordered by the Engineer

When the Engineer suspends in writing the performance of all or any portion of the work for a period of time not originally anticipated, customary or inherent to the construction industry and the Contractor believes that additional compensation for idle equipment or labor is justifiably due as a result of such suspension, the Contractor shall notify the Engineer in writing of his intent to file a claim for additional compensation within 7 calendar days after the Engineer suspends the performance of the work and the provisions of Subarticle 104-8(C) shall be strictly adhered to.

Within 14 calendar days of receipt by the Contractor of the notice to resume work, the Contractor shall submit his claim to the Engineer in writing on the *Contractor Claim Submittal Form* available through the Construction Unit on the Department's website. Such claim shall set forth the reasons and support for such adjustment in compensation including cost records and any other supporting justification in accordance with Subarticle 104-8(C).

(B) Alleged Suspension

If the Contractor contends he has been prevented from performing all or any portion of the work for a period of time not originally anticipated, customary or inherent to the construction industry because of conditions beyond the control of and not the fault of the Contractor, its suppliers or subcontractors at any tier and not caused by weather, but the Engineer has not suspended the work in writing, the Contractor shall submit to the Engineer a written notice of intent to file a claim for additional compensation by reason of such alleged suspension. No adjustment in compensation will be allowed for idle equipment or labor before the time of the submission of the written notice of intent to file a claim for additional compensation by reason of such alleged suspension. Upon receipt, the Engineer will evaluate the Contractor's notice of intent to file a claim for additional compensation. If the Engineer agrees with the Contractor's contention, the Engineer will suspend in writing the performance of all or any portion of the work, and Subarticle 104-8(C) shall be strictly adhered to.

If the Engineer does not agree with the Contractor's contention as described above and determines that no portion of the work should be suspended, he will notify the Contractor in writing of his determination. If the Contractor does not agree with the Engineer's determination, Subarticle 104-8(C) shall be strictly adhered to. Within 14 calendar days after the last day of the alleged suspension, the Contractor shall submit his claim to the

Engineer in writing on the *Contractor Claim Submittal Form* available through the Construction Unit on the Department's website. Such claim shall set forth the reasons and support for such adjustment in compensation, including cost records and any other supporting justification in accordance with Subarticle 104-8(C).

(C) Conditions

No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B) for any reason whatsoever for each occurrence of idle equipment or idle labor that has a duration of 24 hours or less.

No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B) to the extent that performance would have been suspended by any other cause or for which an adjustment is provided for or excluded under any other term or condition of the contract.

No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B) for any effects caused on unchanged work. No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B) except for idle equipment or idle labor resulting solely from the suspension of work in writing by the Engineer.

No adjustment in compensation will be allowed under Subarticles 104-4(A) and 104-4(B) where temporary suspensions of the work have been ordered by the Engineer in accordance with Article 108-7 and the temporary suspensions are a result of the fault or negligence of the Contractor.

104-5 OVERRUNS AND UNDERRUNS OF CONTRACT QUANTITIES

(A) General

The Engineer reserves the right to make at any time during the work such changes in quantities as are necessary to satisfactorily complete the project. Such changes in quantities shall not invalidate the contract, nor release the Surety, and the Contractor agrees to perform the work as changed. The Engineer will notify the Contractor in writing of the significant changes in the quantities.

The Contractor will be entitled to an adjustment in contract unit prices for increased costs incurred over the original bid prices in performing contract items that overrun or underrun the estimated contract quantities only as provided for in this article.

(B) Overruns - Increase in Unit Price

If the actual quantity of any major contract item overruns the original bid quantity by more than 15% of such original bid quantity, or the actual quantity of any minor contract item overruns the original bid quantity by more than 100% of such original bid quantity, an increase to the contract unit price, excluding loss of anticipated profits, may be authorized by the Engineer. Revised contract unit prices pertaining to overruns will be applicable only to that portion of the overrun that is in excess of the percentages stated above.

(1) Whenever it is anticipated that an overrun in a major or minor contract item in excess of that described above will occur, the Contractor may make written request for a revision to contract unit prices. It shall be incumbent upon the Contractor to justify the request for a revision to contract unit prices. After reviewing the Contractor's request, the Engineer will notify the Contractor of his determination as follows:

(a) If the Engineer determines a revision to the contract unit price is justified and the Engineer and the Contractor are in agreement as to the revision to be made to the contract unit price, a supplemental agreement covering the revised contract unit price will be consummated before performing work on that quantity in excess of the percentage set forth above.

If the Engineer determines a revision to the contract unit price is justified and the Engineer and the Contractor are not in agreement as to the revision to be made to the contract unit price, the Engineer will issue a force account notice before performing work on that quantity in excess of the percentage set forth above.

(b) If the Engineer determines a revision to the contract unit price is not justified he will notify the Contractor of his determination in writing and payments will be made for the work at the contract unit price. Upon completion of the work, the Contractor may request an adjustment to the contract unit price as provided below.

(2) Whenever an overrun in a contract item in excess of the percentages previously set forth has occurred and a supplemental agreement establishing an increase to the contract unit price has not been executed or the Engineer has not issued a force account notice, the Contractor may make written request for a revision in the original contract unit price. Any adjustment to the contract unit prices due to overruns will be made by the Engineer based upon his evaluation and comparison of the Contractor's documented cost records of the contract unit prices for those contract items. The Contractor's documented cost records for the work performed on those quantities beyond the percentages stated above shall be kept in accordance with Article 109-3. The Contractor's cost records and supporting data shall be complete in every respect and in such form that they can be checked. It shall be incumbent upon the Contractor to satisfy the Engineer of the validity of any request presented by the Contractor for an adjustment to the contract unit price. After reviewing the Contractor's request, the Engineer can make such adjustment as he deems warranted based upon his engineering judgment and the payment to the Contractor will be made accordingly.

(C) Underruns - Increase in Unit Price

If the actual quantity of any major contract item underruns the original bid quantity by more than 15% of such original bid quantity, an increase to the contract unit price, excluding loss of anticipated profit, may be authorized by the Engineer. Revised contract unit prices pertaining to underruns of major contract items will be applicable to the entire quantity of the contract item that underruns. No revision will be made to the contract unit price for any minor contract item that underruns the original bid quantities.

(1) Whenever it is anticipated that an underrun in a major contract item in excess of that described above will occur, the Contractor may make written request for a revision to the contract unit price. If the Engineer and the Contractor are in agreement as to the revision to be made to the contract unit price, then a supplemental agreement covering the revised unit price will be entered into. If the Engineer and the Contractor are not in agreement, then after performance of the work, a revised unit price may be determined as described below.

(2) Whenever an underrun in a major contract item in excess of the percentage previously set forth has occurred and a supplemental agreement establishing an increase to the contract unit price has not been executed, the Contractor may make written request for a revision to the original contract unit price. The Contractor shall submit sufficient documentation and analysis of his costs to satisfy the Engineer of any non-recovered costs included in the item that underran. Any adjustment to the contract unit prices due to underruns will be made by the Engineer based upon his evaluation of the Contractor's documentation and an analysis showing how changes in contract item cost are attributable to the underrun. An analysis of costs shall be supplemented with the Contractor's documented cost records for work performed on the total quantity of the affected item where the Contractor's request for compensation includes compensation for costs other than recovered fixed costs.

The Contractor's cost records shall be complete in every respect and in such form that the Engineer can check them. It shall be incumbent upon the Contractor to satisfy the Engineer of the validity of any request presented by the Contractor for adjustment to the contract unit price. After reviewing the Contractor's request, the Engineer may make such adjustment as he deems warranted, based upon his engineering judgment. Payment will be made on the final estimate. The total payment, including any additional compensation granted by the Engineer due to an underrun in a major contract item, shall not exceed the payment that would have been made for the performance of 100% of the original contract quantity at the original contract unit price.

Where non-stock fabricated materials are involved in minor items that underrun or in major items that underrun by less than 15%, and where fabrication of such material has begun or been completed before the Contractor is advised of the reduction in the quantity of the pay item, the Department will reimburse the Contractor for the verified fabrication cost, including the cost of material less salvage value, or it may instruct the Contractor to have the fabricated material delivered to a site designated by the Engineer and make payment for such material in accordance with Article 109-6.

(D) Overruns and Underruns - Reduction In Unit Price

Whenever it is anticipated that an overrun or underrun in a major contract item in excess of 15% or an overrun in a minor contract item in excess of 100% will occur, the Engineer may make written request for a reduction to the contract unit price. If the Engineer and the Contractor are in agreement as to the decrease to be made to the contract unit price, a supplemental agreement covering the revised unit price will be consummated before beginning work on that quantity in excess of the allowable percentages. If the Engineer and the Contractor are not in agreement as to the decrease to be made, the Contractor will be directed to perform the affected work on a force account basis. Payment for the affected work will be made based upon force account records kept in accordance with Article 109-3 but shall not exceed that payment that would have been made at the original contract unit price.

104-6 ELIMINATED CONTRACT ITEMS

The Engineer may eliminate any item from the contract, and such action will in no way invalidate the contract. In the event the item of work involves pre-fabricated materials that are not considered to be stock items and fabrication of such material is begun or completed before the Contractor is advised of the elimination of the contract item, the Department may reimburse the Contractor for the verified fabrication cost including the cost of materials less salvage value or may instruct the Contractor to have the fabricated material delivered to a site designated by the Engineer and make payment for such material in accordance with Article 109-6.

If the Contractor has partially completed a contract item before notification of the elimination of such item, the Department will reimburse the Contractor for the verified actual cost of the partially completed work not to exceed the payment that would have been made at the contract unit or lump sum price for the completed work.

No payment will be made for loss of anticipated profits, and no other allowance will be made for eliminated items except as listed above.

104-7 EXTRA WORK

The Contractor shall perform extra work whenever it is deemed necessary or desirable to complete fully the work as contemplated. Extra work, as defined in Section 101, shall be performed in accordance with the contract and as directed. No extra work shall be commenced before specific authorization for the performance of such extra work being given by the Engineer.

Extra work that is specifically authorized by the Engineer will be paid in accordance with Subarticle 104-8(A).

When the Contractor is required to perform work that is, in his opinion, extra work, he shall notify the Engineer in writing before performing such work. The Engineer will investigate and, based upon his determination, one of the following will occur.

(A) If the Engineer determines that the affected work is extra work, the Contractor will be notified in writing by the Engineer and compensation will be made in accordance with Subarticle 104-8(A).

(B) If the Engineer determines that the work is not extra work, he will notify the Contractor in writing of his determination. If the Contractor upon receipt of the Engineer's written determination intends to file a claim for additional compensation by reason of such work, he shall notify the Engineer in writing of such intent before beginning any of the alleged extra work and in conformance with Subarticle 104-8(B).

Work performed without prior written consent of the Engineer will be considered incidental to the work of the contract.

If the Contractor elects to file a written claim or requests an extension of contract time, it shall be submitted on the *Contractor Claim Submittal Form* available through the Construction Unit.

104-8 COMPENSATION AND RECORD KEEPING

(A) Compensation for Articles 104-3 or 104-7

When the Engineer and Contractor agree that compensation is due under Articles 104-3 or 104-7, payment will be made in accordance with one of the following:

(1) When the Engineer and the Contractor agree to the prices to be paid, the agreement will be set forth in a supplemental agreement. If the estimated total cost of the affected work is equal to or less than $25,000 and the prices for performing the work have been mutually agreed to, the Contractor may begin work before executing the supplemental agreement. If the estimated total cost of the affected work is more than $25,000, the Contractor shall not begin the affected work until the supplemental agreement is executed.

(2) When the Engineer and the Contractor cannot agree to the prices to be paid for the affected work, the Engineer will issue a force account notice before the Contractor begins work. In this instance the affected work shall be performed as directed by the Engineer and paid in accordance with Article 109-3.

(B) Claim for Additional Compensation

The Contractor's notice of intent to file a claim for additional compensation under Articles 104-3 and 104-7 shall be given to the Engineer in writing. The Contractor shall keep accurate and detailed cost records in accordance with Article 109-3. The Contractor's cost records and supporting data shall be complete in every respect and in such form that they may be checked by the Engineer. The Contractor's cost records and supporting data shall clearly indicate the cost of performing the work in dispute and shall separate the cost of any work for which payment has been made. The Contractor's cost records shall be kept up to date and the Engineer shall be given the opportunity to review the methods by which the records are being maintained. The cost records shall be prepared weekly for each occurrence for which notice of intent to file a claim has been given and submitted to the Engineer within 7 calendar days after the end of a given weekly period.

If the Contractor chooses to pursue the claim after the disputed work is complete, he shall submit a written claim to the Engineer for an adjustment in compensation based upon his cost records within 120 calendar days after completion of the disputed work. This claim

shall summarize previously submitted cost records and clearly describe the Contractor's justification for an adjustment in compensation under the terms of the contract. The claim shall be accompanied by a certification from an officer of the company or person authorized to execute supplemental agreements, stating that the claim is truthful and accurate.

Upon receipt, the Engineer will review the Contractor's request and supporting documentation and notify the Contractor if the request is complete with all necessary supporting documentation and cost records.

If the Engineer determines that the work covered by the claim is in fact compensable under the terms of the contract, an adjustment in compensation will be made based upon the documentation presented and his engineering judgment. The adjustment will be made on the next partial pay estimate and reflected on the final estimate. The compensation allowed shall be limited to the amount that would be paid if the work was performed in accordance with Article 109-3.

If the Engineer determines that the work covered by the claim is not compensable under the terms of the contract, the claim will be denied. The Engineer will notify the Contractor of his determination whether or not an adjustment of the contract is warranted within 120 calendar days after receipt of the complete request, all necessary supporting justification and cost records.

The failure on the part of the Contractor to perform any of the following shall be a bar to recovery under Articles 104-3 or 104-7:

(1) The failure to notify the Engineer in writing before performing the work in dispute that he intends to file a claim.

(2) The failure of the Contractor to keep records in accordance with Article 109-3.

(3) The failure of the Contractor to give the Engineer the opportunity to monitor the methods by which records are being maintained.

(4) The failure of the Contractor to submit additional documentation requested by the Engineer provided documentation requested is available within the Contractor's records.

(5) The failure of the Contractor to submit cost records weekly.

(6) The failure of the Contractor to submit the written request for an adjustment in compensation with cost records and supporting information within 120 calendar days of completion of the affected work.

(C) Compensation for Article 104-4

The Contractor's notice of intent to file a claim for additional compensation under Subarticle 104-4(A) shall be given to the Engineer in writing within 7 calendar days after the Engineer suspends the performance of the work. For an alleged suspension, the Contractor's notice of intent to file a claim for additional compensation under Subarticle 104-4(B) shall be given to the Engineer in writing. The Contractor shall keep accurate and detailed records of the alleged idle equipment and alleged idle labor. The Contractor's cost records, supporting data and supporting information shall be complete in every respect and in such form that they may be checked by the Engineer. The Contractor's cost records, supporting data and supporting information for equipment idled due to the suspension or alleged suspension shall specifically identify each individual piece of equipment, its involvement in the work, its location on the project, the requested rental rate and justification as to why the equipment cannot be absorbed into unaffected work on the project during the period of suspension or alleged suspension. The Contractor's cost records, supporting data and supporting information for idle labor shall include the specific employees, classification, dates and hours idled, hourly rate of pay,

their involvement in the project and justification as to why they cannot be absorbed into the unaffected work on the project or other projects during the period of suspension or alleged suspension. The Contractor's cost records, supporting data and supporting information shall be kept up to date and the Engineer shall be given the opportunity to review the methods by which the records, data and information are being maintained. The cost records, supporting data and supporting information shall be prepared weekly for each occurrence for which notice of intent to file a claim has been given and submitted to the Engineer within 7 calendar days after the end of a given weekly period.

If the Contractor chooses to pursue the claim after the suspension or alleged suspension period has ended, he shall submit a written claim to the Engineer for an adjustment in compensation based upon his cost records due to idle equipment and/or idle labor within 14 calendar days of receipt of the notice to resume work or within 14 calendar days of expiration of the alleged suspension period. This request shall summarize previously submitted cost records and clearly describe the Contractor's justification for an adjustment in compensation under the terms of the contract.

Upon receipt, the Engineer will evaluate the Contractor's request. If the Engineer agrees that the cost of the work directly associated with the suspension or alleged suspension has increased as a result of such suspension or alleged suspension and the suspension or alleged suspension was caused by conditions beyond the control of and not the fault of the Contractor, his suppliers or subcontractors at any approved tier and not caused by weather, the Engineer will make an adjustment, excluding profit, and will modify the contract in writing accordingly. The Contractor will be paid the verified actual cost of the idle equipment and idle labor. The compensation allowed shall be limited to the equipment, labor, bond, insurance and tax costs, excluding profits, computed in accordance with Article 109-3.

If the Engineer determines that the suspensions of the work by the Engineer or alleged suspensions do not warrant an adjustment in compensation, he will notify the Contractor in writing of his determination.

The Engineer will notify the Contractor of his determination of whether or not an adjustment in compensation is warranted within 120 calendar days after receipt of the complete request, all necessary supporting justification and cost records.

The failure on the part of the Contractor to perform any of the following shall be a bar to recovery under Article 104-4:

(1) The failure to notify the Engineer in writing within 7 calendar days after the Engineer suspends in writing the performance of all or any portion of the work.

(2) The failure to notify the Engineer in writing that he intends to file a claim by reason of alleged suspension.

(3) The failure of the Contractor to keep records in accordance with the details of Article 109-3.

(4) The failure of the Contractor to give the Engineer the opportunity to monitor the methods by which records are being maintained.

(5) The failure of the Contractor to submit additional documentation requested by the Engineer provided the documentation requested is available within the Contractor's records.

(6) The failure of the Contractor to submit cost records weekly.

(7) The failure of the Contractor to submit the written request for an adjustment in compensation with cost records, supporting data and supporting information within 14 calendar days of receipt of the notice to resume work.

(8) The failure of the Contractor to submit the written request for an adjustment in compensation with cost records, supporting data and supporting information within 14 calendar days after the last day of the period during which the Contractor contends he has been prevented from performing all or any portion of the work for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) because of conditions beyond the control of, and not the fault of, the Contractor, its suppliers or subcontractors at any approved tier and not caused by weather.

(D) Notification of Determination

The failure on the part of the Engineer to notify the Contractor of his determination on the requested adjustment in compensation within 120 calendar days after receipt of the complete request, all supporting justification and cost records will result in payment of interest on any monies determined to be due from the requested adjustment in compensation. Interest, at the average rate earned by the State Treasurer on the investment within the State's Short Term Investment Fund during the month preceding the date interest becomes payable, will be paid to the Contractor on the next partial pay estimate and reflected on the final estimate for the period beginning on the 121st day after receipt of the complete request, all supporting justification and cost records, and extending to the date the Engineer makes his determination on the disputed work.

If the Contractor fails to receive such adjustment in compensation for the disputed work as he claims to be entitled to under the terms of the contract, the Contractor may resubmit the written request for an adjustment in compensation to the Engineer as a part of the final claim after the project is complete. The Contractor will only be allowed to submit the request for an adjustment in compensation one time during the construction of the project.

104-9 DISPOSITION OF SURPLUS PROPERTY

All property that is surplus to the needs of the project will remain or become the property of the Contractor, unless otherwise stated in the contract, with the following exceptions:

(A) Materials that are the property of utility companies providing service to buildings that are to be demolished or removed in accordance with Sections 210 and 215,

(B) Materials resulting from the removal of existing pavement in accordance with Section 250 that are to be stockpiled for the use of the Department,

(C) Materials resulting from the removal of existing structures in accordance with Section 402 where the contract indicates that the material will remain the property of the Department,

(D) Aggregate base course where the contract requires that this material become the property of the Department,

(E) Left over materials for which the Department has reimbursed the Contractor as provided in Article 109-6 and

(F) Materials that have been furnished by the Department for use on the project.

Property shall include but not be limited to materials furnished by the Contractor or the Department for either temporary or permanent use on the project, salvaged materials that were part of the existing facility on the date of availability for the project, and all implements, machinery, equipment, tools, supplies, laboratories, field offices and watercraft that are necessary for the satisfactory completion of the project.

All property that is the property of the Contractor shall be removed from the project by the Contractor before final acceptance.

104-10 MAINTENANCE OF THE PROJECT

The Contractor shall maintain the project from the date of availability or the date of beginning work, whichever occurs first, until the project is finally accepted. On resurfacing projects the Contractor shall maintain each part of the project, as defined by map numbers, from the date of beginning work on that part until such part is finally accepted. This maintenance shall be continuous and effective and shall be prosecuted with adequate equipment and forces to the end that all work covered by the contract is kept in satisfactory and acceptable condition at all times.

The Contractor shall maintain all existing drainage facilities, except where the work consists of resurfacing only, such that they are in the same condition upon acceptance of the project as they were when the project was made available to the Contractor.

In the event that the Contractor's work is suspended for any reason, the Contractor shall maintain the work covered by the contract, as provided herein.

When a portion of the project is accepted as provided in Article 105-17, immediately after such acceptance the Contractor will not be required to maintain the accepted portions. Should latent defects be discovered or become evident in an accepted portion of the project, such defective work shall be repaired or replaced at no cost to the Department.

Where an observation period is required that extends beyond the final acceptance date, the Contractor shall perform any work required by the observation period until satisfactory completion of the observation period. The Contractor will not be directly compensated for any maintenance operations necessary, as this work will be incidental to the work covered by the various contract items.

104-11 FINAL CLEANING UP

Before acceptance of the project, the highway, borrow sources, waste areas and all ground occupied by the Contractor within the project limits in connection with the work shall be cleaned of all rubbish, excess materials, temporary structures and equipment. All parts of the work shall be left in an acceptable condition.

The Contractor will not be directly compensated for the work of final cleaning up, as this work will be considered incidental to the work covered by the various contract items.

104-12 VALUE ENGINEERING PROPOSAL

This value engineering specification is to provide an incentive to the Contractor to initiate, develop and present to the Department for consideration, any cost reduction proposals conceived by the Contractor involving changes to the contract. A Design-Build VEP may also be considered in accordance with Subarticle 104-12(F). This specification applies to proposals submitted by the Contractor using the *Value Engineering Proposal (VEP) Submittal Form* on the Department's website. Submittals that propose material substitutions of permanent features, such as, but not limited to, changes from rigid to flexible or flexible to rigid pavements, concrete to steel or steel to concrete bridges will not be considered acceptable VEPs. Depending on the complexity of the evaluation and implementation, VEPs that provide for a total savings before distribution of less than $10,000 may not be considered.

(A) Minimum Requirements for Proposals

Accepted VEPs for technical review are those that would result in a net savings to the Department by providing a decrease in the total cost of construction or reduce the construction time without increasing the cost to construct the project. A VEP must provide an equivalent or better product than what is specified in the Contract. The effects the VEP may have on the following items, but not limited to these items, will be considered by the Department when evaluating the VEP:

(1) Service life,
(2) Safety,

(3) Reliability,
(4) Economy of operation,
(5) Ease of maintenance,
(6) Desired aesthetics,
(7) Design,
(8) Standardized features, and
(9) Environmental impact.

(B) Evaluation of Proposals

The Department reserves the right to reject the VEP or deduct from the savings identified in the VEP to compensate for any adverse effects to these items that may result from implementation of the VEP.

The Department reserves the right to reject, at its sole discretion, any VEP submitted that would require additional right of way. VEPs requiring a construction plan revision will be reviewed in accordance with the current construction revision guidelines. Substitution of another design alternate detailed in the contract plans for the one that the Contractor bid will not be allowed. Plan errors that are identified by the Contractor and that result in a cost reduction will not qualify for submittal as a VEP. Pending execution of a formal supplemental agreement implementing an approved VEP and transferal of final plans (hard copy and electronic) sealed by an engineer licensed in the State of North Carolina incorporating an approved VEP to the Engineer, the Value Management Office and the Design-Build Unit (if applicable), the Contractor shall remain obligated to perform in accordance with the terms of the existing contract. No time extension will be granted due to the time required to develop and review a VEP.

(C) Subcontractors

The Contractor is encouraged to include this specification in contracts with subcontractors. The Contractor shall encourage submissions of VEPs from subcontractors; however, it is not mandatory that the Contractor accept or transmit VEPs proposed by his subcontractors to the Department. The Contractor may choose any arrangement for the subcontractor value engineering payments, provided that these payments shall not reduce the Department's share of the savings resulting from the VEP.

(D) Preliminary Review

The preliminary review is intended to expedite the initial review of a VEP idea, as well as minimize the Contractor's initial capital investment and risk in developing the VEP. This step allows the Contractor to submit a conceptual plan, and only requires the Department to assess the general merits and technical feasibility of the proposal. The Contractor shall submit the preliminary VEP to the Engineer, the Value Management Office at ValueManagementUnit@ncdot.gov and the Design-Build Unit (if applicable). The submittal shall include the *Value Engineering Proposal (VEP) Submittal Form*, description of the proposed change and the associated benefits, concept sketches or mark-ups on existing plan sheets that can be clearly understood and interpreted and an estimate of cost savings associated with the proposal. Include the identity of any Private Engineering Firms proposed by the Contractor to prepare designs or revisions to designs. The Department will review the preliminary submittal only to the extent necessary to determine if it has possible merit as a VEP. This preliminary review does not obligate the Department to approve the final VEP should a preliminary review indicate the VEP has possible merit. The Department is under no obligation to consider any VEP (Preliminary or Final) that is submitted.

(E) Final Proposal

A copy of the Final VEP shall be submitted by the Contractor to the Engineer, the Value Management Office at ValueManagementUnit@ncdot.gov and Design-Build Unit (if applicable). The VEP shall contain the following at a minimum:

(1) A *Value Engineering Proposal (VEP) Submittal Form*.

(2) A description of the difference between the existing contract requirements and the proposed modifications, with the comparative advantages and disadvantages of each.

(3) If applicable, a complete drawing of the details covering the proposed modifications and supporting design computations shall be included in the final submittal. The preparation of new designs or drawings shall be accomplished and sealed by an engineer licensed in the State of North Carolina. Further, the Department may require a review, and possibly the redesign, be accomplished by the project's original designer, or an approved equal. The Department may contract with private engineering firms, when needed, for reviews requested by the Department. The Contractor shall contract with the original project designer, or an approved equal, when required by the Department, for any design work needed to prepare completely and accurately the contract drawings. The Department may waive the requirements to have the preparation of contract drawings accomplished by an engineer licensed in the State of North Carolina or the project's original design based on the extent, detail and complexity of the design needed to implement the proposal.

(4) An itemized list of the contract requirements that would be modified and a recommendation of how to make each modification.

(5) A detailed estimate of the cost of performing the work under the proposed modification.

(6) A statement of the time when approval of the proposal shall be issued by the Department to obtain the total estimate cost reduction during the remainder of the contract, noting any effect on the contract completion or delivery schedule.

The complete review of each submittal (Preliminary or Final) may take up to 20 business days. Additional review time may be needed and should be anticipated for VEPs with construction plan revisions, VEPs requiring extensive and complex changes, and Design-Build VEPs.

(F) Design-Build VEPs

Review of a Design-Build VEP will follow the same process described above. However, only the VEPs which alter the requirements of the Request for Proposal (RFP) issued by the Department and/or the Technical Proposal submitted by the Design-Build Team, will be considered as VEPs. A previously submitted ATC (Alternate Technical Concept) that was not approved can be resubmitted for consideration as a VEP, if applicable.

In addition to the technical review, a Design-Build VEP will be reviewed by the Design-Build Unit for Contractual compliance and the Estimating Management Group for fairness of approximate savings noted by the Contractor.

(G) Modifications

The preparation of new design drawings by or for the Contractor shall be coordinated with the appropriate Design Branch through the State Value Management Engineer. The Contractor shall provide, at no charge to the Department, one set of reproducible drawings of the approved design needed to implement the final VEP. Drawings (hardcopy and electronic) which are sealed by an engineer licensed in the State of North Carolina shall be submitted to the Engineer, Value Management Office at

ValueManagementUnit@ncdot.gov and Design-Build Unit (if applicable) no later than 10 business days after acceptance of the final VEP unless otherwise permitted.

The Contractor has the right to withdraw, in whole or in part, any final VEP not accepted by the Department within the period to be specified in the final VEP per Subarticle 104-12(E)(6).

If a VEP is approved, the necessary changes will be affected by the supplemental agreement. Included as a part of the supplemental agreement will be requirements for price adjustment giving the Contractor 50% of the net savings to the project resulting from the modifications. Supplemental agreements executed for design-bid-build contracts shall reflect any realized savings in the corresponding line items. Supplemental agreements executed for design-build contracts shall add one line item deducting the full savings from the total contract price and one line item crediting the Contractor with 50% of the total VEP savings.

The Department reserves the right to include in the supplemental agreement any conditions it deems appropriate for consideration, approval and implementation of the VEP. Acceptance of the supplemental agreement by the Contractor shall constitute acceptance of such conditions.

The final net savings to be distributed will be the difference in cost between the existing contract cost for the involved unit bid items and the actual final cost resulting from the modification. Only those unit bid items directly affected by the supplemental agreement will be considered in making the final determination of net savings. For design-build VEPs, a cost estimate of the net savings based on the current market values must be included with the submission and will be reviewed and approved by the State Estimator. In determining the estimated net savings, the Department reserves the right to disregard the contract prices if, in the judgment of the Department, such prices do not represent a fair measure of the value of the work to be performed or to be deleted. Subsequent change documents affecting the modified unit bid items, but not related to the VEP, will be excluded from such determination. The Department's review and administrative costs for VEPs will be borne by the Department. The Contractor's costs for designs and/or revisions to designs and the preparation of design drawings will be borne by the Contractor. The costs to either party will not be considered in determining the net savings obtained by implementing the VEP. The Contractor's portion of the net savings shall constitute full compensation to the Contractor for effecting all changes pursuant to the agreement. The net savings will be prorated, 50% to the Contractor and 50% to the Department, for all accepted VEPs.

Upon execution of the supplemental agreement, the Department will thereafter have the right to use, duplicate or disclose, in whole or in part, any data necessary for the use of the modification on other projects without obligation or compensation of any kind to the Contractor. Restrictions or conditions imposed by the Contractor for use of the VEP on other projects shall not be valid.

Except as may be otherwise precluded by this specification, the Contractor may submit a previously approved VEP on another project.

Unless and until a supplemental agreement is executed and issued by the Department and final plans (hard copy and electronic) sealed by an engineer licensed in the State of North Carolina incorporating an approved VEP have been provided to the Engineer, the Value Management Office at ValueManagementUnit@ncdot.gov and the Design-Build Unit (if applicable), the Contractor shall remain obligated to perform the work in accordance with the terms of the existing contract.

Acceptance of the modification and its implementation will not modify the completion date of the contract unless specifically provided for in the supplemental agreement.

The Contractor shall not be entitled to additional compensation under Section 104 for alterations in the plans or in the details of construction pursuant to the VEP.

The Department will not be liable to the Contractor for failure to accept or act upon any VEP nor for any delays to the work attributable to any such VEP.

The Department reserves the right to negotiate desired changes with the Contractor under the requirements of the contract even though the changes are the result of a VEP submitted on another contract. In this instance the savings will be prorated in accordance with the terms of the negotiated agreement.

104-13 RECYCLED PRODUCTS OR SOLID WASTE MATERIALS

It is the policy of the Department to aid in reduction of materials that become a part of our solid waste stream. To that extent the Department encourages contractors to initiate, develop and use products and construction methods that incorporate the use of recycled or solid waste products in the project. Recycled products or waste materials will be those products or materials that would otherwise become solid waste and are collected, separated, or processed and reused or returned to reuse in the form of raw materials or products that are incorporated into a beneficial reuse on the project. Targeted materials include, but are not limited to, the following: plastic, glass, paper, cardboard, shingles, tires, fly ash, bottom ash, sludge and construction and demolition debris.

This Specification will not be applicable to reclaimed asphalt materials used in accordance with Section 610 and shall not be applicable to any recycled or solid waste materials that are specified for use by the Department on the project.

To use recycled or solid waste materials, the Contractor shall submit to the Department of Transportation a Recycled Products or Solid Waste Materials Proposal for approval. This proposal shall be submitted to the Resident Engineer and the Resource Conservation Engineer at ResourceConservation@ncdot.gov. The proposal shall contain, at a minimum, a statement that the request for the modification is being made as a Recycled Products or Solid Waste Materials proposal and the requirements in Subarticles 104-12(E)(2) through 104-12(E)(6).

The Contractor shall be responsible for obtaining any and all permits that may be required for the hauling, storing, or handling of the targeted materials.

If a Recycled Products or Solid Waste Materials proposal is approved, the necessary changes will be effected by supplemental agreement. Included as a part of the supplemental agreement will be requirements for price adjustment as follows:

(A) If the proposal results in a net savings to the Department the savings and distribution of the savings shall be done in accordance with Article 104-12.

(B) If the proposal results in a net increase in the project cost but is judged to have a significant effect on the development of long term markets for the targeted materials, or results in significant beneficial usage of project generated debris that would have otherwise been disposed of in accordance with Section 802, the Department will bear the approved increased costs, if any. This includes recycled products that have been approved by the Department but were not originally included in this contract.

(C) If the proposal is new and innovative, never used in the Department projects before as approved by the Engineer and results in a net savings to the Department, the savings shall be distributed in accordance with Article 104-12. However, when this innovative proposal results in a net increase in project cost, Subarticle 104-13(B) shall apply, and at least $1,500, but not more than $5,000, may be awarded to the Contractor.

The Contractor shall provide certification that verifies the source of the material and the percentage of targeted materials to be used.

The quantities of reused or recycled materials either incorporated in the project or diverted from landfills and any practice that minimized the environmental impacts on the project shall

be reported by July 1 annually by the Contractor to the Resource Conservation Engineer at ResourceConservation@ncdot.gov.

The Contractor shall remain obligated to perform the work in accordance with the terms of the existing contract pending execution of the supplemental agreement that implements an approved Recycled Products or Solid Waste Materials proposal and will not be entitled to any additional compensation or additional contract time if a Recycled Products or Solid Waste Materials proposal is not accepted.

The Department reserves the right to reject, at its discretion, any Recycled Products or Solid Waste Materials proposal. The Engineer will be the sole judge of the acceptability, the value, the estimated net savings and any additional compensation to be paid to the Contractor for all or any part of the proposal.

Article 104-3 does not apply to a Recycled Products or Solid Waste Materials proposal.

Upon execution of the supplemental agreement, the Department will hereafter have the right to use, duplicate or disclose in whole or in part any data necessary for use of the modification on other projects without obligation or compensation of any kind to the Contractor. Restrictions of conditions imposed by the Contractor for use of the proposal by the Department on other projects shall not be valid.

The Department will not be liable to the Contractor for failure to accept or act upon any Recycled Products or Waste Materials proposal submitted pursuant to this Specification, nor for any delays to the work attributable to any third party claims, or fines that may be levied as a result of the Contractor's decision to use targeted materials.

SECTION 105
CONTROL OF WORK

105-1 AUTHORITY OF THE ENGINEER

The Engineer will decide all questions that may arise as to the quality and acceptability of materials furnished, work performed, rate of progress of the work; interpretation of the contract; and fulfillment of the contract on the part of the Contractor. His decision shall be final, and he shall have executive authority to enforce and make effective such decisions and orders as the Contractor fails to carry out promptly.

The Engineer shall have the authority to issue any written order to the Contractor which he considers necessary to the prosecution of the work and shall have executive authority to enforce such written orders the Contractor fails to carry out promptly. Failure on the part of the Contractor to comply with any written order issued by the Engineer may be justification for disqualifying the Contractor from further bidding in accordance with Article 102-15.

105-2 PLANS AND WORKING DRAWINGS

Plans will show details of all structures, lines, grades, typical cross sections of the roadway, location and design of all structures and a summary of items appearing in the proposal.

The plans shall be supplemented by such approved working drawings as are necessary to adequately control the work. Working drawings furnished by the Contractor and approved by the Engineer shall consist of such detailed drawings as may be required to adequately control the work and are not included in the plans furnished by the Department. They may include stress sheets, shop drawings, erection drawings, falsework drawings, cofferdam drawings, bending diagrams for reinforcing steel, catalog cuts, or any other supplementary drawings or similar data required of the Contractor. When working drawings are approved by the Engineer, such approval shall not operate to relieve the Contractor of any of his responsibility under the contract for the successful completion of the work.

Unless otherwise specified, the Contractor shall allow 30 calendar days for review and approval, or acceptance, of working drawings from the date they are received until they are returned by the Engineer, unless otherwise stated. If revised drawings are required, appropriate additional time shall be allowed for review and approval, or acceptance, of the revised drawings. The Contractor shall have no claim for extension of completion dates or additional compensation due to this review period.

Changes on shop drawings after approval or distribution shall be subject to the approval of the Engineer and he shall be furnished a record of such changes.

Payment at the contract prices will be full compensation for all costs of furnishing all working drawings.

105-3 CONFORMITY WITH PLANS AND SPECIFICATIONS

All work performed and all materials furnished shall be in reasonably close conformity as determined by the Engineer with the lines, grades, cross sections, dimensions and material requirements, including tolerances, shown in the contract.

In the event the Engineer finds the materials or the finished product in which the materials are used not within reasonably close conformity with the contract but that reasonably acceptable work has been produced, he will then make a determination if the work is to be accepted and remain in place. If the Engineer determines that the work is to be accepted, he will have the authority to make such adjustment in contract price as he deems warranted based upon his engineering judgment and the final estimate will be paid accordingly.

In the event the Engineer finds the materials, or the finished product in which the materials are used, or the work performed, are not in reasonably close conformity with the contract and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by the Contractor at no cost to the Department.

105-4 COORDINATION OF PLANS, SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS AND SPECIAL PROVISIONS

The *Standard Specifications*, the supplemental specifications, the plans, the special provisions and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are complimentary and provide and describe the complete contract. In case of discrepancy or ambiguity, the following will apply in ascending order:

Calculated dimensions shall govern over scaled dimensions;

Supplemental specifications shall govern over *Standard Specifications*;

Plans shall govern over supplemental specifications and *Standard Specifications*;

Standard special provisions shall govern over plans, supplemental specifications and *Standard Specifications*; and

Project special provisions shall govern over standard special provisions, plans, supplemental specifications and *Standard Specifications*.

The Contractor shall not take advantage of any apparent error or omission in the contract. In the event such errors or omissions are discovered the Engineer will make such corrections and interpretations as may be determined necessary for the fulfillment of the intent of the contract.

105-5 COOPERATION BY CONTRACTOR

The Contractor shall cooperate with the Engineer, his inspectors and other contractors in every way possible and shall give the work the constant attention necessary to facilitate the progress and satisfactory performance thereof. The Contractor shall notify the Engineer in writing at least 7 calendar days before beginning work on the project. He shall notify the

Engineer at least 1 calendar day in advance when work is to be suspended and at least 2 calendar days in advance when work is to be resumed.

The Contractor shall keep available on the project site a copy of the entire contract at all times.

105-6 SUPERVISION BY CONTRACTOR

(A) On Site Personnel

At all times that work is actually being performed, the Contractor shall have present on the project one competent individual who has been authorized to act in a supervisory capacity over all work on the project including work subcontracted. The individual who has been so authorized shall be experienced in the type of work being performed and is to be fully capable of managing, directing and coordinating the work, of reading and thoroughly understanding the contract and of receiving and carrying out directions from the Engineer or his authorized representatives. He shall be an employee of the Contractor unless otherwise approved by the Engineer.

(B) On Call Personnel

At all times during the life of the project the Contractor shall provide one permanent employee who shall have the authority and capability for the overall responsibility of the project and who shall be personally available at the site of work within 24 hours' notice. Such employee shall be fully authorized to conduct all business with the subcontractors, to negotiate and execute all supplemental agreements and to execute the orders or directions of the Engineer.

(C) Exceptions

If the Contractor elects to have the employee described under Subarticle 105-6(B) constantly available in person on the project, then the presence of this employee will be considered as meeting Subarticle 105-6(A). However, whenever such employee is absent from the project then an authorized individual meeting Subarticle 105-6(A) shall be present on the project.

105-7 COOPERATION BETWEEN CONTRACTORS

The Department reserves the right at any time to contract for and perform other or additional work on or near the work covered by the contract.

When separate or additional contracts are let within the limits of any one project, each Contractor shall conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by other contractors. Contractors working within the limits of the same project shall cooperate with each other.

Each Contractor shall conduct his operations in such a manner as to avoid damaging any work being performed by others or that has been completed by others.

When a project is let under more than one contract and the plans or special provisions include a construction schedule, it shall be the responsibility of the Contractors to complete the various phases of the project in accordance with the time limits specified such that the total contracts will be completed by the completion date. This construction schedule will remain in effect until such time as the Contractors, at their option submit to the Engineer a joint construction schedule meeting the approval of the Engineer. This joint construction schedule shall be signed by authorized representatives of each firm and upon the approval of the Engineer shall be binding on each firm. Subsequent modifications to the joint construction schedule may be made during the course of the work in the same manner.

Failure of the Contractor to complete the various phases of work within the time limits set forth in the construction schedule or latest approved joint construction schedule shall be just cause for removing the Contractor from the Department's list of qualified contractors.

A Contractor disqualified by reason of this provision will not be reinstated until such time as his progress is in accordance with the latest approved construction schedule or until the project is completed and accepted, whichever occurs first.

The Department will under no circumstances be liable for any claim for additional compensation due to acts of one contractor holding up the work of another.

The Department will under no circumstances be liable for any damages experienced by one Contractor as a result of the presence and operations of other contractors working within the limits of the same project.

105-8 COOPERATION WITH UTILITY OWNERS

Before the beginning of construction, the Department will notify all utility owners known to have facilities affected by the construction of the project and will make arrangements for the necessary adjustments of all affected public or private utility facilities. The utility adjustments may be made either before or after the beginning of construction of the project. The adjustments will be made by the utility owner or his representative or by the Contractor when such adjustments are part of the work covered by his contract.

The Contractor shall use an independent utility locating service to locate utilities. Identify excavation locations by means of pre-marking with white paint, flags, or stakes or provide a specific written description of the location in the locate request. The Contractor shall use special care working in, around and near all existing utilities that are encountered during construction, protecting them where necessary so that they will give uninterrupted service.

The Contractor shall cooperate with the utility owner and/or the owner's representative in the adjustment or placement of utility facilities when such adjustment or placement is made necessary by the construction of the project or has been authorized by the Department.

In the event that utility services are interrupted by the Contractor, the Contractor shall promptly notify the owners and shall cooperate with the owners and/or the owner's representative in the restoration of service in the shortest time possible.

Existing fire hydrants shall be kept accessible to fire departments at all times.

Before submitting his bid, the Contractor shall make his own determination as to the nature and extent of the utility facilities, including proposed adjustments, new facilities, or temporary work to be performed by the utility owner or his representative; and as to whether or not any utility work is planned by the owner in conjunction with the project construction. The Contractor shall consider in his bid all of the permanent and temporary utility facilities in their present or relocated positions, whether or not specifically shown in the plans or covered in the project special provisions. It will be the Contractor's responsibility to anticipate any additional costs to him resulting from such utility work and to reflect these costs in his bid for the various items in the contract.

No additional compensation, except as provided for in Article 104-4, will be allowed for delays, inconvenience or damage sustained by the Contractor due to any interference from said utility facilities or the operation of moving them, and any such delay, inconvenience or damage, except as provided for in Article 104-4, shall not constitute a basis for a claim for additional compensation.

Where changes to utility facilities are to be made solely for the convenience of the Contractor, it shall be the Contractor's responsibility to arrange for such changes and the Contractor shall bear all costs of such changes.

105-9 CONSTRUCTION STAKES, LINES AND GRADES

Unless otherwise required in the contract, the Engineer will set construction stakes establishing lines, slopes and continuous profile-grade in road work, centerline and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances that require the use of an engineer's level and transit, and will furnish the Contractor with all

necessary information relating to lines, slopes and grades. These stakes and marks shall constitute the field control by, and in accordance with which, the Contractor shall establish other necessary controls and perform the work.

The Contractor shall be held responsible for the preservation of all stakes and marks, and if any of the construction stakes or marks have been destroyed or disturbed by the Contractor, the cost of replacing them will be charged against him and will be deducted from the payment for the work.

105-10 AUTHORITY AND DUTIES OF THE INSPECTOR

Inspectors employed by the Department are authorized to inspect all work performed and materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. The inspector is not authorized to alter or waive the requirements of the contract. The inspector is not authorized to issue instructions contrary to the contract, or to act as foreman for the Contractor; however, he has the authority to reject work or materials until any questions at issue can be referred to and decided by the Engineer. The inspector is not authorized to make any final acceptance of the work.

105-11 INSPECTION OF WORK

All materials and each part or detail of the work shall be subject to inspection by the Engineer. The Contractor shall allow and provide a reasonable access to all parts of the work to the Engineer or his authorized representative. The Contractor shall furnish such information and assistance as is required to make a complete and detailed inspection. Such access shall meet the approval of the Engineer.

The presence of the Engineer or inspector at the work site shall in no way lessen the Contractor's responsibility for conformity with the contract. Should the Engineer or Inspector, at any time before final acceptance, fail to point out or reject materials or work that does not conform to the contract, whether from lack of discovery or for any other reason, it shall in no way prevent later rejection or corrections to the unsatisfactory materials or work when discovered. The Contractor shall have no claim for losses suffered due to any necessary removals or repairs resulting from the unsatisfactory work.

If the Engineer requests it, the Contractor, at any time before final acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. The Contractor shall keep cost records of the work performed and if the uncovered work is found to be acceptable by the Engineer, the Department will pay the Contractor on a force account basis in accordance with Article 109-3 for the cost of uncovering, or removing and the replacing of the covering or making good of the parts removed; but should the work so exposed or examined prove unacceptable by the Engineer, the uncovering or removing and the replacing of the covering or making good of the parts removed, shall be at no cost to the Department.

When any other unit of government or political subdivision is to pay a portion of the cost of the work covered by the contract, its respective representatives shall have the right to inspect the work. When work is to be performed on the right of way of any railroad corporation or in proximity to other public utilities, the representatives of the railroad corporation and/or the public utilities shall have the right to inspect the work. Such inspection shall in no sense make any unit of government or political subdivision or any railroad corporation or public utility a party to the contract and shall in no way interfere with the rights of either party thereunder.

105-12 UNAUTHORIZED WORK

No work shall be performed without established lines and grades except as otherwise permitted by the Engineer. Work performed contrary to the instructions of the Engineer or

contrary to any approvals granted by the Engineer will be considered as unauthorized and may not be paid under the requirements of the contract. Work performed beyond the lines shown in the plans or as given, except as herein specified, or any extra work performed without authority will be considered as unauthorized and may not be paid under the requirements of the contract. Any of the above work so performed may be ordered removed, replaced, or repaired at no cost to the Department.

Upon failure on the part of the Contractor to comply on time with any order of the Engineer made under the provisions of this article, the Engineer will have the authority to cause such unauthorized work to be removed or adjusted or both to conform to the contract and to deduct the cost of removal or adjustment, or both, from any monies due or to become due the Contractor.

105-13 LIMITATIONS OF OPERATIONS

At any time when, in the opinion of the Engineer, the Contractor has obstructed, closed, or is conducting operations on a greater portion of the work than is necessary for the prosecution of the work so as to constitute a hazard to the general public or impair the function of the facility being constructed where traffic shall be maintained, the Engineer may require the Contractor to suspend such unnecessary operations or closures and to finish the portions on which work is in progress before starting work on additional portions of the work.

105-14 NIGHT WORK

Whenever the Contractor's operations are being conducted at night, the Contractor shall provide such artificial lighting as may be necessary to provide for safe and proper construction and to provide for adequate inspection of the work as described in Section 1413. The Contractor shall comply with all applicable regulations governing noise abatement.

105-15 RESTRICTION OF LOAD LIMITS

The Contractor shall comply with all legal load restrictions in hauling equipment and materials on roads under the jurisdiction of the Department.

The Department has the right to place load limit restrictions on the load a Contractor may haul on any road or bridge in the vicinity of his contract. The Contractor, before bidding on a project, will be responsible for making his own investigations to determine the possibility of load limit restrictions being placed on any of the highways he plans to use for hauling purposes. The Contractor shall not be entitled to an extension of time or to compensation for any costs, inconvenience, delay, or any other adversity to the Contractor as the result of any reduction by the Department in load limit, or as the result of a refusal by the Department to raise load limits as hereinafter provided or under any other conditions. Any such reduction in load limit or refusal to raise load limits shall not constitute a basis for a claim for additional compensation.

Wherever load limit restrictions below the statutory legal load limit have been posted on any roads and bridges on the project or within the vicinity of the project, the Department may remove the load limit restrictions from such roads and bridges upon written request from the Contractor, and the Contractor thereafter will be allowed to haul up to the statutory legal limits over such roads and bridges, provided the Contractor enters into an agreement with the Department providing for:

(A) Maintenance by the Contractor of such roads in a condition satisfactory to the Engineer during the haul period.

(B) Repair by the Contractor at his expense, of all damages to such roads after haul is completed to place them in a condition as good as they were before removal of the load limits.

(C) Furnishing a bond by the Contractor in an amount determined by the Engineer for the roads. Furnishing a bond for the roads does not entitle the Contractor to exceed the posted load limits of any bridge.

(D) Assumption by the Contractor of all costs of strengthening any bridges that may be necessary to safely haul loads up to statutory legal limits. The Department will, upon request by the Contractor, make a determination as to the method and extent of strengthening required for the bridges and will advise the Contractor as to the amount of work to be done or an estimate of the charges for the work if performed by Department forces. When Department forces perform the work, the Contractor shall reimburse the Department in the amount of the actual charges for said work. When Contractor's forces perform the work, it shall be done in accordance with plans approved by the Engineer and under his inspection.

(E) Indemnification of the Department against any and all claims from third persons arising out of or resulting from the hauling operation or the maintenance, or lack of maintenance, of haul roads. Haul roads shall be maintained for the Contractor's hauling operations and for the use of the general public.

Equipment operated on proposed bridges shall comply with load restrictions in Table 105-1.

TABLE 105-1
RESTRICTIONS FOR EQUIPMENT ON BRIDGES

Property	Maximum Load in Pounds
Axle load	36,000
Axle load on tandem axles	30,000
Gross load	90,000

The Contractor shall keep the bridge floor clean to reduce impact forces and place approved temporary guides on the bridge floor to position the wheel loads as nearly as possible over the bridge girders. Only one earth-moving vehicle shall be on a bridge at any time. Upon completion of hauling over each bridge, the Contractor shall clean the bridge floor, curbs and rails.

Regulations pertaining to size and weight will not apply to equipment used on the project provided the vehicles involved are not operated on pavement, completed base course, or structures.

105-16 FAILURE TO MAINTAIN THE PROJECT OR PERFORM EROSION CONTROL WORK

Failure on the part of the Contractor to comply with Article 104-10 or to perform erosion control work as directed by the Engineer will result in the Engineer notifying the Contractor to comply with these *Standard Specifications*. In the event that the Contractor fails to begin such remedial action or fails to begin erosion control work within 24 hours after receipt of such notice with adequate forces and equipment, the Engineer may proceed to have the work performed with other forces. No payment will be made to the Contractor for work performed by others. Any costs incurred by the Department for work performed by others as provided above in excess of the costs that would have been incurred had the work been performed by the Contractor will be deducted from monies due the Contractor on his contract.

105-17 INSPECTION AND ACCEPTANCE

Upon completion of the entire project as determined by the Engineer, the Engineer will inspect the project for final acceptance. If all construction provided for and contemplated by the contract is found to be satisfactorily completed, the project will be accepted. The acceptance of projects in their entirety will not be altered except as listed below:

(A) When any continuous project is equal to or in excess of 5 miles in length, the Department will accept the project in two increments with the first increment equaling at least 50% of the total length of the project.

(B) Under resurfacing contracts, the Department will accept the project in parts as defined by map numbers representing at least 25% of the total length of project.

(C) When it is considered to be in the best interest of the Department, other increments or parts of projects may be considered for acceptance.

(D) When the contract contains an intermediate completion date requiring the completion of a portion of the work in its entirety, such portion of the work may be accepted if requested in writing by the Contractor.

(E) Bridge decks and rails that have been constructed or rehabilitated at such time as when they are open to public traffic.

(F) Permanent sign panels, including hardware and retroreflective sheeting, that are located where the roadway is open to public traffic and that are required to be installed before the final acceptance of the project.

Acceptance of any increment or part of a project shall not operate to waive the assessment of all or any portion of liquidated damages assessable under the terms of the contract.

When the inspection discloses any work, in whole or in part, as being unsatisfactory or incomplete, the Engineer will advise the Contractor of such unsatisfactory or incomplete work, and the Contractor shall immediately correct, repair or complete such work. The project will not be accepted and the Contractor shall be responsible for the maintenance of the project and maintenance of traffic until all of the recommendations made at the time of the inspection have been satisfactorily completed.

The Engineer will notify the Contractor in writing that the project has been accepted as soon as practicable after the completion of the project. When an observation period is required that extends beyond the final acceptance date, the satisfactory completion of the observation period shall be covered by the contract bonds.

SECTION 106
CONTROL OF MATERIAL

106-1 GENERAL REQUIREMENTS

(A) General

The materials used in the work shall meet all requirements of the contract and shall be subject to inspection, test, or rejection by the Engineer at any time. Materials used in the work shall be new, recycled, or recovered as permitted by the contract.

It is the Department’s intent to expand the use of recyclable and recovered materials in its construction programs. The Contractor is encouraged to find innovative and alternative ways for beneficial use of recyclable materials that are currently a part of the solid waste stream and that contribute to problems of declining space in landfills.

The Contractor shall make his own determination of the various kinds and quantities of materials that are necessary for the acceptable performance and timely completion of the work. It shall be the Contractor's responsibility to obtain materials that meet the requirements of the contract. The Contractor shall be responsible for the acceptability of all materials used in the work and for the timely delivery of materials to the project so that adequate time will be available for the safe and proper performance of the work.

To facilitate testing by the Department, the Contractor shall furnish a complete statement of the origin of all materials to be used in the construction of the work, together with samples when required. The statement of origin shall be furnished to the Materials and

Tests Unit sufficiently in advance of any shipment or fabrication of materials so that arrangements can be made for proper inspection.

The Contractor shall furnish a SDS with all paints and hazardous chemicals proposed for use on the project. The SDS shall be in accordance with the North Carolina Hazard Communication Standard, 29 CFR 1910.1200.

The Contractor shall provide access, means and assistance in the verification of all testing equipment, scales, measures and other devices operated by him in connection with the testing of the materials.

If the Contractor desires or is required to furnish materials from local deposits, other than those, if any, described in the contract, he shall assume full responsibility for the sampling of the sources and the acceptability of the material in accordance with the specifications. He shall furnish without charge such preliminary samples as may be required; except that, if requested in writing, the Engineer may allow Department forces to take samples as requested by the Contractor. In the latter case, the Contractor shall reimburse the Department for the total expense of the sampling as determined by the Engineer. Tests will be made and reports rendered, but it is understood that such tests shall in no way be construed as a guarantee of acceptance of any material that may be delivered later for incorporation in the work. The Contractor shall assume full responsibility for the production of uniform and satisfactory materials from such local deposits and shall indemnify and save harmless the Department from any and all claims for loss or damages resulting from the opening and operation thereof, or from the failure of the deposit after development to produce materials acceptable to the Engineer, in either quality or quantity.

(B) Domestic Steel

All steel and iron products that are permanently incorporated into this project shall be produced in the United States except minimal amounts of foreign steel and iron products may be used provided the combined material cost of the items involved does not exceed 0.1% of the total amount bid for the entire project or $2,500, whichever is greater. If invoices showing the cost of the material are not provided, the amount of the bid item involving the foreign material will be used for calculations. This minimal amount of foreign produced steel and iron products permitted for use is not applicable to high strength fasteners. Domestically produced high strength fasteners are required.

All steel and iron products furnished as domestic products shall be melted, cast, formed, shaped, drawn, extruded, forged, fabricated, produced, or otherwise processed and manufactured in the United States. Raw materials including pig iron and processed pelletized and reduced iron ore used in manufacturing domestic steel products may be imported; however, all manufacturing processes to produce the products, including coatings, shall occur in the United States.

Before each steel or iron product is incorporated into any project or included for partial payment on a monthly estimate, the Contractor shall furnish the Engineer a notarized certification certifying that the product conforms to the above.

Each purchase order issued by the Contractor or a subcontractor for steel and iron products to be permanently incorporated into any project shall contain in bold print a statement advising the supplier that all manufacturing processes to produce the steel or iron shall have occurred in the United States. The Contractor and all affected subcontractors shall maintain a separate file for steel products permanently incorporated into any project so that verification of the Contractor's efforts to purchase domestic steel and iron products can readily be verified by an authorized representative of the Department or the Federal Highway Administration.

106-2 SAMPLES, TESTS AND CITED SPECIFICATIONS

All tests will be made in accordance with the most recent standard or interim methods of the AASHTO in force on the date of advertisement. Should no AASHTO method of test exist for a material, the most recent standard or tentative method of ASTM or other methods adopted by the Department will be used.

All reference made to a specification published by AASHTO, ASTM or any other organization other than the Department, that does not indicate the date of publication, will be understood to mean the specification current on the date of advertisement for the project. When a more current specification is published during the life of the project, and when it is mutually agreed by the Contractor and the Engineer and such agreement is documented by a supplemental agreement, the Department may accept materials meeting the requirements of the latest publication.

106-3 CONTRACTOR FURNISHED CERTIFICATION

The Contractor shall furnish the Department material certifications obtained from the producer, supplier or an approved independent testing laboratory for the following types of materials, unless otherwise directed by the Engineer:

(A) Materials required to meet criteria documented by tests that are normally performed during the production process;

(B) Materials that are required to meet specifications other than those published by AASHTO, ASTM or the Department;

(C) Materials produced at locations that are not within routine travel distance for Department representatives;

(D) Materials required to meet criteria documented by tests involving special equipment not readily available to Department representatives; and

(E) Any other special material when so directed by the Engineer.

Material certifications of one of the following types shall be furnished for pre-tested materials. The specific type of material certification for each material shall be in accordance with the schedule maintained by the Materials and Tests Unit. Copies of this schedule may be obtained from the Materials and Tests Unit.

Type 1 - Certified Mill Test Report

A certified mill test report shall be a certified report of tests conducted by the manufacturer on samples taken from the same heat or lot number as the material actually shipped to the project. The report shall identify the heat or lot number.

Type 2 - Typical Certified Mill Test Report

A typical certified mill test report shall be a certified report of tests conducted by the manufacturer on samples taken from a lot that is typical of the material actually shipped to the project, but that may or may not be from the lot shipped.

Type 3 - Manufacturer's Certification

A manufacturer's certification shall be a certified statement that the material actually shipped to the project was manufactured by production processes that are periodically and routinely inspected to assure conformance to specification requirements.

Type 4 - Certified Test Reports

A certified test report shall be a certified report of test conducted by an approved independent testing laboratory on samples taken from the same heat or lot number as the material actually shipped to the project. The report shall identify the heat or lot number.

Type 5 - Typical Certified Test Reports

A certified test report shall be a certified report of tests conducted by an approved independent testing laboratory on samples taken from a lot that is typical of the material actually shipped to the project, but that may or may not be from the lot shipped.

Type 6 - Supplier's Certification

A supplier's certification is a signed statement by the supplier that the material described in the certification is of the specification grade required and that the supplier has on hand Type 1 or Type 2 material certifications to cover the material that is included in the Type 6 supplier's certification.

Type 7 - Contractor's Certification

Contractor's certification is a signed statement by a contractor that the used material described in the certification meets the current specifications to the best of the contractor's knowledge and that the contractor had in his possession at the time of purchase a Type 1 or Type 2 material certification to cover the material that is included in the Type 7 Contractor's certification.

106-4 DELIVERY AND HANDLING OF MATERIALS

All materials shall be handled carefully and in such manner as to preserve their quality and fitness for the work. Materials damaged during delivery or handling shall not be used without approval of the Engineer.

106-5 STORAGE OF MATERIALS

Materials shall be stored so as to insure the preservation of their quality and fitness for the work. Stored materials that may have been approved before storage shall be subject to inspection at any time and shall meet the specifications at the time it is put into use. Stored materials shall be located to facilitate their inspection. Subject to the approval of the Engineer, that portion of the right of way not required for public travel may be used for storage purposes and for the Contractor's plant and equipment, but any additional space required therefor shall be provided by the Contractor at no expense to the Department. All storage sites located within the right of way shall be restored to their original condition by the Contractor at no expense to the Department, except where the materials stored are or are to become the property of the Department.

106-6 INSPECTION AT SOURCE

The Engineer may undertake the inspection of materials at the source of supply. This inspection will be performed by Department personnel or private organizations retained by the Department. Provide material samples at no cost to the Department. Where approved by the Engineer, the results of tests performed by private laboratories, producers, or manufacturer's laboratories may be used in determining compliance of a material or product with the specifications.

The Department assumes no obligation to inspect materials at the source of supply. Such inspection will be undertaken only upon condition that:

(A) The cooperation and assistance of the Contractor and the producer with whom he has contracted for materials is assured.

(B) The representative of the Engineer will have full entry authority at all times to such parts of the plant as may concern the manufacture or production of the materials.

(C) Approved laboratory facilities shall be provided when required by the Engineer.

Where the Department agrees to inspect or test materials during their production or at the source of supply, the Contractor shall bear the cost of testing performed on materials ordered by him but not incorporated into the project.

The Department reserves the right to retest all materials that have been tested and accepted at the source of supply after the same have been delivered and to reject all materials that, when retested, do not meet the specifications.

106-7 SCALES AND PUBLIC WEIGHMASTER

When material is to be paid on a per ton basis, the Contractor shall furnish platform scales or other weighing devices that have been certified by the N.C. Department of Agriculture. If the platform scales or other weighing devices are located outside of North Carolina, they shall have been certified by the Department of Agriculture within the particular state. The scales may be constructed and operated to provide automatic weighing, recording and printing of tickets for the load being weighed.

The Department may deny or withhold any portion of payment for any load of materials weighed if in relation to such load of materials, the Contractor falsifies any weighing certification information or otherwise fails to comply with the requirements contained in this contract.

All scales shall be operated by a public weighmaster licensed in accordance with NCGS § 81A. A certified weight certificate shall be issued by a North Carolina public weighmaster for each load. The certificate shall be in the form of a ticket furnished by the Contractor and shall contain the following information:

(A) Department project contract number
(B) Date
(C) Time issued, if for bituminous plant mix or Portland cement stabilized base course mixed in a central plant
(D) Type of material
(E) Gross weight
(F) Tare weight
(G) Net weight of material
(H) Quarry or plant location
(I) Department's Job Mix Formula Number, if ticket is for asphalt plant mix
(J) Department's Asphalt Plant Certification Number, if ticket is for asphalt plant mix
(K) Truck number
(L) Contractor's name
(M) Public weighmaster's stamp or number
(N) Public weighmaster's signature or initials

When certified weighing devices other than platform scales are to be used, the gross weight and tare weight will not be required.

The Engineer may direct the Contractor to re-weigh the contents of any truck load that is to be delivered to the work on approved platform scales at no cost to the Department.

When tractor and trailer units are to be used in hauling material to be weighed, the platform scales shall be of sufficient length so as to accommodate the entire unit or the tractor shall be disconnected and the trailer and its contents weighed as a separate unit.

106-8 DEPARTMENT FURNISHED MATERIAL

The Contractor shall furnish all materials necessary to complete the work, except those materials specified in the contract to be furnished by the Department. Payment at the contract price for the item that includes the use of Department furnished material will be full compensation for all costs of handling and placing such materials after they are delivered or made available to the Contractor.

The Contractor shall be held responsible for all material furnished to him, and deductions will be made from any money due him to make good any shortage and deficiencies from any cause whatsoever and for any damage that may occur after Department furnished material has been made available.

106-9 DEFECTIVE MATERIAL

All materials that are not in conformity to the contract shall be defective and such materials, whether in place or not, may be rejected and removed from the site of the work unless otherwise permitted by the Engineer in accordance with Article 105-3. No rejected material, the defects of which may have been substantially corrected, may be used until approval has been given by the Engineer.

106-10 DENSITY DETERMINATION BY NUCLEAR METHODS

The Engineer may, at his option, use nuclear methods as described in Articles 520-9 and 610-10 to determine the density of selected pavement materials. The use of nuclear methods will include the establishment of the required density through the use of control strips constructed from materials actually being used on the project, and the determination of the density being obtained in test sections located throughout the project.

SECTION 107
LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107-1 LAWS TO BE OBSERVED

The Contractor shall keep himself fully informed of all Federal, State and local laws, ordinances and regulations, and all orders and decrees of bodies or tribunals having any jurisdiction or authority which may in any manner affect those engaged or employed in the work or which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, ordinances, regulations, orders and decrees; and shall indemnify and hold harmless the Board and the Department and their agents and employees from any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, by the Contractor or by his agents and employees. If during the course of the contract any such laws, ordinances and regulations, and all orders and decrees may be changed, the Contractor shall comply fully with the same.

It is unlawful for any vendor or contractor (i.e. architect, bidder, contractor, construction manager, design professional, engineer, landlord, offeror, seller, subcontractor, supplier or vendor), to make gifts or to give favors to any State employee of the Governor's Cabinet Agencies (i.e. Administration, Commerce, Correction, Crime Control and Public Safety, Cultural Resources, Environment and Natural Resources, Health and Human Services, Juvenile Justice and Delinquency Prevention, Revenue, Transportation and the Office of the Governor). This prohibition covers those vendors and contractors who:

(1) Have a contract with a governmental agency; or

(2) Have performed under such a contract within the past year; or

(3) Anticipate bidding on such a contract in the future.

Nondiscrimination: The Contractor, with regard to the work performed by it during the contract, shall not discriminate on the grounds of race, color, national origin, Limited English Proficiency, income-level, sex, sexual orientation, gender identity, age, or disability (or religion, where applicable), in the selection and retention of subcontractors, including procurements of materials and leases of equipment.

The Contractor shall comply with all Federal, State and local regulations when performing building removal, asbestos removal and disposal, or underground storage tank removal and disposal. Any fines resulting from violations of any regulation are the sole responsibility of the Contractor and the Contractor agrees to indemnify and hold harmless the Board and the Department and their agents and employees against any assessment of such fines.

107-2 ASSIGNMENT OF CLAIMS VOID

In accordance with NCGS §143B-426.40A, the Department will not recognize any assignment of claims by any Contractor against the Department.

107-3 PERMITS AND LICENSES

The Contractor shall procure all permits and licenses except as otherwise specified; pay all charges, fees and taxes; and give all notices necessary and incident to the due and lawful prosecution of the work.

For asphalt plants and concrete batch plants located on the Department's rights of way, apply for and obtain all environmental permits and licenses, including stormwater permits, before placement within the project limits or elsewhere on the Department's rights of way. Use proven Best Management Practices and equip all plants with such pollution control equipment and devices as is necessary to meet all applicable Federal, State and local pollution requirements. Conduct compliance monitoring and report findings to each applicable environmental regulatory agency according to their required frequency.

For any plumbing, heating, air conditioning, or electrical work in this contract, the Contractor will be required to sublet such work to a contractor properly licensed in accordance with *Article 2 of Chapter 87 of the General Statutes* (licensing of heating, plumbing, and air conditioning contractors) and *Article 4 of Chapter 87* of the *General Statutes* (licensing of electrical contractors).

107-4 PATENTED DEVICES, MATERIALS AND PROCESSES

If the Contractor employs any design, device, material, or process covered by letters of patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor and his Surety shall indemnify and save harmless the Department from any and all claims for infringement by reason of the use of such patented design, device, material, process, trademark or copyright and shall indemnify and save harmless the Department from any costs, expenses and damages which it may be obligated to pay at any time during the prosecution or after the completion of the work by reason of any alleged infringement.

107-5 ENCROACHMENT ON RIGHT OF WAY

Any entity wishing to encroach on highway right of way shall secure a written permit from the Department. The Contractor is not authorized to allow any entity to perform any work within the limits of the project unless such work has been authorized in writing by the Engineer.

When so directed by the Engineer, the Contractor shall make any repairs necessary due to such encroachments and such work will be paid as extra work.

107-6 FEDERAL PARTICIPATION

When the United States Government pays all or any portion of the cost of the work, the Federal laws authorizing such participation and the rules and regulations made pursuant to such laws shall be observed by the Contractor. The work will be subject to the inspection of the representative of such Federal agencies as are created for the administration of these laws. The Contractor shall have no right to make the Federal Government a party to any court action solely by reason of its participation in the cost of the work or by reason of its inspection of the work.

107-7 SANITARY PROVISIONS

The Contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of employees as may be necessary to comply with the requirements of the State and local Boards of Health, or of other bodies or tribunals having jurisdiction. Control and manage disposal of sanitary waste such that no adverse impacts occur to water quality.

107-8 PUBLIC CONVENIENCE AND SAFETY

The Contractor shall at all times conduct his work as to ensure the least possible obstruction to traffic. The safety and convenience of the general public and the residents along the highway, and the protection of persons and property, shall be provided for by the Contractor as specified in Section 150.

107-9 COORDINATION WITH RAILWAY

All work to be performed by the Contractor on railway right of way shall be performed in accordance with the contract and in a manner satisfactory to the railway company and shall be performed at such times and in such manner as not to unnecessarily interfere with the movement of traffic upon the track of the railway company. The Contractor shall use all care and precautions to avoid accidents, damage, or unnecessary delays or interference with the railway company's traffic or other property. The Contractor shall carry such railroad protective insurance and public liability and property damage insurance as may be stipulated in the contract. The Department shall not be responsible for any damage or injury to the railway company's traffic or property caused by the Contractor.

When the Contractor is required by the contract to transport materials or equipment across the tracks of any railway or to perform work on railway right of way, the Department will obtain any necessary written authority from the railway company for the establishment of a railway crossing or for the performance of work on railway right of way. The Contractor will not be required to bear the cost of any watchman service or flagging protection necessary due to such operations, as the railway company will be reimbursed directly by the Department for the cost of such work.

In case the Contractor elects or finds it necessary to transport materials or equipment across the tracks of any railway at any point where a crossing is not required by the contract or at any point other than an existing public crossing, he shall obtain specific written authority from the railway company for the establishment of a private railway crossing and shall bear all costs in connection with such crossing, including installation, drainage, maintenance, any necessary insurance, watchman service, flagging protection and removal of such private railway crossing.

107-10 WORK IN, OVER OR ADJACENT TO NAVIGABLE WATERS

All work in or over navigable waters shall be in accordance with conditions contained in the permit obtained by the Department from the authority granting the permit. These conditions will be included in the contract. The work shall be performed in such manner so as not to interfere with navigation of the waterways unless approval therefor is obtained from the authority granting the permit. The Department shall not be responsible for any damage or injury to entities upon or adjacent to navigable waters caused by the Contractor.

The Contractor shall prepare drawings necessary to obtain any addenda that may be required for his operations that are not included in the Department's permit and shall coordinate the submission with the Engineer.

107-11 PROTECTION AND RESTORATION OF PROPERTY

The Contractor shall be responsible for the protection from his activities of all public and private property on and adjacent to the work and shall use every reasonable precaution necessary to prevent damage or injury thereto. The Contractor shall use suitable precautions to prevent damage to pipes, conduits and other underground structures and to poles, wires, cables and other overhead structures.

The Contractor shall protect carefully from disturbance or damage all land monuments and property markers until the Engineer has witnessed or otherwise referenced their location and shall not remove them until directed.

The Contractor shall be responsible for the removal, preservation and resetting of all mailboxes disturbed by the construction operations. The mailboxes and their supports, when reset, shall be left in as good a condition as they were before removal. The Contractor will not be required to furnish new material except as required to repair damage resulting from construction operations.

The Contractor shall be held responsible for all damage or injury to property of any character resulting from any act, omission, negligence, or misconduct in the prosecution of the work. When any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, negligence, or misconduct in the execution of the work, he shall either restore at his own expense such property to a condition similar or equal to that existing before such damage or injury was done, or shall make good such damage or injury in a manner acceptable to the owner of the damaged property and to the Department. In case of failure on the part of the Contractor to restore such property or make good such damage or injury, the Department may, at the Contractor's expense, repair, rebuild, or otherwise restore such property in such manner as the Engineer may consider necessary.

107-12 CONTROL OF EROSION, SILTATION AND POLLUTION

(A) General

The Contractor shall take whatever measures are necessary to minimize soil erosion and siltation, water pollution and air pollution caused by his operations. The Contractor shall comply with the applicable regulations of all legally constituted authorities relating to pollution prevention and control. The Contractor shall keep himself fully informed of all such regulations that in any way affect the conduct of the work and shall at all times observe and comply with all such regulations. In the event of conflict between such regulations and the specifications, the more restrictive requirements shall apply.

The Engineer will limit the area over which clearing and grubbing, excavation, borrow and embankment operations are performed whenever the Contractor's operations do not make effective use of construction practices and temporary measures which will minimize erosion, or whenever construction operations have not been coordinated to effectively minimize erosion, or whenever permanent erosion control features are not being completed as soon as permitted by construction operations.

Following completion of any construction phase or operation, on any graded slope or any disturbed area, the Contractor shall provide ground cover sufficient to restrain erosion within 21 calendar days or within a time period specified by the NCG 010000 Construction Permit. The ground cover shall be either temporary or permanent and the type specified in the contract.

(B) Erosion and Siltation Control

The Contractor shall exercise every reasonable precaution throughout the life of the project to prevent the eroding of soil and the silting of rivers, streams, lakes, reservoirs, other water impoundments, wetlands, ground surfaces or other property.

Before suspension of operations on the project or any portion thereof, the Contractor shall take all necessary measures to protect the construction area, including, but not limited to, borrow sources, soil type base course sources and waste areas from erosion during the period of suspension.

Unless otherwise approved in writing by the Engineer, construction operations in rivers, streams and water impoundments shall be restricted to those areas where channel changes are shown in the plans and to those areas which must be entered for the construction or removal of temporary or permanent structures.

Excavated materials shall not be deposited, nor shall earth dikes or other temporary earth structures be constructed, in rivers, streams, or impoundments. As an exception to the

above, confined earth materials will be permitted when approved in writing by the Engineer.

Fording of live streams with construction equipment will not be permitted; therefore, temporary bridges or other structures shall be used wherever stream crossings are necessary. Unless otherwise approved in writing by the Engineer, mechanized equipment shall not be operated in live streams except as may be necessary to construct channel changes and to construct or remove temporary or permanent structures.

(C) Coordination of Erosion Control Operations

Temporary and permanent erosion control measures shall be provided as shown in the plans or as directed by the Engineer. All permanent erosion control work shall be incorporated into the project at the earliest practicable time. Temporary erosion control measures shall be coordinated with permanent erosion control measures and all other work on the project to assure economical, effective and continuous erosion control throughout the construction and post construction period and to minimize siltation of rivers, streams, lakes, reservoirs, other water impoundments, wetlands, ground surfaces, or other property.

Temporary erosion control measures shall include, but not be limited to, the use of temporary berms, dikes, dams, drainage ditches, silt basins, silt ditches, slope drains, structures, vegetation, mulches, mats, netting, gravel, or any other methods or devices that are necessary. Temporary erosion control measures may include work outside the right-of-way or construction limits where such work is necessary as a result of construction such as borrow operations, haul roads, plant sites, equipment storage sites and disposal of waste or debris. The Contractor shall be liable for all damages to public or private property caused by silting or slides originating in waste areas furnished by the Contractor.

Materials for temporary erosion control measures shall have been approved by the Engineer before being used or shall be as directed by the Engineer. The Contractor shall acceptably maintain erosion control measures installed.

(D) Water and Air Pollution

Exercise every reasonable precaution throughout the life of the project to prevent pollution of ground waters and surface waters, such as rivers, streams and water impoundments. Do not discharge onto the ground or surface waters any pollutants such as chemicals, raw sewage, fuels, lubricants, coolants, hydraulic fluids, concrete, bitumens and any other petroleum products. Operate and maintain equipment on site in a manner as to prevent the potential or actual pollution of surface or ground waters of the State. Dispose of spent fluids in accordance with applicable Federal and State disposal regulations. Immediately clean up any spilled fluids to the extent practicable and dispose of properly.

Manage, control and dispose of litter on site such that no adverse impacts to water quality occur. Comply with all Federal, State or local air pollution regulations throughout the life of the project.

(E) Dust Control

The Contractor shall control dust throughout the life of the project within the project area and at all other areas affected by the construction of the project, including, but not specifically limited to, unpaved secondary roads, haul roads, access roads, disposal sites, borrow and material sources and production sites. Dust control shall not be considered effective where the amount of dust creates a potential or actual unsafe condition, public nuisance, or condition endangering the value, utility, or appearance of any property.

The Contractor will not be directly compensated for any dust control measures necessary, as this work will be incidental to the work covered by the various contract items.

(F) Application of Specifications

Article 107-12 shall apply to all construction operations. Further references and detailed requirements concerning erosion, siltation and pollution prevention and control are given in other sections of the *Standard Specifications* as supplements to the general requirements of this article.

(G) Sanctions

In the event that temporary erosion and pollution control measures become necessary due to the Contractor's negligence, carelessness, or failure to incorporate permanent erosion control measures into the project at the earliest practicable time, such measures shall be performed by the Contractor as directed by the Engineer at no cost to the Department. If the Contractor fails to perform such measures as directed, the Engineer may have the work performed in accordance with Article 105-16.

Failure of the Contractor to fulfill any of the requirements of this article may result in the Engineer ordering the stopping of construction operations in accordance with Article 108-7 until such failure has been corrected. Such suspension of operations will not justify an extension of contract time.

Failure on the part of the Contractor to perform the necessary measures to control erosion, siltation and pollution will result in the Engineer notifying the Contractor to take such measures. In the event that the Contractor fails to perform such measures within 24 hours after receipt of such notice with adequate forces and equipment, the Engineer may suspend the work as provided above, or may proceed to have such measures performed with other forces and equipment, or both. No payment will be made to the Contractor for the performance of this work and the cost of such work so performed will be deducted from monies due the Contractor on his contract.

107-13 PROTECTION OF PUBLIC LANDS

In the execution of any work within or adjacent to any National or State forest, park or other public lands, the Contractor shall comply with all regulations of all authorities having jurisdiction over such forest, park or lands, governing the protection of public lands and the carrying out of work within public lands and shall observe all sanitary laws and regulations with respect to the performance of work in public lands. He shall keep the areas in an orderly condition, properly dispose of all refuse and obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks and other structures in accordance with the regulations of the appropriate authorities.

The Contractor shall take all reasonable precaution to prevent and suppress forest fires and shall require his employees and subcontractors, both independently and at the request of forest officials, to do all reasonable within their power to prevent and suppress and to assist in preventing and suppressing forest fires and to make every possible effort to notify a forest official at the earliest possible moment of the location and extent of any fire seen by them.

The Contractor shall obtain any construction permits that may be required for his operations, which are not a part of the project, in accordance with the regulations of the appropriate authorities.

107-14 RESPONSIBILITY FOR DAMAGE CLAIMS

The Contractor shall indemnify and save harmless the Board and its members and the Department, its officers, agents and employees from all suits, actions, or claims of any character brought for any injury or damages received or sustained by any person, persons, or property by reason of any act of the Contractor, subcontractor, its agents or employees, in the performance of the contract. The Contractor's liability to save harmless and indemnify shall include, but not by way of limitation, the following:

(A) Damages or claims for the failure of the Contractor to safeguard the work;

(B) Damages or claims by reason of the failure of the Contractor to erect adequate barricades and post adequate warnings to the public of such barricades;

(C) Any damage or claims caused through the Contractor's use of defective materials or by the performance of defective work;

(D) Any claims by reason of the Contractor's infringement of patent, trademark, or copyright;

(E) Any amounts paid by the Department by reason of the Contractor's failure to comply with or for violations of laws, ordinances, orders, or decrees;

(F) Any damages or claims caused by blasting operations of the Contractor with or without proof of negligence on the part of the Contractor;

(G) Damages or claims caused by the failure of the Contractor to protect private or public property pursuant to Article 107-11, including damages to public and private property caused by silting and slides from waste areas furnished by the contractor, without proof of negligence; and

(H) Damages caused by the failure of the Contractor to control erosion in accordance with the contract.

In addition to any remedy authorized by law, the Department shall have a right to retain from monies due the Contractor, as the Department considers necessary until final disposition has been made of the following suits or claims:

(1) For all claims against the Department involving claims or damages that are the Contractor's responsibility under Section 107. The Contractor and the Surety shall remain responsible until such suits or claims against the Department have been settled and until the Department has been indemnified and saved harmless.

(2) In case of claims by third parties against the Contractor involving tort liability for which the Department might be held liable for as a taking of property, or as a tort before the Industrial Commission. However, monies due the Contractor will not be retained provided the Contractor produces satisfactory evidence to the Department that he is adequately protected from such tort liability by public liability and property damage insurance. In all other cases involving claims or suits by third parties against the Contractor, amounts due the Contractor will not be withheld provided that the consent of the Surety is furnished and the Surety guarantees payment of any amounts for which the Contractor may be determined to be legally liable.

(3) In cases of damage to property of the Department, such amounts necessary to pay for such damage.

In cases where claims are made or suits filed against the Board or its members and the Department, its officers, agents and employees, the Department may retain from any monies due the Contractor, an amount sufficient to indemnify such member of the Board or officer, agent or employee of the Department for any amounts which they may be held liable for but for which the Contractor is responsible under Section 107. In the event that there is not sufficient monies available from the final estimate, the Department may collect from the Contractor or its Surety amounts sufficient to indemnify such employee, agent or officer of the Department or member of the Board for such damages incurred.

107-15 LIABILITY INSURANCE

The Contractor shall be liable for any losses resulting from a breach of the terms of this contract. The Contractor shall be liable for any losses due to the negligence or willful misconduct of its agents, assigns and employees including any subcontractors which causes damage to others for which the Department is found liable under the Torts Claims Act, or in the General Courts of Justice, provided the Department provides prompt notice to the

Contractor and that the Contractor has an opportunity to defend against such claims. The Contractor shall not be responsible for punitive damages.

The Contractor shall at its sole cost and expense obtain and furnish to the Department an original standard *Association for Cooperative Operations Research and Development (ACORD)* certificate of liability insurance evidencing commercial general liability with a limit for bodily injury and property damage in the amount of $5,000,000 per occurrence and $5,000,000 general aggregate, covering the Contractor from claims or damages for bodily injury, personal injury, or for property damages that may arise from operating under the contract by the employees and agents of the Contractor. The required limit of insurance may be obtained by a single general liability policy or the combination of a general liability and excess liability or umbrella policy. The State of North Carolina shall be named as an additional insured on this commercial general liability policy. The policy may contain the following language as relates to the State as an additional insured: "This insurance with respect to the additional insured applies only to the extent that the additional insured is held liable for your or your agent's acts or omissions arising out of and in the course of operations performed for the additional insured."

The Contractor shall maintain all legally required insurance coverage, including without limitation, worker's compensation and vehicle liability, in the amounts required by law. Prior to beginning services, all contractors shall provide proof of coverage issued by a workers' compensation insurance carrier, or a certificate of compliance issued by the Department of Insurance for self-insured subcontractors, irrespective of whether having regularly in service fewer than three employees. Providing and maintaining adequate insurance coverage is a material obligation of the contractor and is of the essence of this contract. All such insurance shall meet all laws of the State of North Carolina. Such insurance coverage shall be obtained from companies that are authorized to provide such coverage and that are authorized by the Commissioner of Insurance to do business in North Carolina. The Contractor shall at all times comply with the terms of such insurance policies.

Upon execution of the contract, provide evidence of the above insurance requirements to the Engineer. When required by the contract, the Contractor shall carry insurance of the kinds and in the amounts specified therein in addition to any other forms of insurance or bonds required under the terms of the contract, or any other insurance carried by the Contractor.

107-16 OPENING SECTIONS OF PROJECT TO TRAFFIC

If it is determined by the Engineer that the Contractor will not complete the work by the completion date, intermediate completion date, or intermediate completion time, the Engineer may notify the Contractor in writing that upon expiration of contract time or intermediate contract time the project, or any portion thereof, will be open to traffic. On such sections that are opened, the Contractor shall conduct the remainder of his operations so as to cause the least obstruction to traffic. The Contractor shall not be relieved of his liability or responsibility, shall not receive any additional compensation due to the added cost of the work, nor shall he receive any extension of the completion date, intermediate completion date, or intermediate completion time, by reason of such openings.

107-17 CONTRACTOR'S RESPONSIBILITY FOR WORK

Until final acceptance of the work by the Engineer, as evidenced in writing, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements, or from any other cause, whether arising from the execution or from the nonexecution of the work. The Contractor shall rebuild, repair, restore and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof, except as provided in other sections of the *Standard Specifications*. The Department will reimburse the Contractor for the repair of the work due to actions of the elements of such exceptional nature as to be contractually classified as Acts of God.

In case of suspension of work from any cause whatsoever, the Contractor shall be responsible for all materials and shall properly store them, if necessary, and shall provide suitable drainage of the roadway and erect necessary temporary structures at no cost to the Department.

107-18 FURNISHING RIGHT OF WAY

The Department will be responsible for the securing of all necessary rights of way.

107-19 PERSONAL LIABILITY OF PUBLIC OFFICIALS

The Board and its members and the Department's officers, agents and employees shall not be held personally liable for any damages connected with the work, it being specifically understood in all such matters that they act solely as agents and representatives of the Board or the Department.

107-20 WAIVER OF LEGAL RIGHTS BY THE DEPARTMENT

Upon completion of the work, the Department will expeditiously make an inspection and notify the Contractor of acceptance. Such final acceptance and processing of the final estimate, however, shall not preclude or estop the Department from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Department be precluded or estopped from recovering from the Contractor or his Surety, or both, such overpayment as it may sustain, or by failure on the part of the Contractor to fulfill his obligations under the contract. A waiver on the part of the Department of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the terms of the contract, shall be liable to the Department for latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the Department's rights under any warranty or guaranty.

107-21 SAFETY AND ACCIDENT PROTECTION

The Contractor shall comply with all applicable Federal, State and local laws, ordinances and regulations governing safety, health and sanitation, and shall provide all safeguards, safety devices and protective equipment, and shall take any other needed actions, on his own responsibility, that are reasonably necessary to protect the life and health of employees on the job and the safety of the public, and to protect property in connection with the performance of the work covered by the contract.

All Contractors' personnel, all subcontractors and their personnel, and any material suppliers and their personnel shall wear a reflective vest or outer garment conforming to MUTCD at all times while on the project.

107-22 WAGES AND CONDITIONS OF EMPLOYMENT

The Contractor's attention is directed to the provisions and requirements of any and all public statutes that regulate hours or conditions of employment on public work. Such provisions and requirements that are appropriate, in accordance with the intent of the particular law, act, or statute, will be applicable to all work performed by the Contractor with his own organization and with the assistance of workmen under his immediate superintendence and to all work performed by subcontract. It shall be the responsibility of the Contractor to ascertain the appropriate application of such provisions and requirements to the work.

In addition to the general requirements of the various regulations referred to above, certain additional regulations and restrictions may be imposed that are peculiar to the particular work under the contract. In such cases, these regulations and restrictions will be included in the contract for the particular project involved.

For projects that are financed wholly or in part with Federal funds, the minimum wage rates to be paid to all mechanics and laborers employed on the project will be determined by the U.S. Secretary of Labor. A schedule of such wage rates will be included in the proposal for such projects. The Contractor shall provide at the job site at no cost to the Department a weatherproof bulletin board covered with glass or rigid transparent plastic and shall display thereon at all times the required federal aid posters with regard to employment and wages that will be furnished to him. The bulletin board shall be located in a conspicuous place easily accessible to all employees.

In the event that changes should occur in any of the regulations referred to in this article, or in any application thereof to the work under contract, no additional compensation will be allowed the Contractor as a result of such changes.

107-23 LIABILITY TO THIRD PARTIES

It is not intended by any of the provisions of any part of these specifications to make the public or any member thereof a third party beneficiary hereunder, or to authorize anyone who is not a party to a contract entered into pursuant to these specifications to maintain a suit for personal injury or property damage otherwise than as authorized and provided by law.

107-24 RIGHT OF THE CONTRACTOR TO FILE VERIFIED CLAIM

If the Contractor fails to receive such settlement as he claims to be entitled to under the terms and provisions of the contract, the Contractor may submit a written and verified claim for such amounts he deems himself or his subcontractor entitled to under the terms and provisions of the contract provided he has complied with the applicable provisions of the contract including, but not limited to, giving written notice of intent to file a claim, keeping and submission of cost records and the initial submission of a written claim within the specified time period. The claim shall be submitted to the Chief Engineer within 60 calendar days from the time the Contractor receives the final estimate as defined by Section 101 and shall be submitted in accordance with NCGS § 136-29.

Submission of records by the Contractor and physical acceptance by the Department, during the course of the project shall not be construed as an admission of liability by the Department and shall be accepted by the Department for record keeping purposes only and not as an acknowledgement of entitlement by the Contractor.

107-25 HAZARDOUS, CONTAMINATED AND TOXIC MATERIAL

When the Contractor's operations encounter or expose any abnormal condition that may indicate the presence of a hazardous, contaminated, or toxic material, such operations shall be discontinued in the vicinity of the abnormal condition and the Engineer shall be notified immediately. Upon notification by the Contractor, the Engineer will investigate the work and, if necessary, suspend the work in accordance with Article 108-7. The presence of storage drums or barrels; old or abandoned underground storage tanks; discolored earth, metal, wood, etc.; visible fumes; abnormal odors; excessively hot earth; smoke; or anything else that appears abnormal may be indicators of hazardous, contaminated or toxic materials and shall be treated with extraordinary caution as they are evidence of abnormal conditions.

The Contractor's operations shall not resume until so directed by the Engineer.

Disposition of the hazardous, contaminated, or toxic material will be made in accordance with Federal, State and local requirements and regulations. Where the Contractor performs work necessary to dispose of hazardous, contaminated, or toxic material, payment will be made at the unit prices for pay items included in the contract that are applicable to such work. Where the contract does not include such pay items, the Engineer may have the work performed by others or the Contractor may perform the work in accordance with Article 104-7 for extra work and the following paragraphs.

The Contractor shall employ a fully experienced and prequalified geoenvironmental firm to oversee and document the disposal of contaminated material removed from within the project

limits. The Contractor shall furnish and deliver to the Department a digital report including all documents necessary to meet the laws, rules and regulations of the environmental regulatory agency(ies) having jurisdiction over each respective site from which contaminated materials are removed. Reports documenting the Contractor's work and laboratory analyses of collected samples shall be submitted to the Department within 30 calendar days after completion of the removal of the contaminated materials. If the Contractor removes any underground storage tanks (UST), a UST Closure Report shall be presented to the Department within 25 calendar days after receipt of laboratory data. The Contractor shall not submit any reports directly to the regulatory agencies. The Contractor shall provide to the Department a certificate of remediation from the disposing/treating facility within 60 calendar days after removal of the materials from the project site unless alternate arrangements are approved in writing by the Department.

Contaminated material removed during construction shall be transported to a waste treatment and disposal facility that is fully approved and permitted by all applicable environmental regulatory agencies to receive, treat and/or dispose of the material. It shall be the Contractor's responsibility to locate such a facility. Departmental approval of the specific facility identified for use by the Contractor shall occur before removal of any materials from the project limits. Contaminated material shall only be removed to the extent necessary to complete a task or as directed by the Engineer. Remaining contamination shall be left in place and documented in reports provided to the Department. The Contractor shall provide the Department with all transportation manifests and certificates of acceptance from the receiving disposal facility weekly. The Department will be the regulatory generator of all waste excavated and removed from within the project limits. The Contractor, with the approval of the Engineer, is authorized to sign all waste transportation and disposal manifests on behalf of the Department.

The Contractor shall maintain qualified personnel on-site at all times during removal of materials from within known areas of contamination for field screening and to monitor ambient air quality. The qualified personnel shall be knowledgeable with the use of an Organic Vapor Analyzer, Flame Ionization Detector, Photo Ionization Detector, or other appropriate monitoring equipment. In the event that there is a need to stockpile contaminated material, the Contractor shall stockpile all contaminated soil excavated from a parcel in a location within the property boundaries of the source parcel in accordance with the Standard Stockpile Containment Detail. If the volume of contaminated material exceeds available space on site, the Contractor shall obtain a permit from the NCDEQ UST (Underground Storage Tank) Section for off-site temporary storage.

The Contractor shall be entirely responsible for compliance with all OSHA, EPA, DOT, NCDEQ, and local rules and regulations pertaining to excavation, transportation and treatment/disposal of the contaminated material. Examples of such rules and regulations include, but are not limited to, 29 CFR 1910 General Industry Standards and 1926 Construction Standards, and 40 CFR 260 Hazardous Waste Management System, 261 General, Identification and Listing of Hazardous Waste, 262 Standards Applicable to Generators of Hazardous Waste, 263 Standards Applicable to Transporters of Hazardous Waste, 264 Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, 265 Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, 49 CFR 173 Shippers-General Requirements for Shipments and Packagings, 49 CFR 178 Specifications for Packagings, 15A NCAC 13A North Carolina Hazardous Waste Management Rules, NCGS § 130A-310 Inactive Hazardous Sites, the Federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Federal Resource Conservation and Recovery Act (RCRA). It must be noted that inclusion of this paragraph is meant to highlight the Contractor's responsibility for regulatory compliance in all phases of work on this project.

107-26 FINES AND LEVIES AGAINST THE DEPARTMENT

In the event there are fines or charges levied against the Department, actions taken by the Department, or remediation required by the Department due to the contractor's negligence, carelessness, or failure, due to violations charged to the Contractor, or due to the Contractor's failure to comply with the contract, monies will be deducted from monies to be paid to the Contractor on this project.

SECTION 108
PROSECUTION AND PROGRESS

108-1 GENERAL

It is the intent of these specifications that the Contractor shall commence work on the date of availability shown in the contract or as soon thereafter as practicable, except that when required by permits included in the proposal, that work in jurisdictional waters and wetlands shall not begin until a meeting is held between the Department, Regulatory Agencies and the Contractor. The Contractor shall not begin work before the date of availability without written approval of the Engineer. If such approval is given, the Department will assume no responsibility for any delays caused before the date of availability by any reason whatsoever, and such delays, if any, will not constitute a valid reason for extending the completion date.

The Contractor shall pursue the work diligently with workmen in sufficient numbers, abilities and supervision, and with equipment, materials and methods of construction as may be required to complete the work described in the contract or as may be amended by the completion date.

108-2 PROGRESS SCHEDULE

The Contractor shall prepare and submit for review and approval a schedule of proposed working progress. This schedule shall be submitted on forms supplied by the Engineer or in a format that is approved by the Engineer. A detailed Critical Path Method (CPM) schedule shall not be submitted to replace the progress schedule details required below.

The proposed progress schedule shall be submitted no later than 7 calendar days before the date of the project preconstruction conference and shall be approved before any payments will be processed for the project.

When the Engineer has extended the completion date or if the project overrun is anticipated to exceed 5%, the Contractor may submit a revised progress schedule to the Engineer for review and approval. If plan revisions are anticipated to change the sequence of operations in such a manner as will affect the progress but not the completion date, then the Contractor may submit a revised progress schedule for review and approval by the Engineer but the completion date shall remain unchanged.

The proposed progress schedule shall contain the following items:

(A) A time scale diagram with major work activities and milestone dates clearly labeled.

(1) For purposes of composing the progress schedule, major work activities are defined as components comprising more than 5% of the total project cost or occupying more than 10% of total contract time and shall include, if applicable, the following:

(a) Clearing and grubbing
(b) Grading
(c) Drainage
(d) Soil stabilization
(e) Aggregate base course
(f) Pavement
(g) Culverts
(h) Bridges (including removal)

(i) Signals, ITS and lighting
(j) Overhead signs

(2) For purposes of composing the progress schedule, major milestones are derived from the project construction phasing and shall include, if applicable, the following:

(a) Start of construction
(b) Intermediate completion dates or times
(c) Seasonal limitation/observation periods/moratoriums
(d) Traffic shifts
(e) Beginning and end of each traffic control phase or work area
(f) Road openings
(g) Completion date

(B) A cash curve corresponding to the milestones and work activities established in Subarticle 108-2(A) above.

(C) A written narrative that explains the sequence of work, the controlling operations, intermediate completion dates, milestones, project phasing, anticipated work schedule and estimated resources. In addition, explain how permit requirements, submittal tracking and coordination with subcontractors, utility companies and other entities will be performed.

108-3 PRECONSTRUCTION CONFERENCE

Immediately after receipt of notice of award, the Engineer and the Contractor will establish a mutually agreeable date on which the preconstruction conference will be held. The Contractor's project superintendent and other individuals representing the Contractor who are knowledgeable of the Contractor's proposed progress schedule or who will be in charge of major items of the work shall attend the preconstruction conference.

108-4 CONSTRUCTION CONFERENCES

After work on the project has begun, construction conferences will be held periodically. The construction conferences are to be scheduled at times that are mutually agreeable to both the project superintendent and the Engineer. It shall be the superintendent's responsibility to attend the conferences.

108-5 CHARACTER OF WORKMEN, METHODS AND EQUIPMENT

The Contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time required by the specifications.

Department employees who elect to become employed by a Contractor may not perform any function on a project with which they have been involved during employment with the Department without written consent of the State. Any person employed by the Contractor and assigned to a project who has previously been involved in the project as a Department employee shall be, at the written direction of the Engineer, removed from the project. An exception to these terms may be granted when recommended by the Secretary and approved by the Board.

Failure of the Contractor to comply may be justification for disqualifying him from further bidding in accordance with Article 102-15 and shall be grounds for termination of this contract.

No person shall be employed by the Contractor or by any subcontractor who has been determined by the Engineer to have engaged in fraudulent activities in connection with any work for the Department.

Any person employed by the Contractor or by any subcontractor who, in the opinion of the Engineer, does not perform his work in a proper and skillful manner or is disrespectful, intemperate, or disorderly or who has been determined by the Engineer to have engaged in fraudulent activities in connection with any work for the Department shall, at the written request of the Engineer, be removed forthwith by the Contractor or subcontractor employing such person and shall not be employed again in any portion of the work without the approval of the Engineer.

Should the Contractor fail to remove such persons as required above, the Engineer may suspend the work in accordance with Article 108-7.

All equipment proposed to be used on the work is to be of sufficient size and in such mechanical condition as to meet the requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no injury to the roadway, adjacent property, or other highways will result from its use. The Engineer may order in writing the removal and replacement of any unsatisfactory equipment.

When the methods and equipment to be used by the Contractor in accomplishing the construction are not prescribed in the contract, the Contractor is free to use any methods or equipment that he demonstrates to the satisfaction of the Engineer will accomplish the contract work in conformity with the contract.

When the contract specifies that the construction be performed by the use of certain methods and equipment, such methods and equipment shall be used unless others are approved by the Engineer. If the Contractor desires to use a method or type of equipment other than those specified in the contract, he may request approval from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approval is given by the Engineer, it will be on the condition that the Contractor will be fully responsible for producing construction work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining construction with the specified methods and equipment. The Contractor shall remove the unsatisfactory work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the construction items involved or in the completion date as a result of authorizing a change in methods or equipment under these provisions.

108-6 SUBLETTING OF CONTRACT

The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or any portion thereof; or of his right, title, or interest therein; without written consent of the Engineer. All requests to sublet work shall be submitted within 30 calendar days of the date of availability or prior to expiration of 20% of the contract time, whichever date is later, unless otherwise approved by the Engineer. In case such consent is given, the sublet work shall be performed by the subcontractor unless otherwise approved in writing by the Engineer. Failure of the Contractor to comply with the *Standard Specifications* will be just cause for the work to be considered unauthorized in accordance with Article 105-12. A firm that has been disqualified due to its failure to maintain satisfactory progress under Article 108-8 will not be approved as a subcontractor until the firm demonstrates the ability to perform the work in a satisfactory manner. When directed by the Engineer, the Contractor shall submit a certified copy of the actual subcontract agreement executed between the Contractor and subcontractor before written consent being issued by the Engineer. In case such consent is given, the Contractor will be permitted to sublet a portion thereof, but shall perform with his own organization, work amounting to not less than 40% of the total original contract amount, except:

(A) Any items designated in the contract as specialty items may be performed by subcontract and the cost of any such special items so performed by subcontract will be deducted from the total amount bid before computing the amount of work required to be performed by the Contractor with his own organization, and

(B) Any other items sublet to Disadvantaged Business Enterprise (DBE), Minority Business (MB) or Women's Business (WB), up to the value of the contract DBE, MB or WB goal, will be deducted from the total amount bid before computing the amount of work required to be performed by the Contractor with his own organization.

In any event, the Contractor shall perform with his own organization work amounting to not less than 35% of the difference between the total amount bid and the value of specialty items that have been sublet. Purchasing materials for subcontractors is not included in the percentage of work required to be performed by the Contractor. If the Contractor sublets items of work but elects to purchase material for the subcontractor, the value of the material purchased will be included in the total dollar amount considered to have been sublet.

Extra work performed in accordance with Article 104-7 will not be considered in the computation of work required to be performed by the Contractor.

An assignment by operations of law or assignment for the benefit of creditors, or the bankruptcy of the Contractor, shall not vest any right in this contract in the Trustee in bankruptcy, the Contractor's creditors, or the agent of the creditors.

A subcontractor shall not sublet, sell, transfer, assign, or otherwise dispose of his contract with a contractor or any portion thereof; or of his right, title, or interest therein; without written consent of the Engineer. When directed by the Engineer, the contractor shall submit a certified copy of the actual subcontract agreement executed between the subcontractor and the second tier subcontractor. In the event of an assignment by operations of law or the bankruptcy of the subcontractor, the contractor shall have the right, power and authority, in its discretion, without violating the contract or releasing the Surety, to terminate the subcontract. An assignment by operations of law or assignment for the benefit of creditors or the bankruptcy of the subcontractor shall not vest any right in this contract in the Trustee in bankruptcy, nor the subcontractor's creditors or agents of the creditors.

Neither the Contractor, nor any subcontractor, shall enter into any written or oral equipment lease or rental agreement, materials purchase agreement or labor agreement that circumvents this article.

If the Contractor or a subcontractor enters into a lease or rental agreement for equipment based upon payment for a unit of work, such agreement will be considered subletting of the contract unless the lease or rental agreement is with a commercial equipment company, manufacturer or commercial leasing agency and such firm has been approved by the Engineer. An equipment lease or rental agreement that is based upon unit prices per unit of time will not be considered subletting of the contract.

The approval of any subcontract will not release the Contractor of his liability under the contract and bonds, nor will the subcontractor or the second tier subcontractor have any claim against the Department by reason of the approval of the subcontract. The Engineer will review and consider subcontractor claims for additional time or compensation provided such claims are submitted by the Contractor in accordance with Article 107-24 and NCGS § 136-29.

Failure of the Contractor to comply with any of the requirements of this article may be justification for disqualifying the Contractor from further bidding in accordance with Article 102-15.

108-7 TEMPORARY SUSPENSION OF THE WORK

The Engineer will have the authority to suspend the work wholly or in part by written order for such periods, as he may deem necessary for any of the following reasons:

(A) Conditions considered unfavorable for the suitable prosecution of the work, or

(B) The Contractor's failure to correct conditions unsafe for workmen or the general public, or

(C) The Contractor has not carried out orders given to him by the Engineer, or

(D) The Contractor's failure to perform any provisions of the contract.

No extension of the completion date will be allowed for the above suspensions except as may be provided for in Article 108-10.

108-8 FAILURE TO MAINTAIN SATISFACTORY PROGRESS

The Engineer will check the Contractor's progress at the time each partial pay estimate is prepared. The Contractor's progress may be considered as unsatisfactory as follows:

(A) The Contractor's progress is found to be less than that described in either count below:

(1) The dollar value of the work completed, excluding material payments allowed by Article 109-5, is less than the dollar value of the work that should have been completed, on the basis of the Contractor's approved progress schedule, by more than 15% of the current contract amount.

The dollar value of the work completed will be the total estimate to date shown in the latest partial pay estimate, excluding material payments allowed by Article 109-5. The current contract amount will be the total amount bid plus accumulated overruns less accumulated underruns shown in the latest partial pay estimate.

(2) The percentage of the work completed is less than the percentage of contract time elapsed on the work by more than 15%. The percentage of work completed will be the dollar value of the work completed as defined above, divided by the current contract amount as defined above.

The percentage of contract time elapsed will be the number of calendar days elapsed as shown in the latest partial pay estimate divided by the total contract time in calendar days.

(B) The Contractor fails to begin and pursue the work in accordance with Article 108-1 before the expiration of 5% of the original contract time after the date work was scheduled to begin based upon the approved progress schedule.

(C) The Engineer anticipates the Contractor will not complete the work described in the contract by the intermediate contract time or the contract completion date.

When the Contractor's progress is found to be unsatisfactory as described in Subarticles 108-8(A), 108-8(B) and 108-8(C) above, the Engineer may make written demand of the Contractor to state in writing the reason for the unsatisfactory progress and produce such supporting data as the Engineer may require or the Contractor may desire to submit. The Engineer will consider the justifications submitted by the Contractor and extensions of the completion date have or may be allowed in accordance with Subarticle 108-10(B).

When the Contractor cannot satisfactorily justify the unsatisfactory progress, the Engineer may invoke one or more of the following sanctions:

(1) Withhold anticipated liquidated damages from amounts currently due or that become due.

(2) Remove the Contractor from the Prequalified Bidders' List.

When any of the above sanctions have been invoked, they shall remain in effect until rescinded by the Engineer.

108-9 DEFAULT OF CONTRACT

(A) Declaration of Default

The Department shall have the right to declare default of the contract for breach by the Contractor of any material term or condition of the contract as determined by the Department. Material breach by the Contractor shall include, but specifically shall not be limited to failure to begin work under the contract within the time specified; failure to provide workmen, equipment, or materials adequate to perform the work in conformity with the contract by the completion date; unsatisfactory performance of the work; refusal or failure to replace defective work; failure to maintain satisfactory work progress; failure to comply with equal employment opportunity contract requirements; insolvency or bankruptcy, or any act of insolvency or bankruptcy; and making an assignment for benefit of creditors.

(B) Corrective Actions upon Default

In the event of a breach of the contract by the Contractor, the Department shall have the right, power and authority, in its sole discretion, without violating the contract or releasing the Surety: to assume full control of the prosecution of the contract in the place and stead of the Contractor in directing Contractor's agents, employees and subcontractors in the performance of the work and in utilizing all materials, tools, machinery, equipment and structures located on the project; to perform the work or any part thereof with Department personnel and equipment or to use any or all materials and equipment located on the project that are suitable and acceptable; to relet the work upon such terms and conditions as the Department shall deem appropriate; to employ any other methods that it may determine are required for completion of the contract in an acceptable manner; and to withhold any sums due the Contractor under the contract without penalty or interest until the work is completed and accepted by the Department.

(C) Notice

Before invoking any of the corrective actions provided for herein, the Department will give the Contractor at least 7 calendar days written notice with a copy to the Surety, that will set forth the breach of contract involved and the corrective actions to be imposed. The Department, in its discretion, may grant the Contractor time in excess of 7 calendar days within which to comply with the contract and the time allowed will be set forth in writing. If the Department determines during such period that the Contractor is not proceeding satisfactorily to compliance, it may impose the corrective actions after 24 hours' notice to the Contractor. If the Department determines that the Contractor is not in compliance at the end of the time allowed, it may immediately impose any of the corrective actions set forth herein and will advise the Contractor, in writing, with a copy to the Surety of the corrective actions imposed.

(D) Payment

After declaration of default has been made final, the Contractor will be entitled to receive payment for work satisfactorily completed or portions of work satisfactorily completed, less any sums that may be due the Department from the Contractor but in no event shall payment exceed the contract unit or lump sum price for such work. The Department, at its election, may retain the sum due the Contractor, or any portion thereof, without interest or penalty, until the contract work is completed; or it may make payment to the Contractor upon declaration of default for work satisfactorily completed to the date that notice of default is received by the Contractor. The Contractor may be required by the Engineer to carry to a stage of completion satisfactory to the Engineer any work in progress, the value of which, otherwise, would be lost by immediate cessation of work. Payment for such work will be made upon the basis hereinafter set out.

In the event that the Contractor's employees, equipment, or materials are used in prosecution of the work, or any part thereof, after default is declared, payment to the

Contractor may be by contract unit or lump sum prices for the work performed, or, if the Engineer determines that such prices do not represent the value of the work performed, payment for the type of work or services performed will be made on a force account basis, as set forth in Article 109-3, less any sums that may be due the Department; but in no event shall payment exceed the contract unit or lump sum price for such work or services. Determination of the method of payment shall be in the sole discretion of the Engineer, and he will advise the Contractor, in writing, of his determination with reference to the specific type of work or service to be performed.

If all costs and expenses incurred by the Department arising out of the breach and imposition of sanctions, together with the total cost to the Department of securing the performance of the work set forth in the contract, exceed the sum that would have been payable under the contract, the Contractor and the Surety shall be liable to the Department for such excess and shall pay such amount to the Department.

(E) Power of Engineer

The Engineer will exercise the powers and discretion vested in him by the contract in carrying out the terms of this article. He will have full power and authority to carry out any orders, directives, or resolutions issued by the Department in connection with a declaration of default. In the event that the Department fails to specify the sanctions to be imposed, the notice to be given or the method of completing the work, the Engineer may, at his discretion, impose such sanctions, give such notice and select such methods of completing the work, as are authorized by this article; and such actions shall have the same effect and validity as if taken pursuant to an express order, directive or resolution of the Department.

(F) Obligation of Contractor and Surety

No term or terms of this article and no action taken pursuant hereto by the Department of Transportation, its agents, or employees, will be construed to release or discharge the Contractor or the Surety upon the obligation set forth in the contract bonds, and the Contractor and the Surety shall remain bound thereon unto the Department until the work set forth in the contract has been completed and accepted by the Department and all obligations of the Contractor and the Surety arising under the contract and contract bond have been discharged.

(G) Provision Not Exclusive

The provisions shall be in addition to and not in place of, any other provisions relating to default, breach of contract and sanctions to be imposed in connection therewith appearing in the contract.

108-10 CONTRACT TIME AND INTERMEDIATE CONTRACT TIME

(A) General

The contract time will be as defined in Section 101. No extensions to the completion date will be authorized except as allowed by this article. No modifications in the date of availability will be made for any reason whatsoever.

Intermediate contract time, as defined in Section 101 will be that as allowed in the contract to complete a part, portion or phase of the total work covered in the contract. Intermediate completion dates and intermediate completion times set forth in the contract may be extended on the same basis as completion dates and as described in this article.

When the liquidated damages stipulated in the contract are to be hourly, extensions, as described in this article, will be considered on an hourly basis.

(B) Completion Date, Intermediate Completion Date and Intermediate Completion Time Extensions

No extension of the completion date, intermediate completion date, or intermediate completion time will be allowed for any reason except as provided for below:

(1) If the total dollar value of the final quantities adjusted as provided below, less the dollar value of quantities represented by supplemental agreements that previously extended the completion date, intermediate completion date or intermediate completion time, exceeds the dollar value of the total amount bid, the completion date, intermediate completion date, or intermediate completion time will be extended by the number of calendar days or hours obtained by multiplying the contract time (days), intermediate contract time (days), or intermediate contract time (hours) as set forth in the contract by that percentage that such reduced final dollar value exceeds the total amount bid. The total dollar value of the final quantities for pro-rata computations shall be adjusted by excluding the following:

(a) Unit bid price changes caused by price adjustments to asphalt cement,

(b) Fuel adjustments,

(c) Unit price reductions under Article 105-3,

(d) Payment for trainees and

(e) Unit price changes due to pay factors established by the specifications.

(2) If supplemental agreements covering the performance of extra work include provisions for an extension of the completion date, intermediate completion date, or intermediate completion time and the final dollar value of the extra work exceeds the estimated dollar value, the number of days or the number of hours by which the completion date, intermediate completion date or intermediate completion time was extended will be increased by the percentage that the final dollar value exceeds the estimated value.

(3) If the Contractor's current controlling operation is delayed by circumstances originating from work required under the contract and beyond his control and without his fault or negligence, he may, at any time before payment of the final estimate, make a written request to the Engineer on the *Contractor Claim Submittal Form*, available through the Construction Unit on the Department’s website, for an extension of the completion date, intermediate completion date, or intermediate completion time. This request shall include:

(a) The circumstances resulting in the alleged delay and documentation of said circumstances as may be required by the Engineer,

(b) The controlling operation alleged to have been delayed,

(c) The calendar dates or calendar dates and times on which the controlling operation was delayed and

(d) The number of calendar days or hours by which he is requesting the completion date, intermediate completion date, or intermediate completion time to be extended.

If the Engineer determines that the controlling operation was delayed because of circumstances beyond the control of and without the fault or negligence of the Contractor, and that the Contractor has pursued the work in accordance with Article 108-1, he will extend the completion date, intermediate completion date, or intermediate completion time unless otherwise precluded by other provisions of the contract. No extension of the completion date, intermediate completion date, or intermediate completion time will be allowed for delays caused by restrictions, limitations or provisions contained in the contract.

Consideration will be given for an extension in the completion date, intermediate completion date, or intermediate completion time involving an intermediate contract time of more than 96 hours if the Contractor's current controlling operation(s) is delayed in excess of 40% of the total contract time (days), as defined in Section 101, excluding the time between December 15 and March 16; the total intermediate contract time (days), as defined in Section 101, excluding the time between December 15 and March 16; or the total intermediate contract time (hours), as defined in Section 101; due to weather or conditions resulting from weather. No other consideration will be given for extensions in the completion date, intermediate completion date, or intermediate completion time due to delays caused by weather.

Where the intermediate contract time is 96 hours or less, no consideration whatsoever will be given for an extension in the intermediate completion time due to weather or conditions resulting from weather.

(4) If changes in the work from that originally contemplated in the contract are ordered by the Engineer and these changes result in reduction in quantities, elimination of items, additional work or extra work, the Engineer will allow an extension in the completion date, intermediate completion date, or intermediate completion time as he may deem warranted by such changes. Pursuit of the work with adequate forces and equipment and efficiency of the Contractor's operations will be considered by the Engineer in determining an extension in the completion date, intermediate completion date, or intermediate completion time. It is, however, the Contractor's responsibility to show just cause for an extension in the completion date, intermediate completion date, or intermediate completion time due to the aforesaid conditions. If the Contractor elects to file a written claim or requests an extension of contract time, it shall be submitted on the *Contractor Claim Submittal Form* available through the Construction Unit on the Department's website.

(5) In the event accumulated authorized extensions in the completion date or intermediate completion date resulting from Subarticles 108-10(B)(1) through 108-10(B)(4) above extend the completion date or intermediate completion date beyond December 15 following expiration of the completion date or intermediate completion date as established in the contract, the completion date will be further extended by the number of calendar days between December 15 of one year and March 16 of the following year. If any portion of such accumulated authorized extensions are for delays that occurred after the original contract time or intermediate contract time (days) expired and during the period between December 15 of one year and March 16 of the following year, this portion of the extension will be deducted from the number of additional calendar days awarded due to extension of the completion date or intermediate completion date beyond December 15.

The Contractor's claim that insufficient contract time (days), intermediate contract time (days), or intermediate contract time (hours) was specified in the contract will not be considered as a valid reason for an extension in the completion date, intermediate completion date, or intermediate completion time.

When all work on the project is totally complete, with the exception of an item or items on which work is precluded by seasonal limitations set forth in the contract, the Engineer may, provided that the Contractor has, as determined by the Engineer, diligently pursued the work with adequate forces and equipment, waive the assessment of liquidated damages during the period of time from the date all work other than that precluded by seasonal limitations was completed until the date of expiration of the seasonal limitations. The Contractor shall make the request to waive the assessment of liquidated damages in writing before the beginning date of the requested waiver. The non-assessment of liquidated damages during the aforesaid period shall not operate to waive any other liquidated damages that may be assessable, or any other terms of the contract.

108-11 LIQUIDATED DAMAGES

The parties acknowledge that time is of the essence for the performance of the work under the contract. Time is an essential element of the contract. Delay in completing the work will result in liquidated damages including but not limited to public inconvenience, obstruction to traffic, interference with business and the increasing of engineering, inspection and administrative costs to the Department. It is therefore agreed that in view of the difficulty of making a precise determination of such liquidated damages, a sum of money in the amount stipulated in the contract, will be charged against the Contractor for each calendar day, each hour, or portion thereof that the work, or any portion of the work as described in the contract, remains uncompleted after the expiration of the completion date, intermediate completion date, or intermediate completion time shown in the contract, not as a penalty but as liquidated damages.

Should the Contractor or, in case of default, the Surety fail to complete the work or any portion of the work by any of the applicable completion dates, intermediate completion dates, or intermediate completion times shown in the contract, a deduction of the amount stipulated in the contract as liquidated damages will be made for each and every calendar day, for each and every hour, or portion thereof that the work or any portion of the work remains uncompleted after the expiration of any completion date, intermediate completion date, or intermediate completion time applicable to the uncompleted work. This amount will be deducted from any money due the Contractor or his Surety under the contract and the Contractor and his Surety will be liable for any liquidated damages in excess of the amount due.

In the event that the contract establishes one or more intermediate completion dates or times in addition to the completion date, each of the liquidated damages stipulated will be considered to be cumulative to any other liquidated damages stipulated.

In case of Contractor default of the contract and the completion of the work by the Department, the Contractor and his Surety will be liable for the liquidated damages under the contract, but no liquidated damages will be chargeable for any delay in the final completion of the work by the Department due to any action, negligence, omission, or delay of the Department.

In any suit for the collection of or involving the assessment of liquidated damages, the reasonableness of the amount stipulated in the contract will be presumed. The liquidated damages referred to herein are intended to be and are cumulative and will be in addition to every other remedy now or hereafter enforceable at law by statute or under the contract.

Permitting the Contractor to continue and finish the work or any part thereof after the expiration of the completion date, intermediate completion date, or intermediate completion time shall in no way operate as a waiver on the part of the Department of any of its rights under this contract.

108-12 EXTENSION OF CONTRACT TIME AND APPORTIONMENT OF LIQUIDATED DAMAGES

In accordance with Articles 108-10 and 108-11, when a contract is not completed by the completion date, intermediate completion date, or intermediate completion time, the Contractor shall be entitled to an extension of the completion date, intermediate completion date, or intermediate completion time and apportionment and remittance of liquidated damages to the extent that the failure to complete was due to the conditions set forth in Article 108-10. The Contractor, however, shall be entitled to an extension of the completion date, intermediate completion date, or intermediate completion time, or an apportionment and remittance of liquidated damages only to the extent and in the proportion that such delays were caused by the conditions set forth in Article 108-10, and it is understood that any extension granted shall not operate to waive any liquidated damages or any claim which the Department has or may have against the Contractor by reason of failure of the Contractor to

complete the said contract by the completion date, intermediate completion date, or intermediate completion time specified therein or as revised by authorized extensions.

108-13 TERMINATION OF CONTRACT

The Department may terminate the contract in accordance with the following provisions:

(A) The Department will consider termination of the contract upon written notification by the Contractor that any of the following circumstances exist. The Contractor shall include adequate documentation of these circumstances along with such notification:

(1) If it is impossible for the Contractor to obtain critical materials for completion of the contract within a practical time limit, or

(2) If it is impossible for the Contractor to complete the work in accordance with the contract by reason of unanticipated conditions at the site, including slides and unstable subsoil, without a major change in the design of the project and the Contractor will be unduly delayed in completing the project by reason of such unanticipated conditions and changes in design, or

(3) If the Contractor is prevented from proceeding with the contract as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense, or

(4) If the Contractor is prevented from proceeding with the work required by the contract as a direct result of a restraining order, or other court order, or by reason of a permit requirement, and the Contractor will be unduly delayed in completing the project by reason of such order or requirement, or

(5) If the Contractor is prevented from proceeding with the work due to the unavailability of the site

(B) The Contract will be terminated under this article if:

(1) Request by Contractor

(a) The Department concurs in the determination by the Contractor of the circumstances or makes an independent determination that such circumstances herein above indicated exist, and

(b) The Department determines that such circumstances are beyond the control of the Contractor, and the Contractor was not at fault in creating the circumstances, and

(c) The Department determines that a termination of the contract is in the best public interest.

(2) Authority of the Department

The Department determines that a termination of the contract is in the best public interest.

(C) The Contractor will be notified in writing by the Engineer of the action of the Department.

(D) After a contract is terminated in accordance with this termination provision, the following provisions shall be applicable:

(1) When the contract is terminated before completion of all items of work in the contract, payment will be made for the actual number of acceptably completed items of work or acceptably completed portions thereof at the contract unit or lump sum prices. When the contract is terminated before completion of all items of work in the contract and items of work are partially completed or not begun, payment will be made in accordance with Article 104-6.

(2) Payment for costs incurred in organization of the work will be based on verified actual costs and will be included in the adjusted contract lump sum price for Mobilization in accordance with Subarticle 108-13(D)(1). The Contractor shall demonstrate through submission of appropriate documentation that these costs were included in the bid item of Mobilization. After reviewing the submitted cost records and the submitted documentation, the Engineer will make such adjustments as he deems warranted.

(3) Upon request from the Contractor, materials meeting the requirements of the contract that were to have been incorporated into the work or were to remain the property of the Department but are not used in the work will be paid in accordance with Article 109-6.

(4) No claim for loss of anticipated profits will be considered and no payment will be made for loss of anticipated profits.

(5) Termination of a contract shall not relieve the Contractor of his responsibilities for any completed portion of the work, nor shall it relieve his Surety of its obligation for and concerning any just claims arising out of the work performed.

108-14 TERMINATION OF CONTRACTOR'S RESPONSIBILITY

After the project has been completed and accepted, as provided for in Article 105-17, the Contractor's responsibility will cease except as provided in Article 107-20 and as set forth in his contract bonds or any warranties provided for under the contract. The Contractor shall remain responsible for any amounts determined to be owed the Department in the processing of the final estimate and such amounts shall be paid by the Contractor upon notification by the Department before processing of the final estimate.

SECTION 109
MEASUREMENT AND PAYMENT

109-1 MEASUREMENT OF QUANTITIES

All work completed under the contract will be measured by the Engineer according to United States standard measures unless otherwise stated in the contract.

The method of measurement and computations used in the determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to accepted engineering practice.

The terms “gauge” and “thickness,” when used in connection with the measurement of plates, sheets and steel wire, shall be applied as follows:

Item	Test Method
Uncoated Steel Sheets and Light Plates	United States Standard Gauge
Galvanized Sheets	AASHTO M 218 or M 167
Aluminum Sheets	AASHTO M 196 or M 197
Steel Wire	AASHTO M 336

The term “ton” will mean short ton (mass) consisting of 2,000 pounds.

Trucks used to haul material being paid by weight will be either weighed empty before each loading or weighed empty daily. When trucks are weighed empty daily, each truck shall be weighed before hauling its first load of the day and shall bear a legible identification mark.

Where aggregates that are to be paid by weight have been stockpiled after being produced, measurement for purposes of payment will be made after the aggregates have been loaded on trucks for direct delivery to the project.

When a complete structure or structural unit, as may be indicated by the unit, lump sum or each, is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

When standard manufactured items are specified, and these items are identified by gauge, unit weight, section dimensions or other dimensions, such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

109-2 SCOPE OF PAYMENT

The Contractor shall receive and accept payment provided for in the contract as full payment for furnishing all materials and performing all work under the contract in a complete and acceptable manner and for all risk, loss, damage, or expense of whatever character arising out of the nature of the work or the prosecution thereof, subject to the requirements of Article 107-20. Payment to the Contractor will be made only for the actual quantities of the various items that are completed and accepted by the Engineer in accordance with the terms of the contract.

If the Measurement and Payment clause in the specifications relating to any unit price or lump sum price in the bid schedule requires that the said unit price or lump sum price cover and be considered compensation for certain work or material essential to the item, this same work or material will not be measured or paid under any other pay item that may appear elsewhere in the contract.

109-3 FORCE ACCOUNT WORK

All force account work shall be performed as directed by the Engineer including the numbers and types of equipment, the numbers and classifications of labor and foremen and material requirements.

All work to be paid on a force account basis shall be paid in the following manner:

(A) Labor

For all authorized labor and foremen in direct charge of the specific operations, the Contractor will receive the rate of base (actual) wages (or scale) actually being paid by the contractor for each hour that the labor and foremen are actually engaged in the specific force account work.

In addition to reimbursement for each hour that the labor and foremen are actually engaged in the specific force account work, the Contractor may receive compensation for travel time to and from the project if and only if the labor and foremen needed are outside a 75 mile radius as included in Subarticle 109-3(B). The base location will be established and approved by the Engineer before performing the specific force account work. If the approved labor and foremen travel to another project upon completion of the specific force account work, payment for travel time may not exceed the travel time that would have been required to return to the point of origin in accordance with Subarticle 109-3(B). When travel time is approved by the Engineer, it shall be included in the total hours approved and worked for that specific week. The Engineer will approve the mode of travel.

Before beginning the specific force account work, the Contractor will submit in writing for the Engineer's approval a list of all wage rates applicable to the work. Approval will not be granted where these wage rates are not actually representative of wages being paid elsewhere on the project for comparable classes of labor performing similar work.

Payment for overtime will be allowed when approved by the Engineer before performing the specific force account work. Overtime for labor and foremen will be paid based on the company's policy for overtime payment. Verification of such payment will be tracked by submission of weekly payrolls as required on federal projects and as requested on all other projects. Failure to submit payrolls as required or requested shall act as a bar to the Contractor for payment of overtime for labor and foremen. If the labor or foremen is employed partly on specific force account work and partly on other work, the amount of overtime to be reimbursed will be prorated based upon the number of hours worked on the specific force account work during the payroll period.

An additive amount equal to the Contractor's actual labor burden rate, up to a maximum of 60%, will be paid to the Contractor for all base (actual) wages paid to labor and foremen for the specific force account work. No additive will be provided for overtime payments. The labor burden rates will include costs associated with the employee's actual base wages benefits, including Federal Insurance Contributions Act (FICA), unemployment contributions, Social Security and Medicare taxes and company fringe benefits. Company fringe benefits are the actual costs paid to, or on behalf of, workers by reason of health and welfare benefits, pension fund benefits, or other benefits, when such amounts are required by prevailing wage laws generally applicable to the classes of labor employed on the work. The Contractor's actual labor burden rates will be submitted to and approved by the Engineer before beginning the work. When the Contractor cannot verify actual labor burden rates, an amount equal to 35% of the total base (actual) wage paid labor and foremen will be added to the total base wages paid to the Contractor. These percentage additives will be full compensation for overhead, benefits, contingencies and all other costs associated with labor for the specific force account work.

(B) Subsistence and Travel Allowances

The Contractor may receive payment for actual costs paid to, or on behalf of, labor and foremen by reason of subsistence and travel allowances under certain circumstances. When the Contractor is required to mobilize a crew for specific operations, the Engineer may approve reimbursement of subsistence, including meals and overnight lodging, if the specific force account work is determined to be outside of the scope of the original contract and the distance from the Contractor's base location to the project is more than 75 miles. Should the Contractor use forces currently working at the location of the specific force account work, the Engineer may approve the payment of subsistence, including meals and overnight lodging, if the work is determined to be outside of the scope of the original contract, the forces currently working at the location has routinely stayed overnight during the life of the project, and the distance from the Contractor's base location to the project is more than 75 miles. The Engineer will approve the mode of travel.

Payment will be made to the Contractor for subsistence, including meals and overnight lodging, paid in accordance with the Contractor's usual policy for authorized labor and foremen in direct charge of the specific operations. Subsistence will be limited to the lesser of actual amount paid or the current maximum in-state rate for State employees. Verification of such costs paid to, or on behalf of, labor and foremen will be submitted to the Engineer. If the labor or foremen are partly employed on specific force account work and partly on other work, the amount of subsistence to be reimbursed will be prorated based upon the number of hours worked on the specific force account work during the payroll period.

(C) Materials

For materials authorized and accepted by the Engineer and used, the Contractor will receive the actual cost of such materials, including sales tax and transportation charges paid by him (exclusive of equipment rentals as hereinafter set forth), to which costs 15% will be added. The Contractor will furnish records to the Engineer to verify the quantities of materials used in the specific force account work, prices of the materials, sales tax and costs of transportation for the materials.

If materials used in the specific force account work are not specifically purchased for such work but are taken from the Contractor's stock, the Contractor will furnish an affidavit certifying that such materials were taken from his stock, the quantity was actually used in the specific force account work and the price and transportation cost claimed represent the actual cost to the Contractor.

(D) Equipment

For all equipment authorized by the Engineer to be used on the specific force account work the Contractor will receive rental payment.

Hourly rental rates paid for equipment in use that is Contractor owned or rented from another Contractor will not exceed 1/176 of the monthly rate listed in the *EquipmentWatch Cost Recovery* that is current at the time the specific force account work is performed.

In determining the hourly rate, the regional adjustment factor and the rate adjustment factor for equipment age, as set forth in the *EquipmentWatch Cost Recovery*, will both be applied to the basic rate. An additive payment equal to 100% of the *EquipmentWatch Cost Recovery* estimated operating cost per hour will be paid for all hours that equipment is in use. This additive payment will be full compensation for fuel, lubricants, repairs, servicing (greasing, fueling and oiling), small tools and other incidentals.

If rental rates for the equipment actually being used in the work are not listed in the *EquipmentWatch Cost Recovery*, the Contractor will receive the prevailing rental rates being paid for such equipment in the area where the project is located. An additive payment equal to 15% of the prevailing rental rate will be paid for all hours equipment is in use. This additive payment will be full compensation for fuel, lubricants, repairs, servicing (greasing, fueling and oiling), small tools and other incidentals.

Hourly rental rates for equipment held in ready as directed by the Engineer will be 50% of the rate paid for equipment in use. An additive payment will not be made for equipment held in ready. When equipment is in use less than 40 hours for any given week and is held in ready as directed by the Engineer, payment for held in ready time will be allowed for up to 40 hours, less hours in use. When payment is made for equipment held in ready as directed by the Engineer, the payment for held in ready time will be allowed for up to 8 hours in a day less hours in use.

Hourly rental rates for idle equipment that is held in ready in accordance with Article 104-4 will be paid at 50% of the rate paid for equipment in use. Hourly rental rates for idle equipment held in ready in accordance with Article 104-4 that is rented from a commercial rental agency will be paid in accordance with the invoice rate for the equipment. An additive payment will not be made for idle equipment. When equipment is in use less than 40 hours for any given week and is held in ready as idle equipment in accordance with Article 104-4, payment for idle equipment time will be allowed for up to 40 hours, less hours in use. When payment is made for idle equipment held in ready in accordance with Article 104-4, the payment for idle equipment time held in ready will be allowed for up to 8 hours in a day less hours in use.

In the event the Contractor does not possess or have readily available such equipment necessary for the performance of the work and such equipment is rented from a commercial rental agency, the Contractor will receive payment based on the approved invoice rate for the equipment.

An additive payment equal to 15% of the calculated hourly invoice rate will be paid for all hours equipment is in use. This additive payment will be full compensation for fuel, lubricants, repairs, servicing (greasing, fueling and oiling), small tools and other incidentals. The commercial rental agency cannot be the Contractor or an affiliate of the Contractor.

No compensation will be made for the use of equipment not authorized by the Engineer.

The Contractor will be reimbursed for the actual transportation costs for equipment that the Contractor is directed to furnish by the Engineer. Such payment will be limited to transportation costs from the nearest source of available equipment. If equipment is not returned to the point of origin, but is transported to another location, transportation costs will not exceed the cost of return to the point of origin. Rental for such equipment will not be paid when the equipment is being transported. The Contractor will furnish records to the Engineer to verify the actual transportation costs for equipment.

The Contractor will provide to the Engineer, for approval, a listing of all equipment and attachments to be used in the prosecution of the work. The list will include the manufacturer's name, type, model, serial number and year of manufacture. The list will include the invoice rate for equipment rented from a commercial rental agency. It will be the Contractor's responsibility to verify the age of the equipment in a manner acceptable to the Engineer. Where such verification is not available, the rate adjustment factor used will be for the oldest equipment listed in the *EquipmentWatch Cost Recovery*.

The above prices and payments will be full compensation for fuel, lubricants, cutting edges, all repairs and all other operating and maintenance costs other than operator's wages.

(E) Owner-Operated Equipment

For all owner-operated equipment authorized by the Engineer to be used on the specific force account work, the Contractor will receive rental payment equal to the existing contract rates with no additive as provided in Subarticles 109-3(A), 109-3(B), 109-3(D) and 109-3(H). When existing contract rates have not been established, the Contractor will submit the proposed rates for the owner-operated equipment with sufficient documentation as deemed necessary by the Engineer for approval.

For fully maintained and operated trucks used for the specific force account work, the Contractor will receive rental payment equal to the existing contract rates with no additive as provided in Subarticles 109-3(A), 109-3(B), 109-3(D) and 109-3(H). When existing contract rates have not been established, the prevailing industry rates for fully maintained and operated trucks will be used for the specific force account work with approval of the Engineer.

For the purposes of force account work, owner-operated equipment, including fully maintained and operated trucks, will be considered subcontractors. No additional additives other than those allowed under Subarticle 109-3(G) will be allowed.

(F) Miscellaneous

No additional allowance will be made for general superintendence, the use of manually powered tools or other costs for which no specific allowance is herein provided.

(G) Subcontracting

For administrative costs of the Contractor in connection with approved subcontract work, at any level, and the use of owner-operated equipment, at any level, the Contractor will receive an additive amount in accordance with Table 109-1. The total cost of such subcontracted work will include applicable labor and additive, bond and insurance, materials and equipment costs incurred by the subcontractor; overhead and profit computed in accordance with Subarticles 109-3(A) through 109-3(D), 109-3(F), 109-3(H) and 109-3(I); and costs for owner-operated equipment, including fully maintained and operated trucks in accordance Subarticle 109-3(E). No additional additives will be allowed.

TABLE 109-1
RATE SCHEDULE FOR SUBCONTRACTING ADDITIVE

Total Cost of Subcontract Work	Rate Schedule
$0 - $10,000	10%
Above $10,000	$1,000 + 5% Above $10,000

(H) Overhead And Profit

An additive payment equal to 10% of the specific force account total will be paid to the Contractor. This specific force account total is exclusive of the portion of the work included with Subarticles 109-3(C), 109-3(E) and 109-3(G). This payment will be full compensation for all costs including but not limited to home office and field overhead, burdens and profit associated with the specific force account work.

An additive payment equal to 10% of the specific force account total for approved subcontract work will be paid to the subcontractor for overhead and profit. This specific force account total for subcontract work is exclusive of the portion of the work included with Subarticles 109-3(C) and 109-3(E). This payment will be full compensation for all costs including but not limited to home office and field overhead, burdens and profit associated with the specific force account subcontracted work. No additional additives will be allowed.

(I) Bond And Insurance

For property damage and liability insurance premiums and bond premiums on the specific force account work the Contractor will receive the actual cost. The Contractor will furnish satisfactory evidence to the Engineer of the rate or rates paid for such insurance and bond.

An annualized composite percentage may be used to determine the cost for bond and insurance. Insurance costs will be limited to the direct costs associated with the specific force account work. The Contractor will furnish satisfactory evidence to the Engineer of the annualized composite percentage for the bond and insurance.

(J) General

The Engineer will maintain the payment records of work performed on a force account basis. The Contractor will compare records of work with the Engineer at the end of each day on which such work is in progress.

Any contention the Contractor may have for an extension in the completion date, intermediate completion date, or intermediate completion time, due to performance of specific force account work will be considered as provided in Article 108-10.

109-4 PARTIAL PAYMENTS

(A) General

Partial payments will be based upon progress estimates prepared by the Engineer at least once each month on the date established by the Engineer. Partial payments may be made twice each month if in the judgment of the Engineer the amount of work performed is sufficient to warrant such payment. No partial payment will be made when the total value of work performed since the last partial payment, excluding mobilization, amounts to less than $10,000. Partial payments will be approximate only and will be subject to correction in the final estimate and payment.

Where lump sum items are included in the contract and the applicable sections of the specifications require that fixed percentages of the total amount bid included in partial pay estimates, the Engineer will determine amounts due on partial pay estimate in accordance with the applicable sections of the contract.

(B) Prompt Payments

Contractors at all levels, prime, subcontractor, or lower tier subcontractor, shall within seven calendar days of receipt of monies, resulting from the satisfactory completion of work performed, pay subcontractors, all lower tier subcontractors, or material suppliers. This seven-day period begins upon knowledgeable receipt by the contracting firm obligated to make a subsequent periodic or final payment. This prompt payment requirement will be met if each firm mails the payment to the next level firm by evidence of postmark within the seven-day period. For the purposes of this section, the satisfactory completion of work performed shall exist when a subcontractor, a lower tier subcontractor or material supplier completes tasks called for in the subcontract and are in conformance with the terms of the Contract as required by the Department. This specification for prompt payment shall be incorporated into each subcontract or lower tier subcontract issued for work performed on the project or for services provided.

The Contractor shall not withhold any payments to a subcontractor, lower tier subcontractor or material supplier for any claim or action arising outside the current contract with the Department. Notwithstanding the provisions of this section, the Contractor may withhold up to 3% retainage if any subcontractor does not obtain a payment and performance bond for their portion of the work. Additionally, this retainage may be increased to a maximum of 10% where the Contractor and any subcontractor have supplied to the Engineer a satisfactorily executed mutual agreement for an increased amount. If any retainage is held on subcontractors, all retainage shall be released within seven calendar days of satisfactory completion of all work. For release of retainage, satisfactory completion is defined as completion of all physical elements and corresponding documentation as defined in the subcontract, as well as agreement between the parties as to the final quantities for all work performed in the subcontract. The Department will provide internal controls to expedite the determination and processing of the final quantities for the satisfactorily completed subcontract portions of the project.

Failure of any entity to make prompt payment as defined herein may result in the Department:

(1) Withholding money from the Contractor due for work performed by that entity in the next partial payment until the necessary assurances are made consistent with this specification; or

(2) Removing an approved Contractor from the prequalified bidders' and subcontractors' list, or the removal of other entities from the prequalified subcontractors' list.

(C) Unbalanced Bids

Any excess monies included in an unbalanced bid price that the Department determines to be in excess of a reasonable unit or lump sum bid price for the work, shall be retained by the Department until the last partial payment estimate, at which time these funds will be paid to the Contractor. These retained funds will not be eligible for deposit in any trust account established pursuant to this contract nor for interest for such delay in the payment for the retained portion of the bid price. Partial payment for work performed on an unbalanced bid item shall be at the reasonable unit or lump sum price determined in accordance with this subarticle.

For purposes of this subarticle, a reasonable unit or lump sum price will be deemed to be the average of the Engineer's Estimate and the individual balanced bid prices received from the other bidders for the item in question.

109-5 PAYMENT FOR MATERIAL TO BE USED IN THE WORK

(A) Material Delivered on the Project

When so authorized by the Engineer, partial payments will be made up to 95% of the delivered cost of materials on hand that are to be incorporated in the work, provided that such materials have been delivered on or in close proximity to the project and stored in an acceptable manner. Material payments will be allowed when 95% of the accumulated costs of unpaid invoices are equal to or greater than $10,000, materials have been inspected and approved by the Engineer, and the documents listed in Subarticle 109-5(C) have been furnished to the Engineer.

(B) Material Stored at Fabricator's Facilities or Contractor's Facilities

When so authorized by the Engineer, partial payments will be made up to 95% of the invoiced cost, exclusive of delivery cost, for bulky materials requiring fabrication at an off-site location that are durable in nature and represent a significant portion of the project cost, if it has been determined by the Engineer, that the material cannot be reasonably stockpiled in the vicinity of the work. Material payments will be allowed when the materials have been inspected and approved by the Engineer and the documents listed in Subarticle 109-5(C) have been furnished to the Engineer.

(C) Required Documents

(1) Written consent of surety to make such partial payments,

(2) Bill of Sale from the Contractor to the Department, and

(3) Copy of invoice from material supplier verifying the cost of the material.

(D) General Requirements

The partial payments will be made on the conditional basis that the material meets the requirements of the contract and will be incorporated into the project. The Contractor shall reimburse the Department for all partial payments for material paid, but not incorporated into the project.

Partial payments for materials on hand will not constitute acceptance, and any faulty material will be rejected even though previous payment may have been made for same in the estimates.

Partial payment will not be made for fuel, supplies, form lumber, falsework, or used materials.

Partial payments will not be made on seed or any living or perishable plant materials except that when such materials have been planted or otherwise incorporated in the work, payment may be made, not as materials, but as work done as part of a contract item for which a contract unit or lump sum price has been established.

Partial payments will not exceed 95% of the contract unit or lump sum prices for the work.

109-6 PAYMENT FOR LEFTOVER MATERIALS

Payment will be made to the Contractor for materials meeting the requirements of the contract that were to have been permanently incorporated into the work or were to remain the property of the Department but due to revisions or elimination of items of work by the Engineer, due to discrepancies in the contract or due to termination of the contract are not used in the work. The Contractor, upon request, will be reimbursed for the verified actual cost of such material delivered to a site designated by the Engineer, including any handling charges less any discount, but in no event shall payment exceed that which would have been made at the contract unit or lump sum price for the completed work.

The Contractor shall furnish invoices and cost records to the Engineer to verify the actual cost of materials, handling charges, discounts that were taken and transportation charges. No percentage additive will be added to the verified cost of such material.

No payment will be made for loss of anticipated profits and no other payment will be made for leftover materials except as listed above.

109-7 COMPENSATION PAID AT CONTRACT PRICES

Except as provided for by this article, payment for work performed will be made at the contract unit price or the contract lump sum price. Payment shall be made at the adjusted contract unit price, as applicable, when a price adjustment or pay factor is provided for by the contract or as determined by the Engineer in accordance with Article 105-3. In addition to the compensation made at the unit or lump sum price, adjustment in compensation will be made in accordance with Article 109-8. The Contractor shall not be paid for any work performed for which there is not a contract price, nor shall the Contractor receive additional compensation over and above the contract price for work performed or for extra work performed, except for work performed pursuant to an executed supplemental agreement or work performed in accordance with Section 104.

109-8 FUEL PRICE ADJUSTMENTS

Fuel price adjustments will be made to the payments due the Contractor for contract items specified in the contract, or for extra work items specified in the supplemental agreement, when the average terminal price has fluctuated from the Base Index Price contained in the contract. The average terminal price is the average of the Freight on Board (F.O.B.) price for diesel fuel at the terminals in Charlotte, Wilmington and Selma, North Carolina. When the average terminal price fluctuates upward or downward from the Base Index Price, an amount will be added to or deducted from the monies due the Contractor as follows.

The current quantity for the specified contract items for which partial payment is made will be multiplied by the respective Diesel Fuel Usage Factor contained in the contract to determine the theoretical diesel fuel usage for each specified contract item. The sum of the theoretical diesel fuel usage for all specified contract items will be multiplied by the algebraic difference between the average F.O.B. price for diesel fuel at the above specified terminals and the Base Index Price contained in the contract to determine the fuel price adjustment to be made on the partial payment estimate.

The following formula will be used to calculate the appropriate payment or credit on the estimate:

$$\mathbf{S} = (A - B)\left(\sum QF\right)$$

Where:

S = Fuel Price Adjustment for Partial Payment
B = Base Index Price
A = Average Terminal Price
Q = Partial Payment Quantity for Contract Item
F = Fuel Factor for Contract Item

The average terminal price in effect on the first day of the month in which the partial payment period ends will be used to make payment adjustments for fuel whether or not more than one price fluctuation has occurred within a single partial payment period.

The Engineer's estimate of quantities for contract items measured by cross sections shall be used on the various partial payment estimates to determine fuel price adjustments. When the Engineer determines after payment for all or a portion of such contract item that is subject to a fuel price adjustment that the total quantity of work paid to date will be adjusted to reflect more accurate quantity determinations, the Engineer will make a pro rata increase or decrease in the fuel price adjustment proportionate to the adjustment in the total quantity of work paid. The prorated fuel price adjustment for the contract item will be determined by multiplying the cumulative fuel price adjustment made for that contract item for the previous estimate period by the adjusted quantity for that contract item and divided by the total quantity of work paid for the previous estimates for the contract item. Payment for the prorated fuel price adjustment will be made accordingly on the partial payment estimate that includes the adjustment in the quantity of work paid.

109-9 FINAL PAYMENT

Upon completion of the final estimate assembly, the Engineer will notify the Contractor giving the final quantities and the apparent liquidated damages, if any are assessed. After the Contractor reviews the final quantities and submits the documents listed in Article 109-10, the entire sum found to be due after deducting all previous payments and all amounts to be retained or deducted under the requirements of the contract will be paid to the Contractor.

109-10 DOCUMENTS REQUIRED FOR THE PROCESSING OF THE FINAL ESTIMATE

Before the processing of the final estimate, the following documents shall have been submitted to and accepted by the Engineer.

(A) Statement of Consent of Surety on the contract bonds for payment of money due the Contractor.

(B) Affidavit of the Contractor that all obligations and debts arising out of the construction have been satisfied or affidavit that shall include a list of obligations not satisfied.

(C) Written notice that the Contractor has no request for any extension in the completion date or any adjustment in compensation from that shown in the final estimate or in lieu thereof written notice presenting all request for adjustment of the final estimate setting forth full justification for such requests.

(D) Any other documents that are required by the contract such as reports, statements and other information necessary for compliance with applicable labor regulations of the FHWA.

Submission of false information in the documents required by this section shall be a basis for disqualifying the Contractor from further bidding in accordance with Article 102-15. If the Contractor fails to submit the required documentation within the timeframe specified by the Department, the Department may consider the Contractor to be nonresponsive and may process the final estimate.

109-11 INTEREST ON FINAL PAYMENT

Should final payment on a project not be made within 120 calendar days after the project final acceptance date, interest, at the average rate earned by the State Treasurer on the investment within the State's Short Term Investment Fund during the month preceding the date interest becomes payable, will be paid to the Contractor on the final payment for the period beginning on the 121st day after final acceptance and extending to the date the final estimate is paid, provided that the documents required by Article 109-10 have been submitted within 30 calendar days of the mailing of the notification outlined in Article 109-9. In the event the Contractor fails to submit the required documents within the stipulated 30 calendar days, and the final estimate is not paid until 120 calendar days following final acceptance of the project, the number of days on which interest accrues will be reduced by the number of calendar days in excess of 30 that the Contractor requires to submit the documents.

SECTION 150
MAINTENANCE OF TRAFFIC

The Contractor will be required to maintain traffic within the limits of the project, including all existing roadways that cross or intersect the project, unless otherwise provided in the contract or approved by the Engineer. Traffic shall be maintained from the time the Contractor begins work on the project site until acceptance of the project, including any periods during which the Contractor's operations are suspended, unless otherwise provided for in the contract or approved by the Engineer. The Contractor shall conduct his work in a safe manner that will create a minimum amount of inconvenience to traffic.

The Contractor shall be responsible for maintaining in a safe, passable and convenient condition, such part or parts of existing roads as are being used by him to maintain traffic within the limits of the project from the time the Contractor begins work on the project until acceptance of the project by the Engineer. As an exception to the above, the Department will be responsible for the removal of ice and snow from all portions of the project open to traffic.

Whenever it is necessary to use traffic control devices as shown in the contract, as determined by the Engineer, or to conform to this section, the work of furnishing, erecting, operating, maintaining, covering, relocating and removing traffic control devices shall be in accordance with Divisions 11 and 12.

DIVISION 2
EARTHWORK

SECTION 200
CLEARING AND GRUBBING

200-1 DESCRIPTION

Perform the work of clearing and grubbing in all wooded areas between the construction limits. Perform the work of clearing and grubbing in all non-wooded areas between the construction limits and the limits of the project right of way or in easements shown on the project plans where seeding and mulching, sprigging, sodding or other work as indicated.

"Clearing" is defined as the cutting, removal and satisfactory disposal of all wooded vegetation and debris.

"Grubbing" is defined as the complete removal and satisfactory disposal of all grassy vegetative matter, root mat, ball and root, topsoil material high in organic content and surface debris.

200-2 MATERIALS

Refer to Division 10.

200-3 CONSTRUCTION METHODS

Perform the following as part of the work of clearing and grubbing:

(A) Remove and dispose of crops, weeds and other annual growth;

(B) Remove and dispose of surface debris such as fences, steps, walls, chimneys, column footings, other footings, foundation slabs, basements, other foundation components, signs, junked vehicles and other rubble and debris;

(C) Fill holes and depressions that exist or are created;

(D) Cut off and plug at the right-of-way or construction limits any private water or sewer line intercepted during the construction of the project;

(E) Cut off and remove from the right-of-way or construction area any septic tank or portion thereof encountered within the right-of-way or construction area during the construction of the project; and

(F) Remove materials in wetland areas to a depth of one foot below existing ground to be measured in accordance with Section 225.

Perform clearing and grubbing operations sufficiently before grading operations to prevent any debris from interfering with the excavation or embankment operations.

In environmentally sensitive areas shown on the original plans or permit drawings, perform grubbing operations no more than 7 calendar days before beginning continuous grading operations.

Perform all work under this section to minimize soil erosion and in accordance with Article 107-12. Coordinate the work with other operations such that no more than 17 acres of exposed, erodible surface area will be accumulated at any one time by the clearing and grubbing operation until erosion control measures are provided. Install temporary or permanent erosion control measures as soon as clearing and grubbing or land disturbing activities begin. Perform such erosion control work, temporary or permanent, as needed to minimize erosion resulting from clearing and grubbing operations.

The Contractor may request an increase in the accumulated acres exposed by clearing and grubbing. If approved, establish and maintain such erosion control measures as needed.

Failure on the part of the Contractor to perform the required erosion control measures will be just cause for the Engineer to direct the suspension of clearing and grubbing operations in accordance with Article 108-7. The suspension will be in effect until such time as the Contractor has satisfactorily performed the required erosion control work. If the Contractor fails to perform the directed work within a reasonable length of time, the Engineer may have the work performed in accordance with Article 105-16.

200-4 CLEARING

Perform clearing within the limits established by the clearing method required by the plans and as directed by the Engineer.

The Engineer will designate all areas of growth or individual trees that shall be preserved due to their desirability for landscape or erosion control purposes. When the trees to be preserved are located within the construction limits, they will be shown in the plans or designated by the Engineer.

Trim or cut branches of trees that overhang the roadbed, utility easements or obstruct sight distances and that are less than 16 feet above the elevation of the finished grade so as to not endanger the health of the tree.

In embankment areas where the depth of the embankment measured under the roadbed exceeds 6 feet in height, cut sound trees at a height of not more than 6 inches above natural ground. When trees are to be cut outside the construction limits and the Engineer has designated that the area is not to be grubbed, cut the trees reasonably close to the natural ground surface. Cut trees to approximately 6 inches above low water level in swamp areas.

At a bridge site, clear the entire width of the right of way beginning at a station 3 feet back of the beginning extremity of the structure and ending at a station 3 feet beyond the ending extremity of the structure.

Prevent limb, bark or root injuries to trees, shrubs or other types of vegetation that are to remain growing and prevent damage to adjacent property. Repair scarred areas in accordance with generally accepted horticultural practice. Where plants are damaged by any construction operations to such an extent as to destroy their value for shade or other landscape purposes, cut and dispose of them.

200-5 GRUBBING

Perform grubbing on all areas cleared, with the following exceptions:

(A) In embankment areas, when the depth of embankment measured under the roadbed exceeds 6 feet in height, cut off sound stumps not more than 6 inches above the existing ground level and do not grub. Remove unsound or decayed stumps to a depth of approximately 2 feet below the natural ground surface.

(B) When authorized, leave stumps outside of construction limits in place. Cut such stumps off reasonably close to the natural ground surface.

(C) Cut off stumps in swamp areas to approximately 6 inches above low water level and do not grub.

(D) Do not grub in areas where waste or unsuitable material is to be deposited unless such areas are to become a part of a future roadway.

(E) Grub all areas where piles are to be driven regardless of fill height.

(F) Fill all holes and other depressions within the areas between the construction limits and the limits of clearing and grubbing. Bring all areas to a uniform contour where later mowing operations will take place.

200-6 DISPOSITION OF TIMBER, STUMPS AND DEBRIS

The property owner will have no right to use or reserve for their use any timber on the project. All timber cut during the clearing operations shall become the property of the Contractor and shall be removed from the project or shall be satisfactorily disposed of as provided hereinafter.

Do not cut any trees and vegetation beyond the clearing limits established. Do not cut any trees and vegetation that is to be preserved for landscape or erosion control purposes as shown in the plans and permit drawings.

Remove from the project and properly dispose of all vegetation, roots, stumps, tree laps, limbs and timber remaining on the project by a satisfactory method.

When vegetation is disposed of by burning, burn so as to prevent injury to property within or outside of the right of way. Comply with all Federal, State and local laws, ordinances and regulations when burning. Secure all necessary burning permits. Perform all burning under the constant care of a competent watchman. Do not allow smoldering or dense smoke to occur during burning.

Before trees or vegetation are disposed of in locations off the right of way and out of sight of the project, furnish the Engineer with verification that the site is permitted. If required, file an approved reclamation plan and furnish a written release from the property owner, or his authorized agent, granting the servitude of his lands.

If it is not burned, dispose of all debris including vegetation in accordance with Section 802.

200-7 SELECT TREE REMOVAL

When the contract includes the item of *Select Tree Removal* and the work of clearing and grubbing has been completed to the original clearing limits, the Engineer may elect to have select trees removed from the project. Trees removed in this manner shall have an average cross section diameter of at least 4 inches at a point 2 feet above the ground level.

Completely remove the select trees including the root ball and properly backfill unless otherwise directed by the Engineer.

200-8 MEASUREMENT AND PAYMENT

Clearing and Grubbing will be paid on a lump-sum basis and no measurement will be made of any clearing and grubbing performed within the limits originally staked and within the right of way or easements shown on the original plans.

Supplementary Clearing and Grubbing that is directed by the Engineer and is performed on areas outside the limits originally staked or beyond the limits of the right of way or easements or within environmentally sensitive areas shown on the original plans will be measured and paid at the contract unit price per acre. All measurement of clearing and grubbing will be made horizontally.

Once the root mat is removed, material that consists predominately of soils will be measured and paid in accordance with Section 225.

Materials used to fill depressions in accordance with Subarticle 200-5(F) will be measured and paid in accordance with Sections 225 or 230, depending on the source of the material.

When the Contractor is required to furnish borrow sources, material sources or waste areas, or when the Engineer permits the Contractor to obtain borrow or deposit waste on any area within the right of way instead of borrow and waste areas which were to have been furnished by the Contractor, no measurement of clearing and grubbing will be made for such areas.

When an increase in accumulated acres exposed by clearing and grubbing is requested by the Contractor and approved by the Engineer, no payment will be made for the temporary seeding and mulching required by the increase in accumulated exposed acres.

Select Tree Removal will be measured and paid as the actual number of select trees removed from the project.

Work performed in cleaning up non-wooded areas between the construction limits and the limits of the project right of way or easements shown in the plans; work performed in the dressing up of areas between the construction limits and the clearing limits; and the removal of weeds, vines, plant stalks, loose rock and small scattered trees will be incidental to the work of clearing and grubbing.

Where plants are damaged by construction operations, the work to cut and dispose of them will be incidental to the work of clearing and grubbing.

Payment will be made under:

Pay Item	Pay Unit
Clearing and Grubbing	Lump Sum
Supplementary Clearing and Grubbing	Acre
Select Tree Removal	Each

SECTION 205
SEALING ABANDONED WELLS

205-1 DESCRIPTION

Seal abandoned wells at locations shown in the contract or as directed by the Engineer. Perform all work in accordance with NCDEQ requirements.

205-2 CONSTRUCTION METHODS

Use a Well Contractor certified by the State of North Carolina to perform abandonment.

Environmental Ground Water Monitoring Well abandonment should be coordinated with the GeoEnvironmental Section of NCDOT.

Seal each well before clearing and grubbing the well site. Check the well from land surface to the entire depth of the well before it is sealed to ensure freedom from obstructions that may interfere with sealing operations. Before sealing, place chlorine in the well in sufficient quantities to produce a chlorine residual of at least 100 milligrams per liter in the well.

All casing and screen materials may be salvaged except casing that is cemented in place. In the case of gravel-packed wells in which the casing and screens have not been removed, perforate the casing opposite the gravel pack at intervals not exceeding 10 feet.

Completely fill bored wells with cement grout or dry clay compacted in place. Completely fill wells constructed in unconsolidated formations with cement grout by introducing it through a pipe extending to the bottom and raising it as the well is filled. Fill wells constructed in consolidated rock formations or that penetrate zones of consolidated rock to at least 5 feet below the top of the consolidated rock with sand, gravel or grout opposite the zones of consolidated rock. Fill the remainder of the well with cement grout.

Complete a certified *Well Abandonment Record* (*Form GW-30*) and submit to the Engineer.

205-3 MEASUREMENT AND PAYMENT

Sealing Abandoned Wells will be measured and paid in units of each for the actual number of wells acceptably sealed. Work includes, but is not limited to, chlorinating the well before sealing; perforating the well casing; filling the well with cement grout, dry clay, sand or gravel; and furnishing all necessary records.

Payment will be made under:

Pay Item	Pay Unit
Sealing Abandoned Wells	Each

SECTION 210
DEMOLITION OF BUILDINGS AND APPURTENANCES

210-1 DESCRIPTION

Demolish, remove and dispose of all buildings, building components and appurtenances indicated in the contract.

210-2 CONSTRUCTION METHODS

Do not remove any building or portion of a building intact for any use or purpose.

All material resulting from the demolition work becomes the property of the Contractor. Dispose of or use all materials resulting from the demolition work, except materials that are the property of utility companies providing service to the building. Provide all permits and dispose of all contaminated material encountered in connection with the work.

Before demolishing any building, comply with the notification requirements of 40 CFR Part 61, Subpart M that applies to asbestos. Notify the North Carolina Department of Health and Human Services, Division of Public Health, Health Hazards Control Unit and the appropriate county agency when enforcement of the Federal regulation is performed by the county (Buncombe, Forsyth and Mecklenburg only). Submit a copy of the notification to the Engineer before the building demolition.

The Department will perform asbestos assessments and abatement for building items identified in the contract. Copies of this report may be obtained through the Division Right-of-Way Agent. When directed to perform removal and disposal of asbestos, do so in accordance with 40 CFR Part 61, NCGS §§ 130A-444 to -453 and 10A NCAC 41C .0601 to .0611.

Comply with all Federal, State and local regulations when performing building demolition, asbestos removal and disposal, UST removal and contaminated material disposal. Any fines resulting from violations of any regulation are the sole responsibility of the Contractor and the Contractor agrees to indemnify and hold harmless the Department against any assessment of such fines.

Known USTs will be removed by the Department before the opening of the bids. Comply with the notification requirements of the 40 CFR Part 280.71(a) before removal of a regulated UST. Notification is not required for nonregulated tanks. Give notification to the appropriate regional office of NCDEQ, Division of Waste Management, UST Section. Submit a copy of the notification to the Engineer before the removal of the UST.

Permanently close UST systems by removal and disposal of the UST in compliance with the regulations set forth in 40 CFR Part 280.71 and 15A NCAC 2N and any applicable local regulations. Assess UST sites at closure for the presence of contamination as required in 15A NCAC 2N .0803 and as directed by the appropriate Regional Office of the Division of Waste Management. Remove and dispose of UST systems and contents in a safe manner in conformance the "Removal and Disposal of Used Underground Petroleum Storage Tanks," *American Petroleum Institute Bulletin 1604*, Chapters 3 through 6. As an exception to these requirements, the filling of the tank with water as a means of expelling vapors from the tank as described in Section 4.2.6.1 of *American Petroleum Institute Bulletin 1604* will not be allowed.

Disposition of any contaminated material associated with UST will be in accordance with Article 107-25.

Demolish and clear from the right of way all buildings, including sheds, outbuildings or other obstructions indicated in the contract. All shelters, porches, roofed areas and other appurtenances that are attached to the building are considered a part of the building. Remove

steps, chimneys, column footings, other footings, foundation slabs, basements or other foundation components.

Do not disturb any fencing, outbuilding or other obstruction that are entirely clear of the right of way unless otherwise indicated in the plans or in the contract.

Conform to all applicable safety codes pertaining to the work, secure all permits that may be required and pay all fees in connection therewith.

210-3 UTILITIES

Make all necessary arrangements with utility companies for the disconnecting of all services and the removal of and recovery by them of all meters, telephones and any other utility facilities or equipment owned by them. Arrange for and actually effect the disconnecting and closing of water and sewer connections to buildings, including but not limited to any work that shall be done in addition to that normally done by the utility company, in conformity with all applicable codes and regulations of the local Boards of Health. Pay for all costs incurred in connection with the above work. All refunds or deposits that may become due as a result of the disconnection of service and the returning of equipment or facilities to any utility company become the property of the Department.

210-4 DISPOSAL

Unless otherwise indicated in the contract, all materials recovered during demolition become the property of the Contractor to remove from the project. Disposal by burning is permitted, subject to all other applicable sections of these *Standard Specifications* and all State and local ordinances.

Dispose of materials and debris in accordance with Section 802.

210-5 MEASUREMENT AND PAYMENT

There will be no direct payment for demolishing the buildings and appurtenances listed in the contract. Payment for this work will be included in the contract lump sum price for *Clearing and Grubbing* in accordance with Article 200-8.

Where underground storage tanks are indicated, there will be no direct payment for the closure or assessment, as payment at the contract lump sum price for *Clearing and Grubbing* will be full compensation for all costs of such closure or assessment.

As an exception to the above, when the description of the work covered by a particular building demolition item does not contain information concerning the presence of asbestos material or underground storage tanks and the asbestos material or underground storage tanks are discovered after the opening of bids for the project, the Engineer may have the work performed by others or the cost of removal and disposal of such asbestos material or underground storage tanks will be paid in accordance with Article 104-7.

SECTION 215
REMOVAL OF EXISTING BUILDINGS

215-1 DESCRIPTION

Remove and dispose of all buildings, building components and appurtenances indicated in the contract.

215-2 CONSTRUCTION METHODS

Buildings may be removed intact, removed in sections or demolished. Dispose of resulting material and debris. All materials resulting from the removal of buildings, except such materials as may be the property of utility companies providing service to the building, become the property of the Contractor to dispose of or use or sell by him as his own property.

Provide all permits and dispose of all contaminated material encountered in connection with the work. Before removal of any building, comply with the notification requirements of 40 CFR Part 61, Subpart M that applies to asbestos. Give notification to the North Carolina Department of Health and Human Services, Division of Public Health Epidemiology Branch and/or the appropriate county agency when the county performs enforcement of the Federal Regulation. Submit a copy of the notification to the Engineer before the building removal.

Perform removal and disposal of asbestos in accordance with 40 CFR. Comply with all Federal, State and local regulations when performing building removal; asbestos removal and disposal; and UST removal and contaminated material disposal. Any fines resulting from violations of any regulation are the sole responsibility of the Contractor and the Contractor agrees to indemnify and hold harmless the Department against any assessment of such fines.

The Department will perform asbestos assessments and abatement for building items identified in the contract. Copies of this report may be obtained through the Division Right-of-Way Agent. When a building has had or will have asbestos removed and the Contractor elects to remove the building such that it becomes a public area, the Contractor is responsible for any additional costs incurred including final air monitoring.

Before removal of a regulated UST, comply with the notification requirements of 40 CFR Part 280.71(a). Notification is not required if the tank is unregulated. Give notification to the appropriate regional office of NCDEQ, Division of Waste Management, UST Section. Submit a copy of the notification to the Engineer before the removal of the UST.

Permanently close UST systems by removal and disposal in compliance with the regulations set forth in 40 CFR Part 280.71 and 15A NCAC 2N and any applicable local regulations. Assess UST sites at closure for the presence of contamination as required in 15A NCAC 2N .0803 and as directed by the appropriate Regional Office of the Division of Waste Management. Remove and dispose of UST systems and contents in a safe manner in conformance with *American Petroleum Institute Bulletin 1604*, Removal and Disposal of Used Underground Petroleum Storage Tanks, Chapters 3 through 6. As an exception to these requirements, the filling of the tank with water as a means of expelling vapors from the tank as described in Section 4.2.6.1 of *American Petroleum Institute Bulletin 1604*, will not be allowed. Disposition of any contaminated material associated with UST will be made in accordance with Article 107-25.

Completely clear from the right of way all buildings, including sheds, outbuildings or other obstructions as indicated in the contract. Remove all shelters, porches, roofed areas and other appurtenances that are attached to the building. Remove steps, chimneys, column footings, other footings, foundation slabs, basements or other foundation components shall be removed.

Do not disturb any fencing, outbuildings or other obstruction, that is entirely clear of the right of way unless otherwise indicated in the plans or in the contract.

Conform to all applicable safety codes pertaining to the work and secure all permits that may be required and pay all fees in connection therewith.

215-3 UTILITIES

Make all necessary arrangements with utility companies for the disconnecting of service and the removal of and recovery by them of all meters, telephones or any other utility facilities or equipment owned by them. Arrange for and effect the disconnecting and closing of water and sewer connections to the buildings, including but not limited to any work that shall be done in addition to that normally done by the utility company, in conformity with all applicable codes and regulations of the local Boards of Health. Pay for all costs incurred in connection with the above work. All refunds or deposits that may become due as a result of the disconnection of service and the returning of equipment or facilities to any utility company becomes the property of the Department.

215-4 DISPOSAL

Unless otherwise indicated in the contract, all materials recovered during demolition become the property of the Contractor to remove from the project. Disposal by burning is permitted, subject to applicable sections of the *Standard Specifications*, State and local ordinances.

Dispose of materials and debris in accordance with Section 802.

215-5 MEASUREMENT AND PAYMENT

There will be no direct payment for removing the buildings listed in the contract. Payment for this work will be included in the contract lump sum price for *Clearing and Grubbing* in accordance with Article 200-8.

Where underground storage tanks are indicated in the contract, there will be no direct payment for the assessment or closure. Payment for this work will be included in the contract lump sum price for *Clearing and Grubbing.*

As an exception to the above, when the description of the work covered by a particular building removal item does not contain information concerning the presence of asbestos material or UST and the asbestos material or UST are discovered after the opening of bids, the Engineer may have the work performed by others or the cost of removal and disposal of such asbestos material or UST will be paid in accordance with Article 104-7.

SECTION 220
BLASTING

220-1 DESCRIPTION

Use blasting as needed to excavate, break up or remove rock, construct stable rock cut slopes and for other approved reasons. This section applies to all types of blasting including production, controlled, pre-split, trim, trench and secondary blasting except blasting adjacent to highway structures. See Article 410-9 for blasting adjacent to highway structures. Unless required otherwise in the contract, design blasts for the vibration and air overpressure limits in this section. Pre-split rock cuts at locations shown on the plans and as directed by the Engineer. Provide blasting plans, blast monitoring and post-blast reports as necessary or required. Perform blasting in accordance with the contract, accepted submittals and as directed by the Engineer. Use a prequalified Blasting Contractor for blasting.

220-2 MATERIALS

Refer to Division 10.

Item	Section
Coarse Aggregate	1005

Use coarse aggregate (standard size No. 67 or 78M) for stemming.

220-3 CONSTRUCTION METHODS

Notify the Engineer and all occupants and owners of residences, businesses and utilities near where blasting will occur of the intention to use explosives. Inform the Engineer, occupants and owners of blasting at least 48 hours before each blast. When blasting in the vicinity of an open travel way, provide traffic control in accordance with the contract and Section 1101.

Control blasting to avoid endangering lives or damaging property. The Contractor is responsible for any injuries and damages due to blasting in accordance with Article 107-11 except for damage to wells and springs, unless the Contractor did not use reasonable care to prevent such damage. Exercise the utmost care when blasting near sensitive environmental or populated areas, urban or sensitive communities or historical structures. Comply with all the latest applicable Federal, State and local codes, laws and regulations, as well as professional society standards for the storage, transportation and use of explosives. Keep a copy of all regulations on site and in case of conflict, the more stringent applies.

The Blaster-in-Charge has authority over the handling, use and security of explosives and is responsible for designing, planning, coordinating, supervising and monitoring blasting. Assign a Blaster-in-Charge to the project that has at least 5 years of experience with blasting similar to that anticipated for the project. Use a Blaster-in-Charge approved as a Blaster-in-Charge (key person) for the Blasting Contractor. The Blaster-in-Charge or designated Assistant Blaster-in-Charge shall be on site during blasting.

When blasts will be within 1,000 feet of a utility, house, residence, building, business or any other structure, a blasting plan and blast monitoring that meet Subarticles 220-3(B) and 220-3(C) are required. Otherwise, provide a blasting plan and monitor blasts as needed.

(A) Vibration and Air Overpressure Limits

Define "peak particle velocity" (PPV) as the maximum ground vibration velocity measured in any direction. Design blasts so the PPV at any utility or structure does not exceed the "Alternative Blasting Level Criteria" from Appendix B of the *U.S. Bureau of Mines Report of Investigations 8507*. Design blasts so the maximum air overpressure at any structure does not exceed 133 dB (linear).

If the PPV or air overpressure limits are exceeded at any utility or structure in any direction from blasts, the Engineer may suspend blasting until the post-blast report is reviewed and a new or revised blasting plan is accepted. Unless required otherwise in the contract or directed by the Engineer, design production, pre-split and trench blasts in accordance with the following:

(1) Production Blasting

(a) For 1.5:1 (H:V) rock cut slopes without pre-splitting, do not use production blast holes more than 4 inches in diameter within 10 feet of finished slope faces or neat lines.

(b) Do not drill production holes below bottom of adjacent pre-split blast holes

(c) Use delay blasting to detonate production blast holes towards a free face

(2) Pre-splitting

(a) Do not use pre-split blast holes more than 3 inches in diameter

(b) Space pre-split holes no more than 10 hole diameters apart (wider pre-split blast hole spacing may be approved by the Engineer if test blast results are satisfactory)

(c) Limit subdrilling to the offset width between lifts

(d) Do not subdrill more than 2 feet below finished grade

(e) Pre-split rock at least 30 feet beyond production blasting lifts or to the end of rock cuts

(f) Provide benches or lifts with a maximum height of 25 feet.

(g) Do not use ammonium nitrate fuel oil (ANFO) or other bulk loaded products

(h) Use cartridge explosives or other explosive types design for pre-splitting

(i) Use charges with a maximum diameter of half the pre-split blast hole diameter except for charges in bottom 2 feet of holes

(j) If pre-split and production blast holes are fired in the same blast, fire pre-split holes at least 25 milliseconds before production holes

(B) Blasting Plan

When required, submit the proposed blasting plan signed by the Blaster-in-Charge for all blasting for acceptance. Acceptance of this plan does not relieve the Contractor of responsibility and liability for blasting in accordance with the contract.

Submit the blasting plan to the Resident Engineer and the appropriate Geotechnical Engineering Unit regional office at least 30 days before starting blasting. Do not deliver explosives to the project site or begin blasting until a blasting plan is accepted by the Engineer. Provide detailed project specific information in the blasting plan that includes the following:

(1) Work procedures and safety precautions for storage, transportation, handling and detonation of explosives;

(2) Explosive products and devices for dry and wet blast holes including explosives, primers and detonators with SDS;

(3) Drilling equipment including methods for maintaining blast hole alignment;

(4) Typical plan, profile and sectional views for blasting showing blasting limits, blast hole diameters, depths, inclinations and spacing, burden, subdrill depths and minimum and maximum charge per delay;

(5) Initiation and delay methods and delay times;

(6) Equipment and procedures for blast monitoring with calibration certificates dated within one year of submittal date; and

(7) Post-blast report format.

If alternate blasting procedures are proposed or necessary, a revised blasting plan submittal may be required. If blasting deviates from the accepted submittal without prior approval, the Engineer may suspend blasting until a revised plan is accepted.

(C) Blast Monitoring

If necessary or required, monitor blasts using seismographs capable of measuring air overpressure and vibration in the vertical, longitudinal and transverse directions. At a minimum, monitor vibration and air overpressure at the closest utility or structure to each blast and the closest utility or structure in the direction of each blast in accordance with the accepted blasting plan. Include the following in post-blast reports for each blast monitoring location:

(1) Type, identification and specific location of seismograph,

(2) Distance and direction from blast,

(3) PPV in each direction and peak vector sum, and

(4) Maximum air overpressure level.

(D) Blasting Requirements

Before beginning drilling, a pre-blast meeting may be required to discuss the blasting and if applicable, blast monitoring. Schedule this meeting with the Engineer after any blast plans have been accepted by the Engineer. The Contractor and Blaster-in-Charge will attend this pre-blast meeting.

Drill and blast in accordance with the contract and if applicable, the accepted blast plan. Use explosives in accordance with all applicable government regulations, professional society standards and manufacturer guidelines and recommendations. Do not allow ANFO to leach into bodies of water.

Before blasting for excavations, remove all overburden material along top of excavations for at least 30 feet beyond blasting or rock limits, whichever is less. Inspect any free faces to ensure adequate burden. Drill blast holes within 3 inches of plan location and maintain hole alignment when drilling.

Pre-split rock cuts as required so irregularities between pre-split blast holes are less than 1 foot from finished slope faces. Alignment is crucial for pre-split holes. Maintain pre-split hole alignment within 6 inches of rock cut slopes and parallel to adjacent pre-split blast holes. Monitor and accurately measure pre-split hole alignment during drilling with a method acceptable to the Engineer. When rock cut heights require multiple benches or lifts, offset pre-split blast holes horizontally for each lift no more than the clearance necessary for drilling equipment.

Cover blast holes after drilling to prevent unwanted backfill and identify and mark each blast hole with hole number and depth. Blast holes shall be free of obstructions the entire depth. Load blast holes without dislodging material or caving in hole walls. Stem blast holes 5 inches or larger in diameter with No. 67 stone and blast holes smaller than 5 inches in diameter with No. 78M stone. Do not stem blast holes with drill cuttings.

Contain flyrock within construction limits. Use matting when blast monitoring or traffic control is required. Soil cover may be used instead of matting, if approved by the Engineer. If flyrock occurs outside the construction limits, the Engineer may suspend blasting until the post-blast report is reviewed and a new or revised blasting plan is accepted by the Engineer. When traffic control is required for blasting, have equipment standing by to remove material that interferes with traffic flow. Check for misfires immediately after each blast before signaling all clear.

Remove all loose, hanging and potentially dangerous material from rock cut slopes by scaling. The Contractor is responsible for the stability of rock cuts. If rock cuts are damaged during blasting, stabilize cuts to the satisfaction of the Engineer. Resume drilling only after scaling is complete. Adjust blast hole alignments to account for any drift occurring in preceding drilling or lifts.

Define “secondary blasting” as blasting to reduce the size of naturally occurring boulders or those resulting from initial blasting. Use an approved method for secondary blasting consisting of small explosive charges in small diameter blast holes. Define “mudcapping” as placing unconfined explosive charges in contact with rock without blast holes and covering charges with mud. Do not use mudcapping for blasting.

(E) Post-Blast Report

Submit a post-blast report within 3 days of each blast or before the next blast, whichever is sooner. Provide post-blast reports signed by the Blaster-in-Charge that include the following:

(1) Material data information about explosive products and devices including explosives, primers and detonators;

(2) Scaled blast drawings with cross sections showing blasting limits, blast hole diameters, depths, inclinations and spacing, burden, subdrill depth, free face location and any joints, bedding planes, weathered zones, voids or other significant rock structure information;

(3) Loading pattern diagram with location and amount of each type of explosive including primers and detonators;

(4) Locations and depths of stemming, column heights and maximum charge per delay for each type of loading;

(5) Delay and initiation diagram showing delay pattern, sequence and times;

(6) Results and effectiveness of the blast and any proposed changes to subsequent blasting;

(7) If applicable, blast monitoring results; and

(8) Blast damage report when necessary.

(F) Blast Damage Report

If damage occurs from blasting, notify the Engineer immediately and submit a blast damage report with the post-blast report that includes the following:

(1) Property owner's and injured person's, if any, names, addresses and telephone numbers;

(2) Details and description of property damage and injury, if any, with photographs or video; and

(3) Any associated tort claims, complaint letters and other applicable information.

220-4 MEASUREMENT AND PAYMENT

Pre-splitting of Rock will be measured and paid in square yards. Pre-splitting will be measured along the slope faces of pre-split rock cuts as the square yards of exposed pre-split rock. No payment will be made for unsatisfactory pre-splitting as determined by the Engineer.

No direct payment will be made for all other blasting including blasting plans, blast monitoring, post-blast reports, scaling and stabilizing rock cuts.

No direct payment will be made for blasting for roadway excavation. Blasting for roadway excavation will be incidental to the contract unit price for *Unclassified Excavation* in accordance with Article 225-7 or the lump sum price for *Grading* in accordance with Article 226-3.

No direct payment will be made for blasting for any pipe, utility or foundation excavation. Blasting for these items will be incidental to the compensation for the excavation. Where no direct payment is made for excavation, blasting will be incidental to the work and no separate payment for will be made for blasting.

Payment will be made under:

Pay Item	Pay Unit
Pre-splitting of Rock	Square Yard

SECTION 225
ROADWAY EXCAVATION

225-1 DESCRIPTION

Excavate, place and compact or satisfactorily dispose of all materials encountered within the limits of the work necessary for the construction of the roadway that are not to be removed under another contract item.

Perform all excavation in conformity with the lines, grades and cross sections shown in the plans or established by the Engineer.

Use care not to cause instability or displacement of the underlying or adjacent materials during construction. The Engineer reserves the right to effect the removal from the grading operation of any equipment that is causing instability or displacement of underlying or adjacent materials to the detriment of the section being constructed.

Construct false sumps in accordance with the details in the plans and at the locations shown in the plans or at other locations as directed by the Engineer.

Define "Unclassified Excavation" as all material excavated under this section, regardless of its nature or composition, except for undercut excavation and material directed to be removed beyond the limits of the original slope stakes.

Define "Undercut Excavation" as the excavation, placement and compaction and/or satisfactory disposal of materials removed from a location below the finished graded roadway cross section, except for the following:

(A) Rock in the bottom of roadway cuts that has been excavated one foot or less below the roadbed and ditches, or

(B) In cut areas, excavation removed below the outside slopes of roadway ditches.

225-2 EROSION CONTROL REQUIREMENTS

Install erosion control measures as required by the plans before any kind of land-disturbing activity.

Unless otherwise required by the plans, conduct operations so that final slopes are completely graded in a continuous operation and permanently seeded and mulched in accordance with Article 107-12.

Should the Contractor fail to comply with the requirements specified above within the time frames established by Article 107-12, the Contractor shall perform temporary seeding and mulching on any exposed areas at his own expense.

When the Contractor fails or neglects to coordinate grading with the permanent seeding and mulching operation, the Engineer may suspend the Contractor's grading operation in accordance with Article 108-7 until the work is coordinated in a manner acceptable to the Engineer. Failure to perform the directed work may result in the Engineer having the work performed in accordance with Article 105-16.

225-3 UNCLASSIFIED EXCAVATION

Use all suitable material removed from the excavation as far as practicable in the formation of embankments, subgrades, shoulders and places indicated in the plans or directed by the Engineer.

The wasting of suitable material removed as part of unclassified excavation before the completion of embankments is permitted where the Contractor executes a supplemental agreement documenting that he agrees to the following:

(A) Provide and incorporate into the project any material required to complete the project up to the volume wasted. Bear all additional costs for providing and incorporating this material into the work, including engineering costs, and

(B) Provide suitable replacement material either wasted from the project or approved borrow material, at the Contractor's option, and

(C) Present no claim for any time arising from the wasting of excess unclassified excavation or for having to replace material wasted from the project that the Department may require to complete the work, and

(D) Waive rights to request additional compensation with regard to wasting unclassified excavation under the compensation requirements of Section 104 as a result of wasting suitable unclassified excavation and providing replacement material required to complete the work except when unclassified excavation is a major contract item, as defined in Section 101, and when unclassified excavation underruns by more than 25%.

Where the work required to complete the project is so phased by the plans to preclude using suitable unclassified excavation, the Contractor will be permitted to waste suitable unclassified excavation without having to execute the above required supplemental agreement.

Furnish disposal areas for the unsuitable material except where the Engineer permits or directs the use of such material in the widening or flattening of fill slopes. The Engineer will designate materials that are unsuitable.

Where suitable materials containing excessive moisture are encountered above grade in cuts, construct above grade ditch drains before the excavation of the cut material when such measures are necessary to provide proper drainage.

Upon execution of a supplemental agreement containing conditions listed below, the Contractor may waste suitable unclassified excavation and replace it with approved borrow material.

(A) Replace with approved borrow material all suitable unclassified excavation that was wasted.

(B) Bear all additional costs associated with the wasting of the unsuitable unclassified excavation and the replacing of it with borrow material, including any additional engineering costs to the Department.

(C) The execution of a supplemental agreement allowing the Contractor to waste suitable unclassified excavation and replace it with approved borrow material bars the Contractor from any claim for any time extensions related to the wasting and replacement operation described in the agreement.

(D) The Contractor specifically waives his rights to request additional compensation with regard to wasting unclassified excavation under the compensation requirements of Section 104 as result of substituting suitable borrow material and wasting suitable unclassified excavation.

Where the contract includes earth shoulder construction, stockpile suitable surplus material for use in the shoulders. To the extent possible, salvage topsoil from within the limits of the slope stake lines and store in stockpiles. Before the topsoil is removed, clear the areas of all weeds, brush, stumps, stones and other debris. Remove the topsoil from only such areas and to only such depths as required by the contract or as directed by the Engineer. Exercise care to avoid mixing subsoil or other unsuitable material with the topsoil. Stockpile an adequate quantity of material to construct the proposed shoulder before wasting any suitable surplus material. Locate the stockpiles along the project at approved locations. Neatly dress each stockpile, when completed. Perform temporary or permanent seeding on the stockpiles where directed by the Engineer or when necessary to prevent erosion. Remove and dispose of any surplus material remaining in the stockpile after the shoulders are completed as provided below for waste matter.

Dispose of waste material in accordance with Section 802.

Uniformly round the intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, as shown in the plans. Concurrent with the excavation of cuts, construct intercepting berm ditches or earth berms along and on top of the cut slopes at locations shown in the plans or as designated. Finish all slopes to reasonably uniform surfaces acceptable for seeding and mulching operations. Leave no rock or boulders in place that protrude more than one foot within the typical section cut slope lines. Clean all rock cuts of loose and overhanging material. Remove all protruding roots and other objectionable vegetation from the slopes.

Where a cut has been finished and the slopes dressed in accordance with the plans and slope stakes, the Contractor will not be required to flatten or widen the slopes of a completed cut unless otherwise directed by the Engineer before beginning the work. When rock is unexpectedly encountered, transition any widening or flattening already begun to leave the cut with a pleasing appearance.

If required, investigate the top 12 inches of the subgrade in cut sections to determine the necessity for rock undercut.

Unless otherwise directed by the Engineer, excavate rock in the bottom of roadway cuts to a depth of 1 foot below the roadbed and ditches. Lower ditches if necessary, so that water will drain from the rock surface to the ditches. Upon completion of the rock excavation below the level of the roadbed and ditches, backfill the areas where such rock has been removed with suitable material, compact, and shape to the required grade and cross section.

Before any work beginning on the structure, excavate all rock under and adjacent to structure sites as directed by the Engineer.

Bring all cuts to the grade and cross section shown in the plans before final inspection and acceptance.

Remove and dispose of slides and overbreaks that occur before final acceptance of the project. Where slides and overbreaks occur due to negligence or carelessness on the part of the Contractor, the removal and disposal of said slides and overbreaks will be at no cost to the Department.

Shape old roadways to produce an acceptable appearance in accordance with Section 808.

Conduct earthwork operations in a manner that will not disturb staking, utility poles or guy wires required to remain in their original location.

Cut off and plug all private utility lines, remove existing shoulder drain and subdrain pipe and remove all underground tanks intercepted within the typical section or in conflict with construction.

Where it is necessary to remove existing sidewalks or driveways, furnish a neat edge along the pavement retained by sawing a neat line approximately 2 inches deep with a concrete saw before breaking the adjacent pavement away.

When excavation operations encounter graves, temporarily discontinue operations in the vicinity of the graves and do not resume until directed by the Engineer.

When excavation operations encounter contaminated soils, temporarily discontinue operations in the vicinity of the contamination and do not resume until directed by the Engineer.

When excavation operations encounter artifacts of historical or archeological significance, temporarily discontinue operations in the vicinity of the artifacts and do not resume until directed by the Engineer. Disposition of the artifacts shall be in accordance with the requirements of the Division of Archives and History.

225-4 UNDERCUT EXCAVATION

When the Engineer determines that the natural soil materials in areas where fills are to be placed are undesirable in their location or condition, the Engineer may require the Contractor to remove the undesirable material and backfill with approved, properly compacted material.

When the Engineer determines that the finished graded roadway cross section contains materials that are undesirable in their location or condition, the Engineer may require the Contractor to remove the materials and backfill with approved, properly compacted material to the finished graded section.

Where undercutting is required adjacent to or beneath the location of the proposed drainage structure, perform undercut and backfill a sufficient distance adjacent to the installation to prevent future operations from disturbing the completed drainage structure.

Use equipment in undercutting and backfilling operations of such weight, size and capability to efficiently remove and replace the material within the limits established. Use equipment of a size and weight that will not displace the underlying or adjacent material.

All material removed in the work of undercut excavation will be classified by the Engineer as either suitable for other use without excessive manipulation and used elsewhere in the work, or unsuitable for further use and disposed of by the Contractor.

Conduct undercut operations so that the Engineer can take the necessary measurements before any backfill is placed. Place backfill in undercut areas in a continuous operation concurrent with the undercutting operation. Do not place backfill material in water unless otherwise permitted by the Engineer.

225-5 TOLERANCES

A tolerance of ± 0.10 foot from the established grade will be permitted in the roadbed after it has been graded to a uniform surface.

225-6 MAINTENANCE

Maintain all work covered by this section during construction until final acceptance. Provide the drainage of surface runoff along and throughout the length of the cut, construct temporary ditches and use any other methods necessary to control excessive soil erosion during construction and until final acceptance of the project.

225-7 MEASUREMENT AND PAYMENT

Unclassified Excavation and *Undercut Excavation* will be measured and paid in cubic yards of materials, measured in their original position and computed by the average end area method that is acceptably excavated in accordance with the contract. The Engineer may elect to use Digital Terrain Modeling (DTM) for determining the earthwork quantities or other technology that has been proven accurate. Original cross sections for the determination of excavation quantities will be taken before any grading begins. Final cross sections will be taken after the excavation has been completed. Final plan cross sections can be used for the final cross sections where, in the opinion of the Engineer, the work has been constructed in reasonably close conformity to the plan typical section.

Original and final cross sections will be taken by either ground or aerial survey methods, as determined by the Engineer.

All materials excavated from a location below the graded roadway cross section are classified as *Undercut Excavation* and will be measured separately except for the following:

(A) Rock in the bottom of roadway cuts excavated 1 foot or less below the roadbed and ditches;

(B) In cut areas, undercut excavation is limited to excavation removed below the roadbed sub-grade, removed below the inside slopes of roadway ditches and removed below the bottom of flat bottom roadway ditches; or

(C) Root mat other than grass, removed as a part of clearing and grubbing.

When the contract does not include *Drainage Ditch Excavation,* measurement will be made in accordance with Article 240-4 and payment for this class of excavation will be made at the contract unit price per cubic yard for *Unclassified Excavation*.

Measurement of materials excavated from overbreaks or slides will be made except where the overbreaks or slides were due to the negligence or carelessness of the Contractor.

No measurement will be made of any materials excavated outside of authorized excavation limits established by the Engineer or any materials excavated before slope stakes were set.

Article 104-5 will not apply for any underruns in the quantity of *Unclassified Excavation* resulting from the permitted use of such material as select granular material.

Berm Ditch Construction will be measured and paid in accordance with Article 240-4.

Materials excavated from stockpiles and used to construct earth shoulders will be paid as *Shoulder Borrow* in accordance with Article 560-4. No payment will be made for the removal and disposal of any surplus material remaining in the stockpile after the shoulders have been completed.

Payment for material that the Engineer directs to be removed beyond the limits of the original slope stakes will be made in accordance with Article 104-3.

If needed, investigative work within the top 12 inches of the subgrade to determine the necessity for rock undercut will be paid in accordance with Article 104-7.

Unclassified Excavation and *Undercut Excavation* payment includes, but is not limited to, excavation, blasting, hauling anywhere along the project both within and across balance points shown in the plans, removal of undesirable material, removal of sidewalk, driveways, curb and gutter, endwalls, traffic islands and drainage structures, disposal of materials, formation and compaction of embankments, subgrades and shoulders, the cutting off, plugging and removal of private utility lines and underground tanks, any backfilling required, removing any existing shoulder drain or subdrain pipe and maintaining the work.

Payment for false sumps will be classified as *Unclassified Excavation, Borrow Excavation* or included in *Grading-Lump Sum*. Payment as *Unclassified Excavation* or *Borrow Excavation* will be at the contract unit price per cubic yard.

Excavation done in the shaping of old roadways in accordance with Section 808 is paid as *Unclassified Excavation*.

Where slides and overbreaks occur due to negligence or carelessness on the part of the Contractor, the removal and disposal of said slides and overbreaks will be incidental to the work of this section.

Payment will be made under:

Pay Item	**Pay Unit**
Unclassified Excavation	Cubic Yard
Undercut Excavation	Cubic Yard

SECTION 226
COMPREHENSIVE GRADING

226-1 DESCRIPTION

The work covered by this section consists of all elements of work covered by Sections 200, 225, 230, 235, 250, 500 and 560, except that the requirements of the above-referenced sections pertaining to measurement and payment will not apply unless specific reference is made to such.

226-2 CONSTRUCTION METHODS

Perform the work in accordance with Sections 200, 225, 230, 235, 250, 500 and 560.

226-3 MEASUREMENT AND PAYMENT

Seeding and mulching of all borrow sources will be measured and paid at the contract unit prices for such items established in the contract.

Payment for material that the Engineer directs the Contractor to obtain from borrow sources to backfill box culverts, pipe culverts, drainage structures or structure bents will be made in accordance with Article 104-7, unless there is a line item for *Borrow Excavation*.

Payment for material that the Engineer directs to be removed beyond the limits of the original slope stakes will be made in accordance with Article 104-3.

Grading will be paid at the contract lump sum price. Partial payments will be equal to the percentage of such item that is complete as estimated by the Engineer. No separate payment will be made for clearing and grubbing, shoulder and fill slope material or draining borrow sources as such work will be incidental to the work covered by this section.

Clearing and grubbing work that is directed to be performed on areas outside the limits originally staked or beyond the limits of the right of way or easements shown on the original plans will be measured and paid at the contract unit price per acre for *Supplementary Clearing and Grubbing*. All measurements will be made horizontally. Where the contract does not include this item, a unit price per acre will be established by supplemental agreement.

Undercut Excavation will be measured and paid at the contract unit price per cubic yard. No separate payment will be made for materials used in backfilling the undercut areas, shoulders and slope areas as payment at the contract unit price per cubic yard for *Undercut Excavation* will be full compensation for furnishing such material. Where the contract does not include a pay item for *Undercut Excavation*, payment for such excavation will be made in accordance with Article 104-7.

Payment will be made under:

Pay Item	**Pay Unit**
Grading	Lump Sum
Supplementary Clearing and Grubbing	Acre
Undercut Excavation	Cubic Yard

SECTION 230
BORROW EXCAVATION

230-1 DESCRIPTION

Excavate approved material from borrow sources. Haul and use such material as required in the plans or as directed by the Engineer. Do not use borrow excavation until all available suitable unclassified excavation has been incorporated into the embankments, subgrades and shoulders except by execution of a supplemental agreement documenting the conditions prescribed below.

(A) All suitable unclassified excavation wasted as a result of the early use of borrow material will be deducted from the total volume of borrow excavation paid under the contract.

(B) Reimburse the Department for all additional costs, including additional engineering cost, associated with the wasting of suitable unclassified excavation.

(C) Any claim for contract time extensions related to the early use of borrow is waived should the Contractor use borrow material before all suitable unclassified excavation being incorporated into the project pursuant to a supplemental agreement.

(D) The Contractor specifically waives rights to request additional compensation with regard to the early use of borrow under the compensation requirements of Section 104 except when unclassified excavation is a major contract item and that unclassified excavation overruns by more than 25%.

Where the work required to complete the project is so phased by the plans to preclude using suitable unclassified excavation, the Contractor will be permitted to construct the required embankments, subgrades or shoulders so controlled by the phasing from approved borrow materials without having to execute the above required supplemental agreement.

230-2 COORDINATION WITH SEEDING OPERATIONS

Coordinate the work in this section with the construction of embankments in accordance with Article 225-2.

230-3 MATERIALS

Refer to Division 10.

Item	Section
Borrow Material	1018
Shoulder and Slope Material	1019

230-4 CONSTRUCTION METHODS

(A) General

Thoroughly clear and grub and clean the surface of the borrow area of all unsuitable material before beginning the excavation and, where applicable, before cross sections are taken. Dispose of material resulting from clearing and grubbing in accordance with Article 200-6. Remove and dispose of overburden in accordance with Section 802.

Do not accumulate exposed, erodible slope area in each borrow operation in excess of 1 acre at any one time without beginning permanent seeding and mulching of the borrow source or installing other approved erosion control measures.

Remove and stockpile topsoil at locations that will not interfere with the borrow operations and that meet the approval of the Engineer. Install temporary erosion control measures as needed to prevent the erosion of the stockpile material. Once all borrow has been removed from the source or portion thereof, uniformly spread the stockpiled topsoil over the area and permanently seed and mulch the area.

Where payment is made by cross section, notify the Engineer sufficiently before beginning excavation of the borrow material so that the area may be staked and cross sectioned. Excavate the material to the lines and slopes as staked in an orderly manner to facilitate measurement at any time.

Where payment is to be made by truck measurement, furnish trucks with bodies suitable for accurate measurement. Load trucks uniformly and load to prevent spillage.

When necessary to haul borrow material over existing roads or streets, comply with Article 105-15. Use all necessary precautions to prevent damage to the existing structures or pavement. Conduct hauling operations so as to not interfere with the normal flow of traffic and keep the traffic lanes free from spillage at all times.

Furnish borrow sources except where otherwise indicated in the contract.

(B) Contractor Furnished Sources

Before the approval of any borrow sources developed for use on any project, obtain certification from the State Historic Preservation Officer of the State Department of Cultural Resources certifying that the removal of the borrow material from the borrow sources will have no effect on any known district, site building, structure or object, architectural and/or archaeological that is included or eligible for inclusion in the National Register of Historic Places. Furnish a copy of this certification to the Engineer before performing any work on the proposed borrow source.

Borrow sources will not be allowed in any area under the USACE regulatory jurisdiction until the Contractor has obtained a permit for such borrow sources from the USACE District Engineer having jurisdiction and has furnished a copy of this permit to the Engineer. Requests for additional contract time, additional compensation or for work stoppage due to permit violations will not be considered.

The approval of borrow sources furnished by the Contractor is subject to the following conditions:

(1) Proof of Rights

Provide written proof of the right to take the material and any rights of access that may be necessary for locating and developing the source and any clearing and grubbing and drainage ditches necessary. The proof shall include an agreement with

the owner that the borrow source be dressed, shaped, seeded, mulched and drained as required by these specifications after all borrow has been removed.

(2) Sampling and Testing

Sampling and testing of contractor furnished borrow material will be in accordance with procedures set forth in the *Borrow Pit Sampling Manual,* as found on the Department's website, in effect on the date of advertisement for the project. The criteria for acceptance of the proposed contractor furnished borrow material is shown in Section 1018.

(3) Reclamation Plan

Except where borrow is to be obtained from a commercial source, jointly submit with the property owner a borrow source development, use and reclamation plan to the Engineer for his approval before engaging in any land disturbing activity on the proposed source other than material sampling that may be necessary. The Department's *Borrow, Waste and Staging Site Reclamation Procedures for Contract Projects* is available on the Department's website and shall be used for all borrow and waste sites on this project. Person preparing this reclamation plan must be Level III ESC/Stormwater Certified. Address the following in the plan:

(a) Topography

Detail the existing topography and locations of the proposed access and egress haul roads. Detail the proposed final topography of the waste or disposal area showing any proposed drainage systems. Excavate the source according to the plan and dress and shape it in a continuous manner to contours that are comparable to and blend in with the adjacent topography. Grade the source to drain such that no water will collect or stand. Provide a functioning drainage system for the source. If drainage is not practical and the source is to serve as a pond, the minimum depth shall be at least 4 feet as determined from the water table at the time the reclamation plan is executed. The slope of the soil below the water shall be between 5:1 and 2:1. The slope of the sides above the water line shall be 2:1 or flatter.

(b) Erosion Control

Detail the temporary and permanent erosion control measures, along with design calculations, that are intended during use of the site and as part of the reclamation. Unless considered impractical due to special circumstances, provide in the plan for the use of staged permanent seeding and mulching and appropriate fertilizer topdressing continually during site use and the immediate total reclamation of the site when the site is no longer needed. Define the seed mixture proposed for establishing temporary and permanent vegetation. Establish permanent stand of vegetation before acceptance of the project.

(c) Buffer Zones

Allocate sufficient area between the nearest property line and the tie-in of the slope to natural ground to allow for the operation of excavation, hauling and seeding equipment and for the installation of any and all erosion control devices required. Leave additional undisturbed area between the source and any water course or body to prevent siltation of the water course or body and the movement of the shore line either into the water course or body or into the waste areas. Determine if the adjoining property owners or other government agencies require any additional buffer zones and comply with those requirements. Suggested minimum distances are 10 feet from property lines and 50 feet from water bodies or water courses. Where it is necessary to drain the borrow source, perform work in accordance with Section 240.

(d) Evaluation for Potential Wetlands and Endangered Species

Hire a prequalified environmental consultant to perform an assessment of the borrow site for potential conflicts with wetlands, Areas of Environmental Concern designated by the Coastal Area Management Act and federally protected species. This evaluation will not be required for permitted commercial sites.

Delineate the boundaries of any wetlands, jurisdictional surface waters and streams encountered. Follow the standard practice for documenting the wetland delineation including completion of the USACE's approved *Jurisdictional Determination Form*. Document information including data regarding soil, vegetation and hydrology. Maintain a minimum 25 foot buffer adjacent to all sides of the wetland boundary and a minimum 50 foot buffer adjacent to any stream. Depict the limits of the delineated wetland and surrounding buffer on the Reclamation Plan. Do not remove borrow material in any area under the USACE' or any other environmental agencies' regulatory jurisdiction unless and until the Department permit has been modified to allow such disposal activity in the jurisdictional area.

Perform a site assessment for federally listed threatened or endangered species to include habitats that may support these species. Provide a detailed technical report on the assessment findings. If federally listed threatened or endangered species or habitat that may support such species exist on the proposed borrow site, notify the Engineer before continued pursuit of such site.

(4) Approval

Obtain written approval from the Engineer before excavating any material within the proposed borrow source area.

Submit a revised or additional reclamation plan if the non-permitted waste or disposal area is expanded by more than one acre or is significantly changed from the previously approved submittal.

If the Contractor proposes a borrow source, the environmental assessment shall include wetland and stream delineation extending 400 feet beyond the proposed borrow source limits.

(a) If wetlands or streams are present within 400 feet of the borrow source, submit a hydrologic analysis (Skaggs Method) or equivalent to determine if lateral effects will permanently impact or cause degradation to wetlands or streams. Perform analysis with an environmental or hydraulics engineer with expertise in this discipline and include:

(i) Hydric soil type,
(ii) Average profile depth to restrictive soil layer,
(iii) Effective hydraulic conductivity or permeability,
(iv) Average drainable porosity or available water capacity and
(v) Required buffer width, including safety factor.

(b) If wetlands or streams are present within 400 feet and the Contractor does not propose to excavate below the seasonal high water table or the water level in the adjacent stream, no documentation will be required.

(c) If wetlands or streams are not present within 400 feet, no additional documentation will be required.

During Department review of the proposed borrow area, the hydrologic analysis will be submitted to the USACE for evaluation. Obtain copy of *Skaggs Method for Determining Lateral Effects of a Borrow Pit on Adjacent Wetlands* from the Department's website.

(C) Maintenance

During construction and until final acceptance, use any methods approved by the Engineer that are necessary to maintain the work covered by this section so that the work will not contribute to excessive soil erosion.

230-5 MEASUREMENT AND PAYMENT

Borrow Excavation will be measured and paid in cubic yards. *Borrow Excavation* will be measured in place in its original position except that truck measurement will be made where called for in the contract or as determined by the Engineer.

If the quantity of borrow excavation used is excessive as evidenced by the presence of surplus suitable material from the roadway excavation, the measured quantity of borrow excavation will be reduced by the quantity of such surplus suitable material.

(A) In-Place Measurement

Borrow Excavation to be paid will be the actual number of cubic yards of approved material, measured in its original position by cross sectioning and computed by the average end area method, that has been excavated from the borrow source and incorporated into the completed and accepted work. No measurement will be made of any overburden, unsuitable material removed from the source or any material excavated before cross sections are taken.

(B) Truck Measurement

Borrow Excavation to be paid will be the actual number of cubic yards of approved material, measured in trucks excavated from the borrow source and incorporated into the completed and accepted work. Each truck will be measured and shall have a legible identification mark indicating its capacity. Load each truck to at least its measured capacity at the time it arrives at the point of delivery. The recorded capacity will be adjusted by making a 25% deduction to allow for shrinkage and the adjusted capacity will be the quantity to be paid.

Topsoil that is stockpiled and placed back on the source as part of the reclamation effort will be measured in the stockpile by cross sectioning and computed by the average end area method and paid per cubic yard for *Borrow Excavation*. No in-place measurement will be made of the topsoil.

Seeding, mulching and establishment of temporary erosion control measures for all borrow sources will be measured and paid at the contract unit prices established in the contract.

Payment includes, but is not limited to, furnishing the source of the borrow; providing and implementing a development, use and reclamation plan, evaluation of potential wetlands and endangered species, building, maintaining and obliterating haul roads, clearing and grubbing or draining the borrow source; removing, stockpiling and replacing topsoil, removing and disposing of overburden and other unsuitable material, excavation, hauling, formation of roadway embankments, subgrades and shoulders, restoration of the source and haul roads to an acceptable condition, obtaining permits and certifications and maintaining the work.

Payment will be made under:

Pay Item	Pay Unit
Borrow Excavation	Cubic Yard

SECTION 235
EMBANKMENTS

235-1 DESCRIPTION

Place suitable material excavated under Sections 225, 226, 230 and 240 in embankments, backfills and earth berms, to conform with the lines, grades and typical cross sections shown in the plans. Fill and compact holes, pits and other depressions when unsuitable material has been removed. Work includes preparation, formation, compaction and maintenance of the embankment area as well as the formation of benches in the existing ground with rises less than 60 inches.

Surcharges and waiting periods may be required for embankments and retaining walls to minimize and control the effects of settlement on structures, approach slabs, pavements, pipes, utilities, etc. Settlement gauges may be required to monitor settlement at approximate locations shown in the plans and as directed by the Engineer.

235-2 MATERIALS

Refer to Division 10.

Use soil consisting of loose, friable, sandy material free of subsoil admixtures, refuse, stumps, rocks, roots, root mats or other unsatisfactory material. Do not use material that meets AASHTO M 145 for soil classification A-2-5 and A-5 with a PI of less than 8 within 12 inches of the subgrade.

Wet, dry or frozen material may be suitable when dried, wetted or thawed, respectively. Aerate and dry material containing moisture content in excess of what is required to achieve embankment stability and specified density. Waste suitable material only with written authorization.

Provide Schedule 40 black steel pipes and couplers with steel or wood bases for settlement gauges. Use steel plates with yield strength of at least 36 ksi and pressure treated wood boards for bases of settlement gauges.

235-3 CONSTRUCTION METHODS

Coordinate work with excavation operations in accordance with Articles 107-12 and 225-2.

(A) Preparation for Embankment

Finish clearing and grubbing within an area in accordance with Section 200 before starting embankment. Remove and waste organic or other unsuitable material unless otherwise directed by the Engineer.

Plow mowed sod and leave in place where the height of embankment to be constructed is greater than 6 feet measured under the roadbed. Plow or scarify and break up cleavage planes of all underlying road surfaces. Remove or break up existing pavement in accordance with Section 250.

Bench existing slopes steeper than 4:1 measured at right angles to the roadway. Provide rises of at least 12 inches and no more than 60 inches as embankment is brought up in layers. Provide sufficient width for the operation of placing and compaction equipment. Begin bench cut at the intersection of the original ground and the vertical side of the previous cut. Construct benches greater than 60 inches in height only when shown in the plans. Such benches will be paid in accordance with the contract.

(B) Embankment Formation

Uniformly spread material in successive, approximately horizontal layers of not more than 10 inches depth, loose measurement, for the full width of the cross section. Compact each layer in accordance with Subarticle 235-3(C).

Shape embankment surface to properly drain at all times.

Route construction equipment uniformly over the full width of the embankment and prevent deep rutting.

May construct the first layer of embankments across saturated or unstable material that does not support the weight of hauling equipment, by successively dumping a uniformly distributed layer of a thickness not greater than necessary to support hauling equipment while placing subsequent layers.

When placing material in swamp or in water, keep unsuitable surge material in a fluid state or remove to prevent trapping in or under embankment.

When shown in the plans or allowed by the contract, form a satisfactory base by end or side dumping in valleys, ravines and at the foot of slopes on side hills.

Where embankments are being constructed principally of rock or broken pavement, place in uniform layers with a maximum depth of 36 inches. Place rock or broken pavement so larger pieces are evenly distributed and are no larger than 36 inches in any dimension. Fill all voids. Place rock or broken pavement lifts at least 2 feet below finished subgrade or finished grade whichever is lower.

Do not place rock or broken pavement 2 inches or greater in diameter within 12 inches of the subgrade or finished grade whichever is lower. Do not place rock or broken pavement in areas where foundations are to be placed.

Place select material where indicated in the contract. Construct the top 6 inches of shoulder and fill slopes with material that meets Article 1019-2. Construct stabilized embankment when required by the contract.

Install pipe culverts as specified in Section 300. Construct subsurface drains adjacent to structures as required by Article 414-8 for box culverts, except for that portion of the drain located below the elevation of the original ground. Do not disturb existing utilities within the project construction limits until released by the Engineer.

Do not place rock or broken pavement in embankment areas where piles or drilled shaft foundations are to be constructed or where underground utilities exist. This requirement shall include, but not be limited to, piles and foundations for structures, metal signal poles, overhead sign structures and high mount lighting.

(C) Embankment Compaction

Compact each layer for its full width to a density equal to at least 95% of that obtained by compacting a sample of the material in accordance AASHTO T 99 as modified by the Department. Copies of these modified procedures found in the *Conventional Density Operator's Manual* are available on the Department's website.

Uniformly bond all layers to preceding layers. Compact all surfaces on embankment slopes, principally constructed of soil, that are flatter than 1.5:1 using tracked equipment or other approved methods.

Increase or decrease moisture content of the material before compacting to produce the maximum density that will provide a stable grade. Exempt portions of rock embankments that cannot be tested by approved methods, from density requirements.

(D) Maintenance

Maintain all embankments made under the contract until final acceptance. Construct and maintain adequate drainage of surface runoff to prevent soil erosion. Replace damaged or displaced embankment.

(E) Surcharges and Waiting Periods

Place surcharges at locations shown in the plans. Unless required otherwise in the contract, surcharge embankments after embankments are constructed to the grade and cross section shown in the plans. Construct surcharges with side slopes as directed, 2:1 (H:V) end slopes outside of surcharge limits and surcharge heights shown in the plans. Place and compact surcharge material in accordance with Subarticles 235-3(B) and 235-3(C). Construct and maintain adequate drainage of surface runoff to prevent erosion of surcharge material.

Waiting period durations are in accordance with the contract and as directed by the Engineer. Surcharge waiting periods apply to surcharge locations shown in the plans and begin after surcharges are constructed to the height shown in the plans.

Unless required otherwise in the contract, bridge waiting periods are required in accordance with the following:

(1) Apply to bridge embankments and retaining walls within 100 feet of end bent and bent locations shown in the plans and

(2) Begin after bridge embankments and retaining walls are constructed to the elevations noted in the plans.

Unless required otherwise in the contract, embankment waiting periods are required in accordance with the following:

(1) Apply to embankment locations shown in the plans and retaining walls for embankments with waiting periods and

(2) Begin after embankments and retaining walls are constructed to the elevations, grade and cross section shown in the plans.

Except for maintaining embankments, do not perform any work on embankments or structures including foundations with waiting periods until waiting periods end unless otherwise approved by the Engineer. Place and compact additional material in accordance with Subarticles 235-3(B) and 235-3(C) to maintain embankment grade elevations during waiting periods. Remove surcharges to the grade and cross section shown in the plans after surcharge waiting periods ends.

(F) Embankment Monitoring

Fabricate and install settlement gauges in accordance with the contract and the *Roadway Standard Drawings*. Make settlement gauges highly visible so gauges are not disturbed while monitoring settlement. Use only hand operated compaction equipment to compact fill material around gauges.

Do not damage settlement gauges. Damaged settlement gauges may require replacement or additional gauges and waiting period extensions as determined by the Engineer.

Bring all embankments to the grade and cross section shown in the plans before final inspection and acceptance.

235-4 TOLERANCES

Finish subgrade surface within ± 0.10 feet from the established grade after it has been graded to a uniform surface.

235-5 MEASUREMENT AND PAYMENT

Payment will not be made for embankment construction. Payment at the contract unit prices for the various items covered by Sections 225, 226, 230 and 240 will be full compensation for all work covered by this section. Repairs to embankments caused by Contractor carelessness or negligence will be incidental to the work of Sections 225, 226, 230 and 240. Repairs to embankments as a result of natural causes will be at the contract unit price for the excavated material required to make the necessary repairs.

Borrow Excavation for surcharge material and additional material for maintaining embankment grade elevations will be measured and paid in accordance with Article 230-5.

Unclassified Excavation for surcharge material, additional material for maintaining embankment grade elevations and removing surcharges will be measured and paid in accordance with Article 225-7. When there is no pay item for *Borrow Excavation* or *Unclassified Excavation* in the contract, surcharge material and removing surcharges will be included in the lump sum payment for *Grading*. Additional material for maintaining embankment grade elevations will be paid as extra work in accordance with Article 104-7.

Embankment Settlement Gauges will be measured and paid in units of each. Settlement gauges will be measured as one per gauge location. The contract unit price for *Embankment Settlement Gauges* will be full compensation for fabricating and installing settlement gauges including placing and compacting fill material around gauges, adding pipes and couplers until embankment monitoring ends and any incidentals necessary to monitor settlement. No payment will be made for interfering with the Contractor's operations due to embankment monitoring or damaged settlement gauges as determined by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Embankment Settlement Gauges	Each

SECTION 240
DITCH EXCAVATION

240-1 DESCRIPTION

Excavate and satisfactorily dispose of all materials excavated in the construction of ditches except silt ditches.

(A) Drainage Ditches

Define "drainage ditches" as inlet and outlet ditches for pipe culverts and structures, changes in channels of streams, ditches draining borrow and material sources and parallel or lateral ditches when such ditches are separated from the roadway slope by an area of natural ground or berm.

Unless otherwise classified in the plans, parallel or lateral ditches constructed as an integral part of the graded roadbed, having a continuous slope from the outer limit of the shoulder to the bottom of the ditch, will be considered to be within the roadway grading limits and will be part of the work covered by Section 225.

(B) Berm Ditches

Define "berm ditches" as ditches constructed by either excavation or the construction of earth berms along the top of cut slopes. The location of berm ditches will be as shown in the plans or as directed by the Engineer.

240-2 GENERAL

Excavate to the lines, grades, typical sections and details shown in the plans or established. Coordinate all work covered by this section with the grading, construction of drainage

structures, excavation of borrow and material sources and other work along the project and maintain in a satisfactory condition so that adequate drainage is provided at all times. Maintain the ditches until the final acceptance of the project. Trim flush with the sides of the ditch any roots that protrude into the ditch. Complete inlet and outlet ditches for pipelines before the pipe is installed unless otherwise permitted by the Engineer.

240-3 DISPOSAL OF MATERIALS

Use all excavated materials in the construction of roadway embankments except where otherwise directed by the Engineer. Deposit materials that are excess to the needs of the project alongside the ditch and spread to form a low, flat, inconspicuous spoil bank of sufficient regular contour to permit seeding and mowing, provided no drainage into the ditch is blocked.

240-4 MEASUREMENT AND PAYMENT

Drainage Ditch Excavation will be measured and paid in cubic yards, measured in the original position by the average end area method of all materials excavated within the limits established by the plans or directed by the Engineer . Work includes, but is not limited to, excavation, shaping of the ditches, disposal of all materials, construction of earth berms and the maintenance of the work in an acceptable condition until final acceptance.

No measurement and payment will be made where excavation has been performed beyond the above limits; made solely for the convenience of the Contractor; for temporary drainage of the project; or for any excavation to provide drainage of borrow or material sources furnished by the Contractor.

Where the contract does not include a pay item for *Drainage Ditch Excavation*, all work of drainage ditch excavation will be treated as *Unclassified Excavation* and will be paid in accordance with Article 225-7.

Berm Ditch Construction will be measured and paid in linear feet, measured along the flow line of the ditch within the pay limits shown in the plans, completed and accepted by the Engineer. Work includes, but is not limited to, excavation, shaping of the ditches, disposal of all materials, construction of earth berms and the maintenance of the work in an acceptable condition until final acceptance.

Payment will be made under:

Pay Item	Pay Unit
Drainage Ditch Excavation	Cubic Yard
Berm Ditch Construction	Linear Foot

SECTION 250
REMOVAL OF EXISTING PAVEMENT

250-1 DESCRIPTION

Break up, remove and satisfactorily dispose of the Portland cement concrete or asphalt components of an existing roadway pavement structure, including paved shoulders, within the limits shown in the plans or as directed by the Engineer. This work includes the removal of any temporary roadway pavement structure placed during construction to serve as a detour.

250-2 PAVEMENT REMOVAL AND DISPOSAL

Break up and remove the pavement for its entire depth. Where concrete or asphalt pavement is to be removed, provide a neat edge along the pavement being retained by sawing the pavement approximately 2 inches deep before breaking the adjacent pavement away. Properly dispose of all materials resulting from the pavement removal as provided herein.

When existing pavement is located where embankment is to be constructed and the depth of the embankment is greater than 1 foot exclusive of base and pavement, do not remove existing pavement, but break up the existing pavement into pieces with the longest dimension no larger than 3 feet. Use all materials in the construction of embankments, unless otherwise directed by the Engineer. Stockpile materials that the Department desires to use, as indicated in the plans at approved locations.

Where the Contractor requests permission to use salvageable material in other parts of the work and such material has been intended for use in the construction of embankments, the Engineer may permit such use provided the Contractor furnishes at no cost to the Department an adequate quantity of material for embankment construction to replace the material used in all other parts of the work.

Dispose of all materials that cannot be used in the work in accordance with Section 802.

250-3 MEASUREMENT AND PAYMENT

Removal of Existing Asphalt Pavement will be measured and paid in square yards of existing asphalt pavement actually removed and disposed of properly. Removal of existing asphalt pavement will be measured by actual surface measurement of the asphalt pavement before its removal.

Removal of Existing Concrete Pavement will be measured and paid in square yards of existing concrete pavement actually removed and disposed of properly. Removal of existing concrete pavement will be measured by actual surface measurement of the concrete pavement before its removal.

Breaking of Existing Concrete Pavement will be measured and paid in square yards of existing concrete pavement actually broken up and left in place. The quantity will be determined by actual surface measurement of the pavement before breaking it up.

Breaking of Existing Asphalt Pavement will be measured and paid in square yards of existing asphalt pavement actually broken up and left in place. The quantity will be determined by actual surface measurement of the pavement before breaking it up.

Where the pavement removed or broken up is a combination of layers of both asphalt and concrete pavement, payment will be made at the contract unit price per square yard for *Removal of Existing Concrete Pavement* or *Breaking of Existing Concrete Pavement*.

Where the pavement removed is a combination of layers of both asphalt and concrete pavement and an item is not established for concrete pavement removal, the cost of removing the combination of layers of asphalt and concrete will be made in accordance with Article 104-7.

Payment includes, but is not limited to, breaking up, removing and disposing of existing concrete or asphalt pavement, including paved shoulders and removing any temporary roadway pavement structure placed during construction to serve as a detour.

This work does not include pavement removal for pipe installation; removing and disposing of sidewalks, driveways, curb and gutter; traffic islands and parking areas; or any other incidental paved structures that are not part of a final roadway pavement structure.

Payment will be made under:

Pay Item	Pay Unit
Removal of Existing Asphalt Pavement	Square Yard
Removal of Existing Concrete Pavement	Square Yard
Breaking of Existing Concrete Pavement	Square Yard
Breaking of Existing Asphalt Pavement	Square Yard

SECTION 260
PROOF ROLLING

260-1 DESCRIPTION

Furnish and operate at the direction of the Engineer, heavy pneumatic tired compaction equipment for compacting the roadbed and testing the roadbed for stability and uniformity of compaction.

260-2 EQUIPMENT

Provide equipment with the following features:

(A) Four rubber tired wheels mounted on a rigid steel frame,

(B) Wheels evenly spaced in one line across the width of the roller and arranged so that all wheels will carry approximately equal loads when operated over an uneven surface,

(C) Maximum center to center spacing between adjacent wheels is 32 inches,

(D) Load capacity from 48 to 50 tons unless otherwise permitted in writing,

(E) Cover or construct the loaded roller to not trap water that will add weight to the ballast,

(F) Other equipment of equal or better effectiveness may be substituted with written permission, and

(G) Tire pressures shall be between 68 and 72 psi unless otherwise permitted in writing. Inflate tires with air only; use no liquid.

Provide ballasts consisting of bulk sand, bulk stone, bags of sand, stone or other materials of known unit weight such that the total weight of the ballast used can be readily determined at all times. Have a sufficient amount of ballast available on the job site to load the equipment to a maximum gross weight of 50 tons.

Use rubber tired or other types of tractive equipment for operation of this equipment on the roadbed. The entire assembly including motivating equipment shall be capable of executing a 180° turn on a 27 feet wide area.

260-3 CONSTRUCTION METHODS

After the roadbed has been completed within 0.5 feet of final grade, compact and test the roadbed with one coverage, unless otherwise directed by the Engineer, with a heavy pneumatic tired roller in accordance with Article 260-2. Coverage is considered that stage in the rolling procedure when the entire width of the area being proof rolled has been in contact with the pneumatic tires of the roller. Operate the roller systematically so the number of coverages over all areas to be proof rolled can be readily determined and recorded.

Operate the equipment at a speed between 225 feet per minute and 300 feet per minute. Perform proof rolling only in the presence of the Engineer. Proof roll areas again following the completion of the necessary corrections.

Protect all structural facilities on the project, such as, but not limited to, bridges, box culverts, pipe culverts and utilities, from damage by the proof rolling equipment. Protection may include unloading and reloading of the roller, detouring, protective earth pads or other suitable measure to avoid damage.

260-4 MEASUREMENT AND PAYMENT

Proof Rolling will be measured and paid as the actual number of hours, measured to the nearest 0.1 hour, during which the heavy pneumatic tired roller has been engaged in proof rolling in the presence of the Engineer, exclusive of hours of proof rolling performed following corrective action made necessary by the negligence of the Contractor or by weather.

Corrective work necessary, as determined by proof rolling, and not due to negligence of the Contractor or to weather, will be paid at the applicable contract unit prices or as extra work, whichever may apply.

Proof rolling after corrective work will be at no cost to the Department if the corrections are necessary due to the negligence of the Contractor or weather.

Payment includes furnishing all labor, equipment, fuel and ballast for loading, loading and unloading ballast as directed by the Engineer and increasing and decreasing tire pressure as directed by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Proof Rolling	Hour

SECTION 265
SELECT GRANULAR MATERIAL

265-1 DESCRIPTION

Furnish and place select granular material in accordance with the contract and as directed by the Engineer.

265-2 MATERIALS

Refer to Division 10.

Item	Section
Select Material, Class II	1016
Select Material, Class III	1016

Use Class II or III select material for select granular material except when contract includes pay item for *Select Granular Material, Class III.* When this occurs, use only Class III select material for select granular material.

265-3 CONSTRUCTION METHODS

Use only Class III select material for embankments in water.

Place select granular material up to 3 feet above geotextile for soil stabilization and the water level.

265-4 MEASUREMENT AND PAYMENT

Select granular material will be paid as *Select Granular Material* or *Select Granular Material, Class III* unless the material is obtained from the same source as the borrow material and the contract includes a pay item for *Borrow Excavation*. When this occurs, select granular material will be paid at the lower bid price per cubic yard for either *Borrow Excavation* or *Select Granular Material* / *Select Granular Material, Class III*.

Select Granular Material and Select Granular Material, Class III will be measured and paid in cubic yards. When undercut excavation is in accordance with Section 226 and the Engineer requires undercut to be backfilled with select granular material, the second sentence of the sixth paragraph of Article 226-3 will not apply, as payment for the backfill will be made as described in this article.

Select granular material will be measured by in place measurement in accordance with Article 230-5 or by weighing material in trucks in accordance with Article 106-7 as determined by the Engineer. When select granular material is weighed in trucks, a unit weight of 135 pcf will be used to convert the weight of select granular material to cubic yards. At the Engineer's discretion, truck measurement in accordance with Article 230-5 may be used instead of weighing material in trucks.

The contract unit prices for *Select Granular Material*, *Select Granular Material, Class III* and *Borrow Excavation* as described above will be full compensation for providing, transporting, handling, placing, compacting and maintaining select granular material.

Payment will be made under:

Pay Item	Pay Unit
Select Granular Material	Cubic Yard
Select Granular Material, Class III	Cubic Yard

SECTION 270
GEOTEXTILE FOR SOIL STABILIZATION

270-1 DESCRIPTION

Supply and install geotextile for soil stabilization in accordance with the contract and as directed by the Engineer.

270-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextile for Soil Stabilization, Type 4a	1056

270-3 CONSTRUCTION METHODS

Grubbing may not be required in areas where geotextile for soil stabilization will be used. Minimize the use of heavy equipment in these areas to limit rutting. Cut trees flush with the ground surface and place geotextiles on relatively undisturbed ground as directed by the Engineer.

Do not leave geotextiles exposed for more than 7 days before covering geotextiles with backfill material except geotextiles for erosion control devices. Place geotextiles on surfaces free of obstructions, debris and soft pockets. Install geotextiles with the long dimension parallel to the roadway centerline. Overlap adjacent geotextiles at least 18 inches. Overlap geotextiles in the direction that material will be placed to prevent lifting the edge of the top geotextile.

Pull geotextiles taut so that they are in tension and free of kinks, folds, wrinkles or creases. Hold geotextiles in place as needed with wire staples or anchor pins. Provide backfill material in accordance with the contract. Do not operate equipment on geotextiles until covered with material as directed by the Engineer. Do not use vibratory compaction equipment on initial lifts of backfill.

270-4 MEASUREMENT AND PAYMENT

Geotextile for Soil Stabilization will be measured and paid in square yards. Geotextiles will be measured along the ground surface as the square yards of exposed geotextiles before placing backfill material. No measurement will be made for overlapping geotextiles. The contract unit price for *Geotextile for Soil Stabilization* will be full compensation for providing, transporting and installing geotextiles, wire staples and anchor pins.

Payment will be made under:

Pay Item	Pay Unit
Geotextile for Soil Stabilization	Square Yard

SECTION 275
ROCK PLATING

275-1 DESCRIPTION

Place rip rap on slopes in accordance with the contract. Rock plating is required to stabilize slopes at locations shown in the plans and as directed by the Engineer.

275-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextile for Rock Plating, Type 2	1056
Plain Rip Rap	1042
Select Material, Class IV	1016
Subsurface Drainage Materials	1044

Provide Type 2 geotextile for filtration geotextiles. Use Class IV select material (standard size No. ABC) over rip rap and Class 1, 2 or B rip rap unless required otherwise in the plans. Provide subdrain coarse aggregate (standard size No. 78M) and PVC subdrain pipes, fittings and outlet pipes for subsurface drainage materials.

275-3 CONSTRUCTION METHODS

Construct embankments in accordance with the contract. Compact fill slopes to the satisfaction of the Engineer with tracked equipment or other approved methods. Excavate materials as need to install rock plating on cut slope faces or embed rock plating below the ground line.

Do not leave filtration geotextiles exposed for more than 7 days before covering with rip rap or ABC. Unroll geotextiles down slopes, i.e., perpendicular to the roadway centerline. Bury filtration geotextiles at top of slopes and embed geotextiles at toe of slopes as shown in the plans. Filtration geotextiles should be continuous down slopes. If geotextile roll length is too short, overlap ends of geotextile rolls at least 5 feet with the upper geotextile over the lower as shown in the plans. Filtration geotextiles may be discontinuous down slopes in the direction perpendicular to the roadway centerline only once per roll width.

Overlap adjacent filtration geotextiles along slopes at least 18 inches as shown in the plans. Pull geotextiles taut so that they are in tension and free of kinks, folds, wrinkles or creases. Hold geotextiles in place as needed with wire staples or anchor pins. Do not displace or damage filtration geotextiles while placing rip rap. When shown in the plans, install 6 inch diameter perforated subdrain pipes and No. 78M stone at toe of slopes in accordance with Article 815-3.

Place rip rap so smaller stones are uniformly distributed throughout rip rap. Install rip rap with mechanical methods and if necessary, by hand to form a well graded, dense, neat layer of rip rap.

When shown in the plans, place filtration geotextiles and 18 inches of ABC over rip rap at top of slopes. Compact ABC to 92% of AASHTO T 180 as modified by the Department or to the highest density that can be reasonably obtained.

275-4 MEASUREMENT AND PAYMENT

Rock Plating will be measured and paid in square yards. Rock plating will be measured along slope faces of rock plated slopes as the square yards of exposed rip rap and if applicable, ABC. No measurement will be made for portions of rock plating embedded below the ground line. The contract unit price for *Rock Plating* will be full compensation for providing, transporting and installing filtration geotextiles, wire staples, anchor pins, rip rap and ABC.

The contract unit price for *Rock Plating* will be full compensation for excavating materials to install rock plating on cut slope faces and embed rock plating below the ground line.

Subdrain Coarse Aggregate and __" *Perforated Subdrain Pipe* will be measured and paid in accordance with Article 815-4.

Payment will be made under:

Pay Item	**Pay Unit**
Rock Plating	Square Yard

DIVISION 3
PIPE CULVERTS

SECTION 300
PIPE INSTALLATION

300-1 GENERAL

Excavate, undercut, provide material, condition foundation, lay pipe, joint and couple pipe sections and furnish and place all backfill material as necessary to install the various types of pipe culverts and fittings required to complete the project.

Install pipe in accordance with the details in the plans.

Do not waste excavation unless permitted. Use suitable excavated material as backfill; or in the formation of embankments, subgrades and shoulders; or as otherwise directed by the Engineer. Furnish disposal areas for the unsuitable material. The Engineer will identify excavated materials that are unsuitable.

Where traffic is to be maintained, install pipe in sections so half the roadway width is available to traffic.

300-2 MATERIALS

Refer to Division 10.

Item	Section
Flowable Fill, Excavatable	1000-7
Grout, Type 2	1003
Geotextiles, Type 4a	1056
Joint Materials	1032-6(F)
Select Materials	1016

Provide foundation conditioning material in accordance with Article 1016-3 for Class V or VI select material as shown in the contract.

Provide bedding material in accordance with Article 1016-3 for Class II (Type 1 only) or Class III select material as shown in contract.

Provide backfill material in accordance with Article 1016-3 for Class II (Type 1 for flexible pipe) or Class III select material as shown in the contract.

Provide filtration geotextile in accordance with Section 1056 for any type of geotextile.

Provide foundation conditioning geotextile and geotextile to wrap pipe joints in accordance with Article 1056 for Type 4a geotextile.

Do not use corrugated steel pipe in counties listed in Article 310-2.

300-3 UNLOADING AND HANDLING

Unload and handle pipe with reasonable care. Do not roll or drag metal pipe or plates over gravel or rock during handling. Take necessary precautions to ensure the method used in lifting or placing the pipe does not induce stress fatigue in the pipe. Use a lifting device that uniformly distributes the weight of the pipe along its axis or circumference. Repair minor damage to pipe when permitted. Remove pipe from the project that is severely damaged or is rejected as being unfit for use. Undamaged portions of a joint or section may be used where partial lengths are required.

300-4 PREPARATION OF PIPE FOUNDATION

Prepare the pipe foundation in accordance with the applicable method as shown in the contract, true to line and grade and uniformly firm.

Where material is found to be of poor supporting value or of rock and when the Engineer cannot make adjustment in the location of the pipe, undercut existing foundation material within the limits established in the plans. Backfill the undercut with foundation conditioning material. Encapsulate the foundation conditioning material with foundation conditioning geotextile before placing bedding material. Overlap all transverse and longitudinal joints in the geotextile at least 18 inches.

Maintain the pipe foundation in a dry condition.

300-5 INVERT ELEVATIONS

The proposed pipe culvert invert elevations shown on the Drainage Summary Sheets are based upon information available when the plans were prepared. If proposed invert elevations are adjusted during construction based upon actual conditions encountered, no claim for an extension of time for any reason resulting from this information will be allowed.

When a pipe culvert is to be installed in a trench and the average actual elevation of the pipe between drainage structures deviates from the average proposed elevation shown on the Drainage Summary Sheets by more than one foot, a pay adjustment will be made as follows:

$$\text{Pay Adjustment (per linear foot)} = \left[\left(APE - AAE\right) \pm 1\right]\left(0.15 \times CUP\right)$$

Where:

APE = Average Plan Elev. = $\dfrac{\left(Plan\ \ Inlet\ \ Elev. + Plan\ \ Outlet\ \ Elev.\right)}{2}$

AAE = Average Actual Elev. = $\dfrac{\left(Actual\ \ Inlet\ \ Elev. + Actual\ \ Outlet\ \ Elev.\right)}{2}$

CUP = $Contract\ \ Unit\ \ Price\ of\ \ Pipe\ Culvert$

When the actual location of a pipe culvert is changed from the location shown in the plans, the Engineer will make a pay adjustment deemed warranted based upon the relation of the pipe culvert as shown in the plans to the finished roadway and the relation of the pipe culvert as constructed to the finished roadway.

The top elevation column on the drainage summary sheet indicates the flow elevation at the top of structures intended to collect surface water.

The top elevation column on drainage structures not intended to collect surface water indicates the elevation at the top of the cover.

300-6 LAYING PIPE

The Department reserves the right to perform forensic testing on any installed pipe.

(A) Rigid Pipe

Concrete and welded steel pipe will be considered rigid pipe. Lay pipe on prepared foundation, bell or groove end upgrade with the spigot or tongue fully inserted. Check each joint for alignment and grade as the work proceeds.

Use flexible joint material except when material of another type is specified in the contract. Joint material of another type may be used when permitted.

Repair lift holes in concrete pipe, if present. Thoroughly clean and soak the lift hole and completely fill the void with grout. Submit alternate details for repairing lift holes to the Engineer for review and approval.

For all pipes 42 inches in diameter and larger, wrap geotextile around all pipe joints. Extend geotextile at least 12 inches beyond each side of the joint. Secure geotextile against the outside of the pipe by methods approved by the Engineer.

(B) Flexible Pipe

Corrugated steel, corrugated aluminum, polypropylene, HDPE and PVC pipe will be considered flexible pipe. Place flexible pipe carefully on the prepared foundation starting at the downstream end with the inside circumferential laps pointing downstream and with the longitudinal laps at the side or quarter points.

Handle coated corrugated steel pipe with special care to avoid damage to coatings.

Join corrugated steel and corrugated aluminum pipe sections with coupling band, fully bolted and properly sealed. Provide coupling bands for annular and helical corrugated metal pipe with circumferential and longitudinal strength sufficient to preserve the alignment, prevent separation of the sections and prevent backfill infiltration. Match-mark all pipe 60 inches or larger in diameter at the plant for proper installation on the project.

Only at locations with rod and lug connectors indicated in the plans, join corrugated steel pipe sections together with rod and lug coupling bands, fully bolted. Use sleeve gaskets in conjunction with rod and lug couplings and seal the joints properly.

For HDPE, polypropylene, and PVC pipe use a gasketed bell and spigot connection where not otherwise specified in the plans.

Only at locations with couplers indicated in the plans, join HDPE and polypropylene pipe sections together with coupling bands. Provide coupling bands with circumferential and longitudinal strength sufficient to preserve the alignment, prevent separation of the sections and prevent infiltration of backfill material.

300-7 BACKFILLING

Loosely place bedding material, in a uniform layer, a depth equal to the inside diameter of the pipe divided by 6 or 6 inches, whichever is greater. Leave bedding material directly beneath the pipe uncompacted and allow pipe seating and backfill to accomplish compaction. Excavate recesses to receive the bells where bells and spigot type pipe is used.

Place fill around the pipe in accordance with the applicable method shown in the plans in layers not to exceed 6 inches loose unless otherwise permitted by the Engineer. Compact to the density required by Subarticle 235-3(C). Approval of the backfill material is required before its use. Use select material as shown in the contract.

Take care during backfill and compaction operations to maintain alignment and prevent damage to the joints. Keep backfill free from stones, frozen lumps, chunks of highly plastic clay or other objectionable material.

Grade and maintain all pipe backfill areas in such a condition that erosion or saturation will not damage the pipe foundation or backfill.

Flowable fill may be used for backfill when approved by the Engineer. When using flowable fill, ensure that the pipe is not displaced and does not float during backfill. Submit methods for supporting the pipe and material placement to the Engineer for review and approval.

Do not operate heavy equipment over any pipe until it has been properly backfilled with at least 3 feet of cover. Place, maintain and finally remove the required cover that is above the

proposed finished grade. Remove and replace pipe that becomes misaligned, shows excessive settlement or has been otherwise damaged by the Contractor's operations.

300-8 INSPECTION AND MAINTENANCE

Ensure proper jointing and that deformations do not exceed allowable limits as described in the Department's *Guidelines for Post Installation Evaluation and Repair of Newly-Installed Drainage Pipe*. Maintain all pipe installations in a condition such that they will function continuously from the time the pipe is installed until the project is accepted by the Engineer. The Engineer will randomly video, deflection test, and/or manually inspect installations of completed pipelines prior to final acceptance.

300-9 MEASUREMENT AND PAYMENT

No measurement will be made of any work covered by this section except as listed below. Removal and disposal of existing pavement and unsuitable material above the pipe invert are a part of the excavation for the new pipe culvert installation. Repair of the pavement will be made in accordance with Section 654. Placing, maintaining and removing the required cover is incidental to the work of this section. Removing and replacing pipe that becomes misaligned, shows excessive settlement or has been otherwise damaged by the Contractor's operations is incidental to the work of this section.

(A) Using Local Material

Undercut Excavation is all excavation removed by undercutting below the bottom of the trench as staked. *Undercut Excavation* will be measured as the actual number of cubic yards of undercut excavation, measured in its original position and computed by the average end area method, that has been removed as called for in the contract and will be paid at double the contract unit price for *Unclassified Excavation* in accordance with Article 225-7.

Local material used for conditioning the foundation will be measured and paid in accordance with Article 225-7 for *Unclassified Excavation* or in accordance with Article 230-5 for *Borrow Excavation* depending on the source of the material.

Local material used to replace pipe undercut excavation will be measured and paid in accordance with Article 225-7 or Article 230-5.

(B) Using Other than Local Material

No measurement and payment will be made for *Undercut Excavation*. The material used to replace pipe undercut excavation will be classified as foundation conditioning material.

Foundation Conditioning Material, Minor Structures will be measured and paid as the actual number of tons of this material weighed in trucks on certified platform scales or other certified weighing devices.

No direct payment will be paid for *Undercut Excavation*. Payment at the contract unit price for *Foundation Conditioning Material, Minor Structures* will be full compensation for all work of pipe undercut excavation.

(C) Foundation Conditioning Geotextile

Foundation Conditioning Geotextile will be measured and paid in square yards. The measurement will be based on the theoretical calculation using length of pipe installed and two times the standard trench width. No separate measurement will be made for overlapping geotextile or the vertical geotextile dimensions required to encapsulate the foundation conditioning material.

(D) Bedding and Backfill with Select Material

No measurement will be made for select bedding and backfill material required in the contract. The select bedding and backfill material will be included in the cost of the installed pipe.

Where unclassified excavation or borrow material meets the requirements for select bedding and backfill and is approved for use by the Engineer, no deductions will be made to these pay items to account for use in the pipe installation.

Payment will be made under:

Pay Item	Pay Unit
Foundation Conditioning Material, Minor Structures	Ton
Foundation Conditioning Geotextile	Square Yard

SECTION 305
DRAINAGE PIPE

305-1 DESCRIPTION

Where shown in the plans, the Contractor may use reinforced concrete pipe, aluminum alloy pipe, aluminized corrugated steel pipe, galvanized corrugated steel pipe, HDPE pipe, polypropylene pipe or PVC pipe in accordance with the following requirements.

305-2 MATERIALS

Refer to Division 10.

Item	Section
Aluminized Corrugated Steel Pipe	1032-3(A)(7)
Corrugated Aluminum Alloy Pipe	1032-2(A)
Corrugated HDPE Pipe	1032-7
Polypropylene Pipe	1032-4
Elbows	1032
PVC Pipe	1032-8
Reinforced Concrete Pipe, Class II, III, IV, or V	1032-6(B)

Corrugated steel pipe will not be permitted in counties listed in Article 310-2.

Only pipe with smooth inside walls will be allowed for storm drain systems. Define “storm drain systems” as pipe under curb and gutter, expressway gutter and shoulder berm gutter that connects drainage structures and is not open ended. Corrugated pipe without a smooth interior is only for use at storm drain system inlets and outlets if pipe slope is greater than 10%.

305-3 CONSTRUCTION METHODS

Install pipe culverts in accordance with Section 300. Where allowed by the plans, use any of the several alternate pipes shown herein, but only one type of pipe and elbow will be permitted between drainage structures or for the entire length of a cross line pipe.

305-4 MEASUREMENT AND PAYMENT

__" *Drainage Pipe* will be measured and paid as the actual number of linear feet of pipe that has been incorporated into the completed and accepted work. Measurement of pipe will be made by counting the number of joints used and multiplying by the length of the joint to obtain the number of linear feet of pipe installed and accepted. Measurements of partial joints will be made along the longest length of the partial joint to the nearest 0.1 foot. Select bedding and backfill material will be included in the cost of the installed pipe.

__" *Drainage Pipe Elbow* will be measured and paid in units of each.

Payment will be made under:

Pay Item	Pay Unit
__" Drainage Pipe	Linear Foot
__" Drainage Pipe Elbows	Each

SECTION 310
PIPE CULVERTS

310-1 DESCRIPTION

Furnish and install drainage pipe at locations and size called for in the contract. The work includes construction of joints and connections to other pipes, endwalls and drainage structures.

310-2 MATERIALS

Refer to Division 10.

Item	Section
Concrete Pipe Tees and Elbows	1032-6(D)
Corrugated Aluminum Alloy Culvert Pipe and Pipe Arch	1032-2(A)
Corrugated Aluminum Alloy Pipe Tees and Elbows	1032-2(B)
Corrugated Steel Culvert Pipe and Pipe Arch	1032-3(A)
Corrugated Steel Eccentric Reducers	1032-3(D)
Corrugated Steel Pipe Tees and Elbows	1032-3(C)
HDPE Smooth Lined Corrugated Plastic Pipe	1032-7
Polypropylene Pipe	1032-4
Precast Concrete Pipe End Sections	1032-6(C)
Prefabricated Corrugated Steel Pipe End Sections	1032-3(B)
PVC Pipe	1032-8
Reinforced Concrete Culvert Pipe	1032-6(B)

Use suppliers of metal pipe culverts, fittings and all other accessories covered by this section that meet the Department's Brand Certification program requirements for metal pipe culverts and are listed on the Materials and Tests Unit's pre-approved producer/suppliers list. The pre-approved list is available on the Department's website.

Do not use plain galvanized or aluminized corrugated steel pipe in the following counties:

> Beaufort, Bertie, Bladen, Brunswick, Camden, Carteret, Chowan, Columbus, Craven, Currituck, Dare, Gates, Hertford, Hyde, Jones, Martin, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrell and Washington.

310-3 PIPE INSTALLATION

Install pipe, pipe tees, couplers and elbows according to Section 300.

310-4 SIDE DRAIN PIPE

Define "side drain pipe" as storm drain pipe running parallel to the roadway to include pipe in medians, outside ditches, driveways and under shoulder berm gutter along outside shoulders greater than 4 feet wide.

Where shown in the plans, side drain pipe may be Class II, III, IV, or V reinforced concrete pipe, aluminized corrugated steel pipe, galvanized corrugated steel pipe, corrugated aluminum alloy pipe, polypropylene pipe, HDPE pipe or PVC pipe. Use of plain, galvanized, aluminized or other coated corrugated steel pipe is restricted in the counties listed in Article 310-2. Install side drain pipe in accordance to Section 300. Cover for side drain pipe shall be at least one foot.

310-5 PIPE END SECTIONS

Choose which material to use for the required end sections. Both corrugated steel and concrete pipe end sections will work on concrete pipe, corrugated steel pipe, polypropylene smooth lined corrugated plastic pipe and HDPE smooth lined corrugated plastic pipe.

310-6 MEASUREMENT AND PAYMENT

Pipe will be measured and paid as the actual number of linear feet of pipe that has been incorporated into the completed and accepted work. Measurement of pipe will be made by counting the number of joints used and multiplying by the length of the joint to obtain the number of linear feet of pipe installed and accepted. Measurements of partial joints will be made along the longest length of the partial joint to the nearest 0.1 feet. Select bedding and backfill material will be included in the cost of the installed pipe. Such price and payment will be full compensation for all materials, labor, equipment, and other incidentals necessary to complete the work.

Pipe End Sections, Tees, Elbows, Couplers and Eccentric Reducers will be measured and paid in units of each that have been incorporated into the completed and accepted work.

Payment will be made under:

Pay Item	Pay Unit
__" R.C. Pipe Culverts, Class ____	Linear Foot
__" x __" x __" R.C. Pipe Tees, Class ____	Each
__" R.C. Pipe Elbows, Class ____	Each
__" C.A.A. Pipe Culvert, __" Thick	Linear Foot
__" x __" x__" C.A.A. Pipe Tees, __" Thick	Each
__" C.A.A. Pipe Elbows, __" Thick	Each
__" C.A.A. Pipe Arch Culvert, __" Thick	Linear Foot
__" x __" x__" C.A.A. Pipe Arch Tees, __" Thick	Each
__" C.A.A. Pipe Arch Elbows, __" Thick	Each
__" C.S. Pipe Culverts, __" Thick	Linear Foot
__" x __" C.S. Pipe Arch Culverts, __" Thick	Linear Foot
__" x __" x__" C.S. Pipe Tees, __" Thick	Each
__" C.S. Pipe Elbows, __" Thick	Each
__" x __" C.S. Eccentric Reducers, __" Thick	Each
__" HDPE Pipe Culverts	Linear Foot
__" Polypropylene Pipe Culverts	Linear Foot
__" PVC Pipe Culverts	Linear Foot
__" Side Drain Pipe	Linear Foot
__" Side Drain Pipe Elbows	Each
__" Side Drain Pipe Couplers	Each
__" Pipe End Section	Each

SECTION 330
WELDED STEEL PIPE

330-1 DESCRIPTION

This work shall consist of furnishing and installing welded steel pipe by trenchless methods as shown in the contract and as directed by the Engineer.

330-2 MATERIALS

Refer to Division 10.

Item	Section
Welded Steel Pipe	1032-5

Use suppliers of metal pipe culverts, fittings and all other accessories covered by this section that meet the Department's Brand Certification program requirements for metal pipe culverts and are listed on Materials and Tests Unit's pre-approved producer/suppliers list as listed on the NCDOT APL. The pre-approved list is available on the Department's website.

330-3 PIPE INSTALLATION

Install the pipe by trenchless construction, true to line and grade and so settlement does not occur. Fill all voids around the pipe. Replace installations that become damaged or have to be abandoned.

Conduct a pre-construction meeting in the presence of the Engineer at least 48 hours before the beginning of the pipe installation. The meeting shall consist of, but not be limited to:

(A) Reviewing all installation methods to install the pipe true to the line and grade given,

(B) Methods to insure there is no settlement of the pipe or of the completed roadway section, and

(C) Methods for filling any potential voids around the pipe.

330-4 MEASUREMENT AND PAYMENT

__" *Welded Steel Pipe,* __" *Thick, Grade B in Soil* will be measured and paid as the actual number of linear feet of pipe measured along the flow line to the nearest foot, which has been installed in soil.

__" *Welded Steel Pipe,* __" *Thick, Grade B Not in Soil* will be measured and paid as the actual number of linear feet of pipe measured along the flow line to the nearest foot which has been installed in non-soil, as observed and confirmed by the Engineer. Non-soil is defined as all material other than soil. The Contractor shall request and obtain the Engineer's observation and confirmation of the limits of the installation not in soil before and during the installation of the pipe or portion of the pipe not in soil.

Failure of the Contractor to request and obtain the Engineer's observation and confirmation of the limits of the pipe not in soil before and during the installation will result in the payment at the unit price for __" *Welded Steel Pipe,* __" *Thick, Grade B in Soil*.

Such payment will include, but is not limited to, furnishing all labor, tools, equipment, materials and incidentals, miscellaneous grading or excavation necessary to complete the work. Installations that become damaged or are abandoned will be replaced at no cost to the Department.

Payment will be made under:

Pay Item	Pay Unit
__" Welded Steel Pipe, __" Thick, Grade B in Soil	Linear Foot
__" Welded Steel Pipe, __" Thick, Grade B Not in Soil	Linear Foot

SECTION 340
PIPE REMOVAL

340-1 DESCRIPTION

Remove and dispose of all existing roadway drainage pipe, including flared end sections, where the removal of the existing pipes is required by the plans or as directed by the Engineer. Unless otherwise indicated in the plans, this work excludes the removal and disposal of any existing public or private water or sewage pipe or subsurface and shoulder drain pipe.

The Contractor has the option of leaving pipes in place and filling with flowable fill.

340-2 MATERIALS

Refer to Division 10.

Item	Section
Chemical Admixtures	1024-3
Fine Aggregate	1014-1
Flowable Fill	1000-7
Fly Ash	1024-5
Portland Cement	1024-1
Type IP Blended Cement	1024-1
Type IS Blended Cement	1024-1
Water	1024-4

For fine aggregate, bottom ash may be used with permission of the Engineer.

For chemical admixtures, high-air generators or foaming agents may be used instead of conventional concrete air-entraining agents with the permission of the Engineer.

For fly ash, certain requirements of this article and ASTM C618 may be waived with the permission of the Engineer.

340-3 CONSTRUCTION METHODS

Remove existing pipe when so designated in the plans or as directed by the Engineer. When an existing pipe is encountered that is not shown in the plans, do not remove until the Engineer is notified of its presence and has directed its removal.

Remove pipe in sections so traffic is maintained. Remove existing pipe so nearby facilities will not be damaged.

Backfill the area disturbed by the removal of an existing pipe in accordance with the *Standard Specifications* applicable to the adjacent construction.

Salvaged pipe is the property of the Contractor unless otherwise indicated by the contract.

Discharge flowable fill material directly from the truck into the space to be filled or by other methods approved by the Engineer. The mix may be placed full depth or in lifts as site conditions warrant.

340-4 MEASUREMENT AND PAYMENT

Pipe Removal will be measured and paid as the actual number of linear feet of pipe and flared end sections, measured to the nearest 0.1 feet that has been removed in accordance with this section. No measurement and payment will be made for pipe removal when a new pipe is placed back in the same trench.

Flowable Fill will be measured and paid as the item for which it was substituted. In no case will payment for the use of flowable fill as a substitute be made for more than one deleted item of work.

Any additional backfill material that is necessary will be paid at the contract unit price for *Unclassified Excavation* in accordance with Article 225-7 or at the contract unit price for *Borrow Excavation* in accordance with Article 230-5, depending on the source of the material.

Payment includes but is not limited to removing pipe, hauling pipe and all excavating and backfilling that may be necessary.

Payment will be made under

Pay Item	Pay Unit
Pipe Removal	Linear Foot

SECTION 350
PIPE CLEAN OUT

350-1 DESCRIPTION

Clean out silt accumulations and other debris from existing drainage pipes at locations shown in the plans and as directed by the Engineer.

350-2 CONSTRUCTION METHODS

Use a pipe clean out method that does not damage the existing pipe.

350-3 MEASUREMENT AND PAYMENT

Pipe Clean Out will be measured and paid as the actual number of existing pipes, structure to structure, cleaned out and accepted by the Engineer, except where the work of cleaning out the pipe was made necessary by the Contractor's negligence in taking appropriate erosion control measures. Such price and payment will be full compensation for cleaning out existing pipe and disposing of all silt and debris.

Payment will be made under:

Pay Item	**Pay Unit**
Pipe Clean Out	Each

DIVISION 4
MAJOR STRUCTURES

SECTION 400
TEMPORARY STRUCTURES

400-1 DESCRIPTION

Furnish any design calculations and drawings required; furnish members and deck materials for structures and any other materials necessary; erect, maintain, remove and dispose of temporary structures required for the maintenance of pedestrian, highway and other traffic. Construct temporary structures in accordance with the contract.

400-2 MATERIALS

Use materials for temporary structures that conform to Division 10 or previously used materials conforming to the contract. Obtain approval for the use of salvaged materials and materials not covered by Division 10 before their use. Unless otherwise specified, untreated timber is allowed.

400-3 PLANS

(A) Furnishing Plans

Use the plans for the structure furnished by the Department or submit a design in accordance with Subarticle 400-3(B).

Design the structure when the plans furnished by the Department do not include detail plans for the structure. For all Contractor designs, submit design calculations and detail drawings of the structure in accordance with Subarticle 400-3(B) for review and comment.

Do not perform any work until the detail drawings are accepted by the Engineer. Acceptance of such drawings does not relieve the Contractor of any responsibility for safely and continuously maintaining traffic.

(B) Design Requirements for Contractor Furnished Drawings

Provide temporary structures of such carrying capacity, dimensions, grades and alignment as required by the contract or as directed by the Engineer. Design temporary structures carrying highway and pedestrian traffic in accordance with the *AASHTO LRFD Bridge Design Specifications*. Ensure that an engineer licensed by the State of North Carolina provides sealed designs and details of the temporary structure. Construct the temporary structure in accordance with this design.

Indicate in the plans, the specifications for the materials used in the temporary structure.

400-4 CONSTRUCTION METHODS

Construct and maintain temporary structures to adequately and safely carry traffic during the entire period for which they are required.

Remove and dispose of the temporary structures after they are no longer required in accordance with Article 402-2.

Upon removal of the temporary structure, all material furnished by the Contractor for use in this structure shall remain the property of the Contractor unless otherwise provided in the contract.

Unless otherwise specified in the contract, remove temporary piling to the streambed level or to one foot below existing ground.

400-5 MEASUREMENT AND PAYMENT

The price and payment below will be full compensation for all work required to provide temporary structures including, but not limited to, those items contained in Article 400-1.

The work covered by this section will be paid at the contract lump sum price for *Construction, Maintenance and Removal of Temporary Structure at Sta. ____*.

Payment will be made under:

Pay Item	Pay Unit
Construction, Maintenance and Removal of Temporary Structure at Sta. ____	Lump Sum

SECTION 402
REMOVAL OF EXISTING STRUCTURES

402-1 DESCRIPTION

Excavate as necessary to remove the structure. Dismantle, salvage and stockpile materials and components of the structure and preserve those portions that should remain intact. Dispose of waste and debris.

Maintain traffic on the existing structure unless otherwise stipulated by the contract. Do not exceed the posted load limits or damage the existing structure while maintaining traffic. Maintenance of the existing structure, if required, will be performed by Department forces.

402-2 REMOVAL OF EXISTING STRUCTURE

(A) General

Evaluate the current condition of the structure(s) and use approved methods and procedures for dismantling and removing the structure(s) in a safe and controlled manner. Bridge inspection reports are available for informational purposes and may be requested from the Structures Management Unit. Upon removal, all materials become the property of the Contractor unless otherwise indicated in the contract. Dispose of waste and debris from the structure(s) in accordance with Section 802.

Perform removal operations while preventing damage to adjacent property. Protect new construction during blasting or other operations necessary for the removal of the existing structure.

Ensure the stability of the structure at all times during the demolition operation. Prior to opening traffic (vehicular, pedestrian, vessel) underneath a partially demolished structure, maintain a sufficient number of girders and cross frames to provide a stable structure and remove all equipment and demolition debris. Any equipment or material that remains on the bridge must be analyzed by an engineer licensed in the State of North Carolina, and approved by the Engineer.

Unless otherwise required by the contract, remove substructures down to the streambed or one foot below the natural ground surface. Remove the substructure, including footings or piles as necessary to avoid interference with construction of the proposed structure.

Prevent erosion of soil and silting of rivers, streams, lakes, reservoirs, water impoundment, ground surfaces or other property. Do not deposit excavated materials and do not construct earth dikes or other temporary earth structures in rivers, streams or impoundment, or so near to such waters that they are carried into any river, stream or impoundment by stream flow or surface runoff. Do not use equipment in any body of water unless it is impossible or impractical to perform specific operations in any other way. When this occurs, these operations are specifically allowed through applicable environmental permits and controls to minimize erosion and siltation through best management practices. Do not drop components of structures into any body of water. Remove these existing bridges by sawing

or other non-shattering methods. Remove any component of a structure from the water so as to minimize siltation.

(B) Requirements for Materials Which Remain the Property of the Department

Pile materials salvaged from the structure neatly on the right of way at locations as directed by the Engineer.

Do not use any materials, either temporarily or permanently, which are removed from the structure unless so permitted by the contract.

Remove structural materials carefully without damage.

Do not use explosives to remove concrete floor slabs from steel superstructures that remain the property of the Department.

(C) Requirements for Partial Removal

Perform partial removal to the lines indicated in the plans. Submit a plan for partial removal of bridges for approval before beginning removal. Do not remove concrete by blasting, wrecking balls or other methods that may cause damage to the concrete or reinforcement that is used in the completed structure. Any damage to the portions remaining in service shall be repaired by the Contractor at the Contractor's expense.

Use equipment and methods to remove portions of a concrete structure undergoing widening which are sufficient to obtain plan lines and slopes without undue spalling at edges of the concrete.

Before beginning concrete removal operations involving the removal of a portion of a monolithic concrete element, a saw cut approximately 1 inch deep shall be made to a true line along the limits of removal on all faces of the element that will be visible in the completed work.

Concrete shall be carefully removed to the lines indicated in the plans by sawing, drilling, chipping or other methods approved by the Engineer. The surfaces presented as a result of this removal shall be reasonably true and even, with sharp, straight corners that will permit a neat joint with the new construction or be satisfactory for the intended use. Where existing reinforcing bars are to extend from the existing structure into new construction, the concrete shall be removed so as to leave the projecting bars clean and undamaged. Where projecting bars are not to extend into the new construction, they shall be cut off flush with the surface of the existing concrete.

During full-depth removal of deck concrete over beams or girders which are to remain in place, the Contractor shall exercise care so as not to spall, notch, gouge or distort the top flanges. Any damages shall be repaired at the direction of the Engineer and at the expense of the Contractor.

(D) Demolition Plan

(1) Prior to removal, prepare and submit to the Engineer for review and acceptance a demolition plan for each structure included in the contract indicating the methods and sequence of demolition. The Contractor is encouraged to examine existing structure plans, if available, and visit the site prior to preparing a demolition plan. The Contractor shall be responsible for the methods and sequence of demolition, including effects of the overall stability of each structure being removed. At a minimum, the demolition plan shall include:

(a) The name of the Contractor's on-site employee designated in responsible charge of all removal operations.

(b) The removal method and sequence of removal for each individual structure, including the staging of materials.

(c) Equipment type and locations of equipment on the structure(s) or adjacent roadways during the removal operations.

(d) Locations and type of work to be performed directly adjacent to traffic.

(e) Temporary bracing or supports to be used.

(f) Details and locations of protective covers and other measures to ensure that people, property and improvements will not be endangered or damaged as a result of the removal operations. This shall include methods for protecting any pavement surfaces including shoulders, concrete barriers and other highway features.

(g) Proposed methods of removal or containment of loose debris from structures with traffic to be open below.

(h) Proposed methods of access and containment methods of debris and slurry from removal of bridges over water.

Acceptance of the demolition plan does not relieve the Contractor of the responsibility and liability to safely and satisfactorily demolish the structure.

402-3 MEASUREMENT AND PAYMENT

The price and payment below will be full compensation for demolition plans and all items required to remove existing structures including, but not limited to, those items contained in Article 402-1.

When the contract includes the item of *Removal of Existing Structure at Station* ____, the work of removing the structure will be paid at the contract lump sum price for this item.

When the contract includes the item of *Removal of Existing Structures at Station* ____, the work of removing the structures will be paid at the contract lump sum price for this item.

Payment will be made under:

Pay Item	**Pay Unit**
Removal of Existing Structure at Station ____	Lump Sum
Removal of Existing Structures at Station ____	Lump Sum

SECTION 410
FOUNDATION EXCAVATION

410-1 DESCRIPTION

Excavate any material as necessary for the construction of foundations and end bent caps for bridges, retaining walls of reinforced concrete or reinforced masonry, arch culverts and box culverts without floor slabs in accordance with the contract or as directed by the Engineer. Excavate, perform exploratory drilling at footings to a depth not to exceed 5 feet, blast, drain, divert water, bail and pump. Provide and remove bracing, shoring, sheeting, cribbing and cofferdams; substructure scour protection, subsurface drainage and drawings; and backfill including hauling and disposal of materials.

Do not deposit excavated materials or construct earth dikes or other temporary earth structures in rivers, streams or impoundment or so near to such waters that they are carried into any river, stream or impoundment by stream flow or surface runoff. As an exception to the above, obtain written approval for the use of confined earth materials in cofferdams for structure foundations.

410-2 MATERIALS

Refer to Division 10.

Item	Section
Subsurface Drainage Materials	1044

410-3 FOUNDATION EXCAVATION

Notify the Engineer a sufficient time before beginning the excavation to allow measurements of the undisturbed ground.

Where necessary for safety, slope, shore, brace or protect by cofferdams the foundation openings in accordance with State and local safety standards. Perform foundation excavation and related work in such sequence that no portion of the structure is endangered by subsequent operations. Adequately protect completed portions of a structure during blasting operations.

Consider the dimensions and elevations of footings, as shown in the plans as approximate only. The Engineer may order, in writing, such changes in dimensions or elevations of footings as necessary to secure a satisfactory foundation.

Notify the Engineer after excavating each foundation. Do not place concrete before obtaining approval for the excavation depth, the character of the foundation and permission to proceed. Perform drilling as may be required by the Engineer to obtain information as to the depth to which the rock or other hard foundation material extends below the bottom of the footing.

Clean all rock or other hard foundation material of all loose material and cut to a firm surface, either level, stepped or serrated, as directed by the Engineer. Clean out all seams and fill with concrete, mortar or grout. Remove all loose and disintegrated rock and thin strata. Leave the rock surface in a rough condition to form an adequate key against lateral movement of the footing.

When the footing rests on an excavated surface other than rock, take special care not to disturb the bottom of the excavation until immediately before placing reinforcing steel and concrete. Remove foundation material softened and weakened by exposure and inundation down to sound, solid material before placing steel and concrete.

When using piles or drilled piers, complete the excavation of each pit before installing piles or piers.

When water or other unsuitable material is encountered, pile driving liquefies the soil, or the bed is otherwise unsuitable as determined by the Engineer, remove the material as required and backfill to the required elevation with subdrain fine or coarse aggregate. Such work will be paid as extra work in accordance with Article 104-7.

410-4 COFFERDAMS

(A) General

The term cofferdam designates any temporary or removable structure constructed to hold the surrounding earth, water or both, out of the excavation. It includes timber cribs, any type of sheet piling, removable steel shells or similar structures, all necessary bracing and the use of pumping wells or well points for the same purpose. Ensure cofferdams located in bodies of water are designed, detailed and sealed by an engineer licensed by the State of North Carolina when the distance from the water surface to the bottom of the excavation is 5 feet or greater.

(B) Construction

Design and construct cofferdams to adequate depths and heights, safely and as watertight as is necessary for the proper performance of the work. Provide interior dimensions of cofferdams as to give sufficient clearance for the construction and inspection of forms and to permit pumping outside the forms. Provide at least 5 feet of clearance between the proposed edge of footing and inside face of cofferdam when a keyed footing is required and at least 3 feet when a keyed footing is not required. Right, rest or enlarge cofferdams that are tilted or moved laterally during the process of sinking to provide the necessary clearance.

Construct cofferdams to protect plastic concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. Do not leave timber or bracing in cofferdams that could extend into the substructure concrete without permission from the Engineer.

(C) Removal

After the completion of the substructure, unless otherwise provided in the contract, remove cofferdams with all sheeting and bracing to the streambed or one foot below existing ground. Take care not to disturb or damage the finished concrete.

410-5 PUMPING

Perform pumping operations in accordance with Article 414-5.

410-6 PRESERVATION OF CHANNEL

Unless otherwise required by the contract or permitted by the Engineer, do not excavate in stream channels outside of cofferdams. Do not disturb the natural streambed adjacent to the structure without permission. Backfill any excavation or dredging made at the site of the structure outside of the cofferdam limits to the original ground surface or streambed with approved material.

Remove materials placed within the stream area and leave the stream in its original condition, unless otherwise permitted by the Engineer.

410-7 UTILIZATION OF EXCAVATED MATERIAL

Use suitable excavated material as backfill. Use suitable material that is not required for backfill to form embankments, subgrades or shoulders. Furnish disposal areas for excavated unsuitable materials and suitable materials not required in connection with other work included in the contract. Do not place excavated material in a stream or other body of water or wetland.

Do not deposit excavated material at any time so as to endanger the partly finished structure, either by direct pressure, indirectly by overloading banks adjacent to the operations or in any other manner.

410-8 BACKFILLING AND FILLING

Use approved material for backfill that is free from large or frozen lumps, wood or other undesirable material. Where there is not an adequate quantity of suitable backfill material available from the excavation, provide suitable backfill material compensated in accordance with Article 410-10.

Refill all excavated spaces, not filled with permanent work, with earth up to the ground surface existing before the excavation. Place backfill to provide adequate drainage as soon as concrete surfaces are finished in accordance with Subarticle 420-17(B) and the concrete has been inspected and approved by the Engineer. The Engineer has the authority to suspend all operations until such backfilling is acceptably completed.

Eliminate any slope adjacent to the excavation for abutments, wingwalls and retaining walls by stepping or serrating to prevent wedge action.

Place and compact all portions of the backfill that become a part of roadway typical sections or their foundations in accordance with Subarticles 235-3(B) and 235-3(C). Place all other portions of the backfill in layers not more than 10 inches in depth of loose measure and compact to a density comparable to the adjacent undisturbed material.

Place backfill or embankment material simultaneously to approximately the same elevation on both sides of an abutment, pier or wall. If conditions require placing backfill or embankment higher on one side, do not place the additional material on the higher side until the concrete develops the minimum specified strength for the class of concrete required for the structure as specified in Table 1000-1.

Do not place backfill or embankment behind abutments of rigid frame structures such as arch culverts and box culverts without floor slabs, until the top slab is placed and has developed the minimum compressive strength of the class of concrete required for the structure. Place backfill and embankment simultaneously behind opposite abutments of rigid frames.

Place backfill to not cause excess lateral forces against the structure by heavy equipment or from earth masses transmitting pressures caused by earth moving equipment. Place backfill immediately adjacent to the structure by hand operated mechanical tampers. Do not operate heavy earth moving equipment within 10 feet of the structure in backfilling operations.

410-9 BLASTING ADJACENT TO HIGHWAY STRUCTURES

Conduct blasting operations adjacent to highway structures in accordance with the following requirements.

Submit a blasting plan for approval by the Engineer before conducting any blasting operation.

Do not conduct blasting operations within 60 feet of any structure until the concrete strength reaches 2,400 psi. After the concrete achieves a strength of 2,400 psi, limit the maximum PPV to 4 in/sec measured at the closest structure extremity.

For multi-column bents with column heights up to 40 feet and a combined span length for the 2 adjacent spans of 160 feet or less, adhere to the following criteria:

(A) Do not blast within 6 feet without obtaining prior written approval.

(B) At distance of 6 feet to 10 feet, do not use a quantity of explosives more than 0.5 lbs. per delay period.

(C) From 11 feet to 60 feet, use a maximum charge weight per delay of 0.5 lb. and 0.5 lb. of explosives per foot of distance over 10 feet.

No vibration measurements are required if the above criteria are met. If unable to meet the above criteria, monitor the structure for vibrations. If the 4 in/sec limit is exceeded, the Engineer will evaluate each subsequent blast, and if deemed necessary, will apply more restrictive controls than those above to prevent damage.

410-10 MEASUREMENT AND PAYMENT

The prices and payments below will be full compensation for all items required to complete foundation excavation, including but not limited to those items listed in Article 410-1.

Payment of blasting operations is included in the bid price for *Foundation Excavation* at the affected substructure unit.

(A) Foundation Excavation on a Cubic Yard Basis

When the contract calls for payment of *Foundation Excavation* on a cubic yard basis, it will be measured and paid as the actual number of cubic yards of materials, measured in their original position within the limits described below and computed by the average end area method, that are acceptably excavated.

The upper limits for measurement are the actual ground surface at the time of starting work, except where the excavation is performed in cut areas excavated under Section 225, the upper limits are the roadway plan typical section. For keyed footings the upper limits of the keyed section are as shown in the plans. Define a "keyed footing" as a footing placed without forms for the keyed depth in an excavation whose sides, as near as practical, are located at the neat line dimensions of the footing and are vertical.

When the foundation material is other than rock, the lower limits for measurement are the elevation of the bottom of footing as established by the plans or as directed by the Engineer. When the foundation material is rock, the lower limits for measurement are the actual rock elevations after the foundation is approved.

As an exception to the lower limits established above, when in the opinion of the Engineer excess excavation is performed due to carelessness or negligence on the part of the Contractor, the Engineer notifies the Contractor of that portion of the excavation which is not measured for payment.

Horizontal limits for measurement are established by vertical planes located 18 inches outside of the neat line dimensions of the footing as established by the plans or directed in writing by the Engineer. For keyed footings the horizontal limits for measurement of the keyed section are established by vertical planes located at the neat line dimensions of the footing as established by the plans or directed in writing by the Engineer.

Measurement includes mud, muck or similar semi-solid material within the limits described above provided such material is present at the time excavation begins and cannot be drained away or pumped without the use of a jet or nozzle.

(1) No measurement is made of the following excavation, as such excavation is incidental to the work being performed:

(a) Excavation necessary to construct end bent caps and the berm adjacent to the cap.

(b) Excavation necessary to construct pile encasement.

(c) Excavation outside of the limits described in this subarticle.

(d) Excavation necessary from heaving of a foundation due to the driving of piles.

(e) Excavation necessary from overbreaks or slides.

(f) Mud, muck or similar semi-solid material which can be drained away or pumped without the use of a jet or nozzle.

(g) Excavation made before the Engineer makes measurements of the undisturbed ground.

(h) Excavation necessary due to exposure or inundation allowed by the Contractor or negligence on the part of the Contractor.

(2) *Foundation Excavation* will be paid at the contract unit price per cubic yard for *Foundation Excavation* except where the Engineer directs the Contractor in writing to excavate below the original plan elevation of the bottom of the footing. Payment for such excavation will be made as follows:

(a) For excavation made below the original plan elevation of the bottom of the footing to an elevation 3 feet below such plan elevation, payment will be made at the contract unit price per cubic yard for *Foundation Excavation*.

(b) For excavation made below an elevation 3 feet below the original plan elevation of the bottom of the footing but not more than 6 feet below such plan elevation, payment will be made at 150% of the contract unit price per cubic yard for *Foundation Excavation*.

(c) For excavation made below an elevation 6 feet below the original plan elevation of the bottom of the footing, payment will be made as extra work in accordance with Article 104-7.

(d) In areas where piles have been driven, removal of material and backfilling with subdrain fine or coarse aggregate in accordance with Article 410-3 will be paid as extra work in accordance with Article 104-7.

(B) Foundation Excavation on a Lump Sum Basis

When the contract calls for payment of *Foundation Excavation* on a lump sum basis, no measurement will be made of any foundation excavation made at such locations.

(1) When the contract calls for payment on a lump sum basis, payment will be made at the contract lump sum price for *Foundation Excavation for Bent No. ____ at Station ____* or *Foundation Excavation for End Bent No. ____ at Station ____* except as otherwise provided below.

(2) Where the Engineer directs the Contractor to excavate below the original plan elevation of the bottom of the footing by a distance which is less than 3 feet the character of the work will not be considered to be materially changed and no additional compensation will be allowed for the foundation excavation at such location.

(3) Where the Engineer directs the Contractor in writing to excavate more than 3 feet below the original plan elevation of the bottom of the footing, payment for such excavation will be made as extra work in accordance with Article 104-7.

(C) Furnishing and Hauling Backfill Material

Where it is necessary to provide backfill material from sources other than excavated areas or borrow sources used in connection with other work in the contract, payment for furnishing and hauling such backfill material will be paid as extra work in accordance with Article 104-7. Placing and compacting such backfill material is not extra work but is incidental to the work being performed.

When the Contractor has been directed by the Engineer to drill in the vicinity of a footing to obtain subsurface information, such drilling in excess of a 5 foot depth will be paid as extra work in accordance with Article 104-7.

When so used, no additional payment will be made for use of the material under other pay items or for stockpiling the material for use under other pay items.

Payment will be made under:

Pay Item	**Pay Unit**
Foundation Excavation	Cubic Yard
Foundation Excavation for Bent No. ____ at Station ____	Lump Sum
Foundation Excavation for End Bent No. ____ at Station ____	Lump Sum

SECTION 411
DRILLED PIERS

411-1 DESCRIPTION

Construct drilled piers consisting of CIP reinforced concrete cylindrical sections in excavated holes typically stabilized with casings or slurry. Provide permanent casings, standard penetration tests, integrity testing and assistance with the shaft inspection device as noted in the plans. Construct drilled piers with the required resistances and dimensions in accordance with the contract and accepted submittals. Use a prequalified Drilled Pier Contractor to construct drilled piers.

Define "excavation" and "hole" as a drilled pier excavation and "pier" as a drilled pier. Define "permanent casing" as a casing that remains in the excavation and acts as a form for Drilled Pier concrete and "temporary casing" as any casing that is not permanent. Define "rock" as a continuous intact natural material with a standard penetration resistance of 0.1 foot or less per 60 blows or a rock auger penetration rate of less than 2 inches per 5 minutes of drilling at full crowd force or as determined by the Engineer when rock is not encountered as expected based on these criteria. This definition excludes discontinuous loose natural materials such as boulders and man-made materials such as concrete, steel, timber, etc. and is not for measurement and payment purposes. See Article 411-7 for measurement and payment of drilled piers.

411-2 MATERIALS

Refer to Division 10.

Item	Section
Grout, Type 2	1003
Portland Cement Concrete, Class Drilled Pier	1000
Reinforcing Steel	1070

Provide Type 3 material certifications in accordance with Article 106-3 for permanent casings and roller, chair, steel pipe and cap materials. Store steel materials on blocking at least 12 inches above the ground and protect it at all times from damage; and when placing in the work make sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials. Load, transport, unload and store drilled pier materials so materials are kept clean and free of damage.

(A) Steel Casing

Define "casing" as a temporary or permanent casing. If permanent casing is required for an excavation, the largest diameter casing in the hole is the permanent casing. This does not apply to working casings around permanent casings as approved by the Engineer. Use smooth non-corrugated clean watertight steel casings of ample strength to withstand handling and installation stresses and pressures imposed by concrete, earth, backfill and fluids.

(1) Temporary Casings

Provide temporary casings with a nominal wall thickness of at least 0.375 inch and an outside diameter equal to or larger than the design pier diameter for which temporary casing is used.

(2) Permanent Casings

Use permanent casings with a yield strength of at least 36 ksi and a nominal wall thickness that meets Table 411-1.

TABLE 411-1 MINIMUM PERMANENT CASING WALL THICKNESS	
Casing Diameter	**Nominal Wall Thickness**
< 48"	0.375"
48" - 78"	0.500"
> 78"	0.625"

Provide permanent casings with an outside diameter equal to the design pier diameter for which permanent casing is used unless larger diameter permanent casings are approved by the Engineer.

(B) Slurry

Define "slurry" as bentonite or polymer slurry. Mix bentonite clay or synthetic polymer with water to make bentonite or polymer slurry.

(1) Bentonite Slurry

Provide bentonite slurry that meets Table 411-2.

TABLE 411-2 BENTONITE SLURRY REQUIREMENTS[A]		
Property	**ANSI/API RP[B] 13B-1**	**Requirement**
Density[C] (Mud Weight)	Section 4 Mud Balance	64.3 - 72.0 pcf
Viscosity	Section 6.2 Marsh Funnel	28 - 50 sec/qt
Sand Content	Section 9	≤ 4 %[D]
		≤ 2 %[E]
pH	Section 11 Glass Electrode pH Meter[F]	8 - 11

A. Slurry temperature of at least 40°F required.
B. American National Standards Institute/American Petroleum Institute Recommended Practice,
C. Increase density requirements by 2 pcf in saltwater,
D. In tanks before pumping slurry into excavations,
E. In excavations immediately before placing concrete,
F. pH paper is also acceptable for measuring pH,

(2) Polymer Slurry

Use polymer slurry products qualified by the Department. Provide polymer slurry with density, viscosity, sand content and pH properties that meet the product requirements. The polymer slurry QPL with the property requirements for each qualified polymer slurry product is available on the Geotechnical Engineering Unit's website.

(C) Rollers and Chairs

Use rollers and chairs that are non-metallic and resistant to corrosion and degradation. Provide rollers with the necessary dimensions to maintain the minimum required concrete cover shown in the plans and center rebar cages within excavations. Use chairs of sufficient strength to support rebar cages in excavations and of the size necessary to raise cages off bottom of holes to maintain the minimum required distance shown in the plans.

(D) Steel Pipes and Caps

Use Schedule 40 black steel pipes for access tubes for crosshole sonic logging (CSL). Provide CSL tubes with an inside diameter of at least 1.5 inches. Use CSL tubes with a round, regular inside diameter free of defects and obstructions, including any pipe joints,

in order to permit free, unobstructed passage of probes for CSL testing. Provide watertight CSL tubes free of corrosion with clean internal and external faces to ensure a good bond between concrete and tubes. Fit CSL tubes with watertight plastic caps on the bottom and removable caps on top.

411-3 PRECONSTRUCTION REQUIREMENTS

(A) Drilled Pier Construction Plan

Submit the proposed drilled pier construction plan for all drilled piers for acceptance by the Engineer. Provide an electronic copy of this plan at least 30 days before starting drilled pier construction. Do not begin drilled pier construction until a construction plan is accepted by the Engineer. Provide detailed project specific information in the drilled pier construction plan that includes the following:

(1) Overall description and sequence of drilled pier construction;

(2) List and sizes of equipment including cranes, drill rigs, vibratory and downhole hammers, Kelly bars, augers, core barrels, casings (diameters, thicknesses and lengths), cleanout buckets, air lifts, pumps, slurry equipment, tremies, pump pipes and other equipment;

(3) Procedures for casing installation and temporary casing removal including how telescoping temporary casings will be removed;

(4) If applicable, details of slurry testing and use including intended purpose, product information and additives, manufacturer's recommendations for use, name and contact information for slurry manufacturer's technical representative, mixing and handling procedures and how slurry level will be maintained above the highest piezometric head;

(5) Methods for drilling and cleaning holes including how cores will be removed and drilling spoils and slurry will be handled and disposed of;

(6) Details of CSL tubes, caps and joints including pipe size and how tubes will be attached to reinforcing steel;

(7) Procedures for lifting and setting reinforcing steel including how rebar cages will be supported and centralized;

(8) Procedures for placing concrete including how tremies and pump pipes will be controlled and contaminated concrete will be contained;

(9) Concrete mix design that meets Section 1000;

(10) Approved packaged grout or grout mix design that meets Section 1003;

(11) CSL Consultant including Field and Project Engineer; and

(12) Other information shown in the plans or requested by the Engineer.

If alternate construction procedures are proposed or necessary, a revised drilled pier construction plan submittal may be required. If the work deviates from the accepted submittal without prior approval, the Engineer may suspend drilled pier construction until a revised plan is accepted by the Engineer.

(B) Preconstruction Meeting

Before starting drilled pier construction, hold a preconstruction meeting to discuss the installation, monitoring and inspection of the drilled piers. Schedule this meeting with the Engineer after the Drilled Pier Contractor mobilizes to the site. If this meeting occurs before all drilled pier submittals have been accepted, additional preconstruction meetings may be required before beginning construction of drilled piers without accepted submittals.

The Prime Contractor and Drilled Pier Contractor Superintendent shall attend preconstruction meetings.

411-4 CONSTRUCTION METHODS

Do not excavate holes, install piles or allow equipment loads or vibrations within 20 feet of completed piers until 16 hours after drilled pier concrete reaches initial set.

When drilling from a barge, use a fixed template that maintains hole position and alignment during drilled pier construction. Do not use floating templates or templates attached to barges.

Check for correct drilled pier alignment and location before beginning drilling. Check plumbness of Kelly bars before beginning and frequently during drilling.

For drilled piers constructed with slurry or permanent casings, the pier diameter may be 2 inches less than the design pier diameter shown in the plans. For all other drilled piers, construct piers with the minimum required diameters shown in the plans except for portions of drilled piers in rock which may be 2 inches less than the design pier diameter.

Install drilled piers with tip elevations no higher than shown in the plans or approved by the Engineer. Provide piers with the minimum required tip resistance and, when noted in the plans, penetration into rock.

(A) Excavation

Excavate holes with equipment of the sizes required to construct drilled piers. Use equipment and methods accepted in the drilled pier construction plan or approved by the Engineer. Inform the Engineer of any deviations from the accepted plan.

Use drill rigs with sufficient capacity to drill through soil, rock, boulders, timbers, man-made objects and any other materials encountered and drill 20 feet deeper or 20% longer than the maximum drilled pier length shown in the plans, whichever is greater. Drilling below pier tip elevations shown in the plans may be required to attain sufficient resistance.

Do not use blasting to advance drilled pier excavations. Blasting for core removal is only permitted when approved by the Engineer. See Articles 107-11 and 107-12 for protection of public and private property and control of siltation, dust and air and water pollution from blasting, drilling and excavating with down-the-hole hammers. Contain and dispose of drilling spoils and waste concrete in accordance with Section 802 or as directed by the Engineer. Drilling spoils consist of all materials and fluids removed from excavations.

Stabilize excavations with only casings or slurry and casings except, as approved by the Engineer, portions of excavations in rock. Use casings or slurry in rock if unstable material is anticipated or encountered. Stabilize excavations from beginning of drilling through concrete placement. If excavations become unstable, the Engineer may suspend drilling and require a revised drilled pier construction plan. If it becomes necessary to replace a casing during drilling, backfill the excavation, insert a larger casing around the casing to be replaced or stabilize the excavation with slurry before removing the casing.

When noted in the plans, do not dewater drilled pier excavations. Otherwise, if excavations are in rock, dewater excavations to the satisfaction of the Engineer.

(B) Casings

Provide temporary casings to stabilize holes and protect personnel entering excavations. Permanent casings may be required as noted in the plans. Install permanent casings with tip elevations no deeper than shown in the plans or approved by the Engineer. Additional drilled pier length and reinforcing steel may be required if permanent casings are installed below elevations noted in the plans.

Install casings in continuous sections. Overlap telescoping casings at least 24 inches. Remove portions of permanent casings above the ground line or top of piers, whichever is

higher, after placing concrete. Do not cut off permanent casings until Drilled Pier concrete attains a compressive strength of at least 3,000 psi.

When using slurry construction without permanent casings, temporary casings at least 10 feet long are required at top of excavations. Maintain top of casings at least 12 inches above the ground line.

(C) Slurry Construction

Unless noted otherwise in the plans, slurry construction or polymer slurry is at the Contractor's option.

Use slurry and additives to stabilize holes in accordance with the manufacturer's recommendations. Provide a technical representative employed by the slurry manufacturer to assist and guide the Drilled Pier Contractor onsite during the construction of the first drilled pier. If problems are encountered during drilled pier construction, the Engineer may require the technical representative to return to the site.

Provide documentation that mixing water is suitable for slurry. Use slurry equipment that is sufficient for mixing, agitating, circulating and storing slurry. Thoroughly premix slurry with water in tanks before pumping into excavations. Allow bentonite slurry to hydrate at least 24 hours in tanks before use.

Pump slurry into excavations before encountering water. Maintain slurry level at least 5 feet or one pier diameter, whichever is greater, above the highest piezometric head along the drilled pier length. The highest piezometric head is anticipated to be the static water or groundwater elevation. However, the Drilled Pier Contractor is responsible for determining the highest piezometric head for each pier.

Maintain the required slurry properties at all times. Desand or replace slurry as needed to meet the required sand content in tanks before pumping slurry into excavations and in excavations immediately before placing concrete.

(1) Time

Agitate bentonite slurry in holes at least every 4 hours. If this 4-hour time limit is exceeded, the Engineer may require holes to be overreamed at least 1 inch and no more than 3 inches below casings. Overream holes with grooving tools, overreaming buckets or other approved methods.

Construct drilled piers so the maximum time slurry is in contact with uncased portions of holes from drilling through concrete placement does not exceed 36 hours. If this 36 hour time limit is exceeded, the Engineer may require the hole diameter to be enlarged at least 6 inches. If the enlarged hole diameter is greater than the permanent casing diameter, replace casing with a larger permanent casing with an outside diameter equal to the diameter of the enlarged hole.

(2) Slurry Testing

Define a "sample set" as slurry samples collected from mid-height and within 2 feet of the bottom of slurry tanks or holes. Take a sample set from slurry tanks to test slurry before beginning drilling. Do not pump slurry into excavations until both slurry samples from tanks meet the required slurry properties. Take sample sets from excavations to test slurry at least every 4 hours and immediately before placing concrete. Do not place Drilled Pier concrete until both slurry samples from an excavation meet the required slurry properties. If any slurry test results do not meet the requirements, the Engineer may suspend drilling until both samples from a sample set meet the required slurry properties.

Sign, date and submit slurry test reports upon completion of each pier. The Department reserves the right to perform comparison slurry tests at any time.

(3) Disposal

Comply with all Federal, State and local regulations, as well as the project permits and commitments, when disposing of slurry and drilling spoils mixed with slurry. Contain slurry and drilling spoils and keep out of water at all times.

(D) Cleaning and Inspection

Provide clean holes with level bottoms so elevations within bottom of holes do not vary by more than 12 inches. Remove soft and loose material from bottom of holes using methods accepted in the drilled pier construction plan or approved by the Engineer. When bottom of holes are not hand cleaned, remove sediment from holes with cleanout buckets, air lifts or pumps.

After cleaning is complete, provide all equipment, personnel and assistance required for the Engineer to visually inspect holes from above or by entering excavations. Remove all cleaning and drilling equipment from holes during inspections and do not interfere with inspections.

(1) Tip Resistance

If the Engineer determines that the material below an excavation does not provide the minimum required tip resistance, increase the drilled pier length and lengthen reinforcing steel as directed by the Engineer. One of the following methods may be required to check the conditions and continuity of material below excavations.

(a) Test Hole

If excavations are in rock, drill a 1.5 inch diameter test hole at least 6 feet below bottom of holes to determine the continuity of rock below holes.

(b) Standard Penetration Test

Standard penetration tests (SPT) may be required as noted in the plans. When required, drive a split-barrel sampler 18 inches below bottom of holes or to refusal in accordance with ASTM D1586. Perform SPT in holes at least 12 inches away from casing walls and support drill rods so rods remain vertical and straight. Report the number of blows applied in each 6 inch increment and provide recovered samples to the Engineer. The Engineer will determine the standard penetration resistance required.

(2) Bottom Cleanliness

Holes are clean if at least 50% of bottom of holes has less than 0.5 inch of sediment and no portions of bottom of holes have more than 1.5 inches of sediment. If bottom of holes does not meet this cleanliness criteria, remove sediment from holes until the Engineer determines holes are clean. One or more of the following methods may be required to inspect the bottom cleanliness of holes.

(a) Steel Probe

If drilled pier excavations are not dewatered or as directed by the Engineer, provide a #10 rebar steel probe that is 24 inches long with a flat tip on one end and a non-stretch cable connected to the other end. Provide a cable long enough to lower the steel probe to the bottom of holes for the Engineer to determine the amount of sediment in holes.

(b) Shaft Inspection Device

The Engineer may use the shaft inspection device (SID) as noted in the plans. The Engineer provides the SID and personnel to operate it. Notify the Engineer at least 2 days before finishing holes that will be inspected with the SID.

Assist the Engineer in handling the SID and associated equipment and supporting the SID during inspections. Provide working areas large enough for the SID, associated equipment and SID personnel within reach of the SID cables and clear view of holes being inspected. If necessary, provide a secure location to store the SID and associated equipment onsite overnight.

Approximately one hour is required to inspect a hole with the SID after the SID and associated equipment are set up. The Engineer will use the SID to measure the amount of sediment at 5 locations around the bottom of holes.

(E) Reinforcing Steel and Concrete

Assemble rebar cages consisting of bar and spiral reinforcing steel shown in the plans. Securely cross tie reinforcing steel at each intersection with double wire. Attach a chair under each reinforcing bar and rollers near the top and bottom of rebar cages and every 10 feet along cages in between. The number of rollers required at each location along rebar cages is one roller per foot of design pier diameter with at least 4 rollers per location. Space rollers equally around rebar cages at each location. Attach rollers so rollers are supported across 2 adjacent reinforcing bars and will freely rotate when rebar cages are lowered into excavations.

If CSL tubes are required, securely attach CSL tubes to spiral reinforcing steel on the inside of rebar cages with at least 3 inches of clearance to vertical reinforcing bars. Extend CSL tubes from 6 inches above pier tip elevations to at least 2 feet above the ground line or top of permanent casings, whichever is greater. The number of CSL tubes required for each drilled pier is one tube per foot of design pier diameter with at least 4 tubes per pier. Space CSL tubes equally around rebar cages so distances between tubes measured around spiral reinforcing steel are uniform. Install CSL tubes as straight and parallel to each other as possible. Fit caps on top and bottom of CSL tubes.

After the Engineer determines that the material below excavations provides the minimum required tip resistance and holes are clean, place rebar cages and then concrete in excavations. Do not rack or distort rebar cages and CSL tubes when lifting and handling cages. Set rebar cages directly on bottom of holes or, as approved by the Engineer, hang cages from permanent casings. When hanging rebar cages, leave devices supporting cages in place until Drilled Pier concrete attains a compressive strength of at least 3,000 psi.

Do not delay placing cages or concrete unless excavations are cased to rock or otherwise approved. If delays occur, the Engineer may require removal of rebar cages to reinspect bottom cleanliness of holes. If bottom of holes does not meet the cleanliness criteria in Subarticle 411-4(D)(2), remove sediment from holes until the Engineer determines holes are clean before resetting rebar cages.

After placing rebar cages with CSL tubes, remove top caps, fill tubes with clean water and reinstall caps before placing concrete. Check for correct cage position before placing concrete and keep rebar cages plumb during concrete placement. Maintain cage position so rebar cages do not move vertically more than 6 inches and columns or footings have the minimum required concrete cover shown in the plans.

Remove all temporary casings during concrete placement. Do not twist, move or otherwise disturb temporary casings until the concrete depth inside casings is at least 10 feet or half the head, whichever is greater, above the bottom of casing being disturbed. Define “head” as the difference between the highest piezometric head along the drilled pier length and the static water elevation inside the excavation.

When removing temporary casings, maintain the required concrete depth above the bottom of casing being removed except when the concrete level is at or above top of piers. Sustain sufficient concrete depths to overcome pressures imposed by earth, backfill and fluids. As temporary casings are withdrawn, ensure fluids trapped behind casings is displaced upward and discharged out of excavations without contaminating or displacing concrete.

Pour concrete in excavations to form uniform jointless monolithic drilled piers. Do not trap soil, air, fluids or other contaminants in concrete. Remove contaminated concrete from top of piers at time of concrete placement.

Inform the Engineer of the volume of concrete placed for each pier. For piers constructed with slurry or as directed by the Engineer, record a graphical plot of depth versus theoretical and actual concrete volumes.

Dry or wet placement of concrete is at the Contractor's option for piers constructed with only casings if the water inflow rate into excavations is less than 6 inches per half hour after removing any pumps from holes. Wet placement of concrete is required for all other drilled pier construction.

(1) Dry Placement

If holes are filling with water for dry placement of concrete, dewater excavations as much as possible before placing concrete. For drilled piers less than 80 feet long, pour concrete down the center of excavations so concrete does not hit reinforcing steel or excavation sidewalls. For piers longer than 80 feet, place concrete with a tremie or pump pipe down the center of excavations so length of free fall is less than 80 feet.

(2) Wet Placement

For wet placement of concrete, maintain static water or slurry levels in holes before placing concrete. Place concrete through steel tremies or pump pipes. Use tremies with watertight joints and a diameter of at least 10 inches. Pump concrete in accordance with Article 420-5. Use approved devices to prevent contaminating concrete when tremies or pump pipes are initially placed in excavations. Keep tremies or pump pipes embedded into concrete at least 5 feet at all times except when the concrete is initially placed.

When the concrete level reaches the static water elevation inside the excavation, dry placement of concrete is permitted. Before changing to dry placement, pump water or slurry out of holes and remove contaminated concrete from the exposed concrete surface.

411-5 INTEGRITY TESTING

Define "integrity testing" as crosshole sonic logging (CSL) and pile integrity testing (PIT). Integrity testing may be required as noted in the plans or by the Engineer. The Engineer will determine how many and which drilled piers require integrity testing. Do not test piers until Drilled Pier concrete cures for at least 7 days and attains a compressive strength of at least 3,000 psi.

(A) Crosshole Sonic Logging

If CSL testing is required, use a prequalified CSL Consultant to perform CSL testing and provide CSL reports. Use a CSL Operator approved as a Field Engineer (key person) for the CSL Consultant. Provide CSL reports sealed by an engineer approved as a Project Engineer (key person) for the same CSL Consultant.

(1) CSL Testing

Perform CSL testing in accordance with ASTM D6760. If probes for CSL testing will not pass through to the bottom of CSL tubes, the Engineer may require coring to replace inaccessible tubes. Do not begin coring until core hole size and locations are approved by the Engineer. Core at least 1.5 inches diameter holes the full length of piers. Upon completion of coring, fill holes with clean water and cover to keep out debris. Perform CSL testing in core holes instead of inaccessible tubes.

For piers with 4 or 5 CSL tubes, test all tube pairs. For piers with 6 or more CSL tubes, test all adjacent tube pairs around spiral reinforcing steel and at least 50% of remaining

tube pairs selected by the Engineer. Record CSL data at depth intervals of 2.5 inches or less from the bottom of CSL tubes to top of piers.

(2) CSL Reports

Submit each CSL report within 7 days of completing CSL testing. Include the following in CSL reports:

(a) Title Sheet

(i) Department's TIP number and WBS element number
(ii) Project description
(iii) County
(iv) Bridge station number
(v) Pier location
(vi) Personnel
(vii) Report date

(b) Introduction

(c) Site and Subsurface Conditions (including water table elevation)

(d) Pier Details

(i) Pier and casing diameters, lengths and elevations
(ii) Drilled Pier concrete compressive strength
(iii) Installation methods including use of casings, slurry, pumps, tremies, dry or wet placement of concrete, etc.

(e) CSL Results

(i) Logs with plots of signal arrival times and energy vs. depth for all tube pairs tested

(f) Summary/Conclusions

(i) Table of velocity reductions with corresponding locations (tube pair and depth) for all tube pairs tested
(ii) List of suspected anomalies with corresponding locations (tube pair(s) and depth range)

(g) Attachments

(i) Boring log(s)
(ii) Field inspection forms and concrete curves (from Engineer)
(iii) CSL tube locations, elevations, lengths and identifications
(iv) CSL hardware model and software version information
(v) PDF copy of all CSL data

(B) Pile Integrity Testing

If required, the Engineer will perform PIT. Provide access to and prepare top of piers for PIT as directed by the Engineer. See ASTM D5882 for PIT details.

(C) Further Investigation

Define "further investigation" as any additional testing, excavation or coring following initial integrity testing. Based on concrete placement and initial integrity testing results, the Engineer will determine if drilled piers are questionable and require further investigation within 7 days of receiving CSL reports or completing PIT. For initial CSL testing, the Engineer will typically determine whether further investigation is required based on Table 411-3.

TABLE 411-3 DRILLED PIER FURTHER INVESTIGATION CRITERIA (For Initial CSL Testing)	
Velocity Reductions	**Further Investigation Required?**
< 20%	No
20 - 30%	As Determined by the Engineer
> 30%	Yes

If further investigation is necessary, the Engineer will typically require one or more of the following methods to investigate questionable piers.

(1) CSL Testing

If required, use CSL testing as described above to retest questionable piers and as directed by the Engineer, perform testing with probes vertically offset in CSL tubes. CSL offset data will typically be required for all locations (tube pair and depth) with velocity reductions greater than 30% and at other locations as directed by the Engineer. Record offset data at depths, intervals and angles needed to completely delineate anomalies.

Provide CSL reports that meet Subarticle 411-5(A)(2). When CSL offset data is required, perform tomographic analysis and provide 3 dimensional color coded tomographic images of piers showing locations and sizes of anomalies.

(2) Excavation

If required, excavate around questionable piers and remove permanent casing as needed to expose Drilled Pier concrete. Do not damage piers when excavating or removing casings. The Engineer will determine the portions of piers to expose.

(3) Coring

If required, core questionable piers and provide PQ size cores that meet ASTM D2113. The Engineer will determine the number, location and depth of core holes required. Handle, log and store concrete cores with methods acceptable to the Engineer. Provide cores to the Engineer for evaluation and testing. Sign, date and submit core logs upon completion of each core hole.

(D) Defective Piers

For questionable piers that are exposed or cored, the Engineer will determine if piers are defective based on the results of excavation or coring. For questionable piers that are not exposed or cored, the Engineer will determine if piers are defective based on the results of integrity testing. Questionable piers with only CSL testing will be considered defective if any velocity reductions between any tube pairs are greater than 30%.

411-6 DRILLED PIER ACCEPTANCE

Drilled pier acceptance is based in part on the following criteria:

(A) Temporary casings and drilling tools are removed from the drilled pier excavation or the Engineer determines that a temporary casing may remain in the excavation.

(B) Drilled Pier concrete is properly placed and does not have any evidence of segregation, intrusions, contamination, structural damage or inadequate consolidation (honeycombing) and meets compressive strength required in Table 1000-1.

(C) Center of pier is within 3 inches of plan location and 2% of plumb. Top of pier is within 1 inch above and 3 inches below the elevation shown in the plans or approved by the Engineer.

(D) Rebar cage is properly placed and top and center of cage is within tolerances for center of pier. Tip of permanent casing does not extend below the elevation noted in the plans or approved by the Engineer.

(E) Drilled pier is not defective or the Engineer determines the defective pier is satisfactory. A pier will be considered defective based on Subarticle 411-5(D).

Do not grout CSL tubes or core holes, backfill around a pier or perform any work on a drilled pier until the Engineer accepts the pier. If the drilled pier is accepted by the Engineer, dewater and grout CSL tubes and core holes, and backfill around the pier with approved material to finished grade. If the Engineer determines a pier is unacceptable, remediation is required. Remediation may include, but is not limited to grouting, removing part or all of unacceptable piers, modifying pier designs or providing replacement or additional piers or piles. Submit working drawings and design calculations for acceptance in accordance with Article 105-2. Ensure remediation submittals are designed, detailed and sealed by an engineer licensed by the State of North Carolina. Do not begin remediation work until remediation plans are approved by the Engineer. When repairing unacceptable piers, perform post repair testing to gauge success of the repair. No extension of completion date or time will be allowed for remediation of unacceptable drilled piers or post repair testing.

411-7 MEASUREMENT AND PAYMENT

____ *Dia. Drilled Piers in Soil*, ____ *Dia. Drilled Piers Not in Soil* and ____ *Dia. Drill Piers* will be measured and paid in linear feet. Acceptable drilled piers will be measured as the difference between the specified top of pier and pier tip elevations or revised elevations approved by the Engineer.

For bents with a not in soil pay item shown in the plans, drilled piers will be paid as ____ *Dia. Drilled Piers in Soil* and ____ *Dia. Drilled Piers Not in Soil*. Define "not in soil" as material with a rock auger penetration rate of less than 2 inches per 5 minutes of drilling at full crowd force. When not in soil is encountered, seams, voids and weathered rock less than 3 feet thick with a rock auger penetration rate of greater than 2 inches per 5 minutes of drilling at full crowd force will be paid at the contract unit price for ____ *Dia. Drilled Piers Not in Soil*. Seams, voids and weathered rock greater than 3 feet thick will be paid at the contract unit price for ____ *Dia. Drilled Piers in Soil* where not in soil is no longer encountered. For bents with a not in soil pay item shown in the plans, drilled piers through air or water will be paid at the contract unit price for ____ *Dia. Drilled Piers in Soil*.

For bents without a not in soil pay item shown in the plans, drilled piers will be paid as ____ *Dia. Drill Piers*. The contract unit price for ____ *Dia. Drilled Piers* will be full compensation for drilling through any materials encountered.

The contract unit prices for ____ *Dia. Drilled Piers in Soil*, ____ *Dia. Drilled Piers Not in Soil* and ____ *Dia. Drill Piers* will also be full compensation for spoils and slurry containment and disposal, supplying and placing Drilled Pier concrete, temporary casing and slurry construction including a slurry manufacturer representative and overreaming and enlarging piers and any concrete removal, miscellaneous grading and excavation. No additional payment will be made for excess Drilled Pier concrete due to caving or sloughing holes or telescoping casings.

Reinforcing steel will be measured and paid in accordance with Article 425-6.

Permanent Steel Casing for ____ Dia. Drilled Pier will be measured and paid in linear feet. Permanent casings will only be paid for when required by the Engineer or shown in the plans. Permanent casings will be measured as the difference between the ground line or specified top of pier elevation, whichever is higher, and the specified permanent casing tip elevation or revised elevation approved by the Engineer. If a permanent casing cannot be installed to the casing tip elevation shown in the plans, up to 3 feet of casing cut-off will be paid at the contract unit price for *Permanent Steel Casing for ____ Dia. Drilled Pier*.

SID Inspections will be measured and paid in units of each. *SID Inspections* will be measured as one per pier. The contract unit price for *SID Inspections* will be full compensation for inspecting holes with the SID the first time. No additional payment will be made for subsequent inspections of the same hole.

The Contractor is responsible for any damage to the SID equipment due to the Contractor's fault or negligence. Replace any damaged equipment at no additional cost to the Department.

SPT Testing will be measured and paid in units of each. *SPT Testing* will be measured as the number of standard penetration tests performed except no payment will be made for *SPT Testing* to determine if temporary casing is necessary.

CSL Testing will be measured and paid in units of each. *CSL Testing* will be measured as one per pier. The contract unit price for *CSL Testing* will be full compensation for performing initial CSL testing and providing CSL reports. Subsequent CSL testing of and CSL reports for the same pier will be considered further investigation. No separate payment will be made for CSL tubes. CSL tubes including coring for inaccessible tubes and grouting will be incidental to the contract unit prices for drilled piers.

No payment will be made for stuck temporary casings that cannot be removed from drilled pier excavations or additional drilled pier length and reinforcing steel required due to temporary casings that remain in excavations. No payment will be made for PIT. No payment will be made for further investigation of defective piers. Further investigation of piers that are not defective will be paid as extra work in accordance with Article 104-7. No payment will be made for remediation of unacceptable drilled piers or post repair testing.

Payment will be made under:

Pay Item	**Pay Unit**
____ Dia. Drilled Piers in Soil	Linear Foot
____ Dia. Drilled Piers Not in Soil	Linear Foot
____ Dia. Drilled Piers	Linear Foot
Permanent Steel Casing for ____ Dia. Drilled Piers	Linear Foot
SID Inspections	Each
SPT Testing	Each
CSL Testing	Each

SECTION 412
UNCLASSIFIED STRUCTURE EXCAVATION

412-1 DESCRIPTION

Excavate any material not classified as foundation excavation, box culvert excavation or channel excavation whose removal is required for the construction of bridges, retaining walls of reinforced concrete or reinforced masonry, arch culverts and box culverts without floor slabs, and which is classified as unclassified structure excavation in the plans, in accordance with the contract or as directed by the Engineer. Excavate, blast, brace, shore, provide sheeting and cribbing, backfill, haul and dispose of materials.

Do not deposit excavated materials, nor construct earth dikes or other temporary earth structures, in rivers, streams or impoundment or so near to such waters that they are carried into any river, stream or impoundment by stream flow or surface runoff.

Dispose of all timber, stumps and debris in accordance with Article 200-6.

412-2 PRESERVATION OF CHANNEL

Unless otherwise required by the contract, do not excavate in stream channels. Do not disturb the natural streambed adjacent to the structure without permission from the Engineer.

Do not place material in a stream without approval by the Engineer. Remove materials placed within the stream area and leave the stream in its original condition, unless otherwise permitted by the Engineer.

412-3 UTILIZATION OF EXCAVATED MATERIAL

Use and place suitable excavated material in accordance with Articles 410-7 and 410-8.

Notify the Engineer a sufficient time before beginning the excavation so measurements may be taken of the undisturbed ground.

412-4 MEASUREMENT AND PAYMENT

The price and payment below will be full compensation for all items required to complete unclassified structure excavation including, but not limited to, those items contained in Article 412-1.

Unclassified Structure Excavation at Station ____ will be paid at the contract lump sum price.

Payment will be made under:

Pay Item	Pay Unit
Unclassified Structure Excavation at Station ____	Lump Sum

SECTION 414
BOX CULVERT EXCAVATION

414-1 DESCRIPTION

Excavate all material necessary for the construction of box culverts with floor slabs in accordance with the contract or as directed by the Engineer. Excavate, blast, drain and divert water, bail, pump, brace, shore, provide sheeting, cribbing, cofferdams, culvert foundation conditioning, subsurface drainage and drawings; backfill, haul and dispose of materials.

Do not deposit excavated materials, nor construct earth dikes or other temporary earth structures in rivers, streams or impoundment or so near to such waters that they are carried into any river, stream or impoundment by stream flow or surface runoff. As an exception to the above, obtain written approval from the Engineer for the use of confined earth materials in cofferdams for structure foundations.

414-2 MATERIALS

Refer to Division 10.

Item	Section
Select Materials	1016
Subsurface Drainage Materials	1044

Use Class V or VI select material for foundation conditioning material.

414-3 FOUNDATION EXCAVATION

Notify the Engineer a sufficient time before beginning the excavation so measurements may be taken of the undisturbed ground. Do not disturb the existing ground at the culvert site without permission by the Engineer.

Where necessary for safety, slope, shore, brace or protect by cofferdams the foundation openings in accordance with State and local safety standards. Perform foundation excavation and related work in such sequence that no portion of the culvert will be endangered by subsequent operations. Protect completed portions of a culvert from blasting.

Remove and dispose of boulders, vegetative matter and any other objectionable material.

Notify the Engineer after excavating each foundation. Do not place any concrete until obtaining approval of the excavation depth, the character of the foundation material and permission to proceed.

Take special care not to disturb the bottom of the excavation until immediately before placing foundation conditioning material.

414-4 CONDITIONING CULVERT FOUNDATION

Excavate below the bottom of the barrel or wing footing to a depth as directed by the Engineer and replace the excavated material with foundation conditioning material.

When the foundation material beneath a portion of the barrel or wing footing is rock or incompressible material and softer material is beneath the remainder of the barrel or wing footing, excavate the rock material within the neat lines of the barrel or footing to a depth of 12 inches below the bottom of the barrel and footings and backfill with foundation conditioning material.

414-5 PUMPING

Pump from the interior of any foundation enclosure to preclude the possibility of the movement of water over or through any fresh concrete. Do not pump while placing concrete or for at least 24 hours thereafter, unless done from a suitable sump separated from the concrete work by a substantially watertight wall.

414-6 UTILIZATION OF EXCAVATED MATERIAL

Use suitable excavated material in accordance with Article 410-7.

414-7 BACKFILLING AND FILLING

As soon as practical after completing the box culvert, place the backfill and redirect the stream through the culvert.

Use approved material for backfill that is free from large or frozen lumps, wood or other undesirable material. Where there is not an adequate quantity of suitable backfill material available from culvert excavation, provide suitable backfill material compensated in accordance with Subarticle 410-10(C).

Eliminate any excavated slope adjacent to backfill areas by stepping or serrating to prevent wedge action.

Place and compact all portions of the backfill that become a part of roadway typical sections or their foundations in accordance with Subarticles 235-3(B) and 235-3(C). Place all other portions of the backfill in layers not more than 10 inches in depth of loose measure and compact to a density comparable to the adjacent undisturbed material. Refill all excavated spaces not filled with permanent work with earth up to the ground surface existing before the excavation.

Place backfill or embankment material simultaneously to approximately the same elevation on both sides of the culvert. Do not place backfill or embankment behind the walls of culverts to an elevation higher than one foot above the top of footing or bottom slab until after placing the top slab and until the concrete develops the minimum required strength for the class of concrete specified as listed in Table 1000-1.

414-8 SUBSURFACE DRAINAGE AT WEEP HOLES

Cover weep holes with hardware cloth and place a stone drain consisting of 1 cubic foot of subdrain coarse aggregate (standard size No. 78M) contained in a bag of Type 1 geotextile at each weep hole. Place subdrain fine aggregate beneath, around and over the stone drain, so the drain is covered by a layer of subdrain fine aggregate at least 1 foot thick. Connect all drains with a horizontal drain of subdrain fine aggregate at least 1 foot square in cross section. In the case of abutments and retaining walls, in addition to the above requirements, place a vertical

drain of subdrain fine aggregate at least 1 foot square in cross section at each weep hole to an elevation 2 feet below the subgrade or surface of the embankment.

414-9 MEASUREMENT AND PAYMENT

The prices and payments below will be full compensation for all items required to complete box culvert excavation including, but not limited to, those items in Article 414-1.

Foundation Conditioning Material, Box Culvert will be measured and paid in tons of material that is placed within the established limits. The number of tons of material is determined by weighing the material in trucks in accordance with Article 106-7. No deduction will be made for any moisture contained in the material at the time of weighing. Such price and payment will be full compensation for all excavation made below the bottom of the barrel and wing footings in addition to furnishing, hauling and placing the foundation conditioning material.

Box Culvert Excavation, Sta. ____ will be paid at the contract lump sum price. No measurement for payment will be made for this pay item, and no adjustment in the contract lump sum price will be made unless the size, length, elevation or location of the culvert is revised. If the size, length, elevation or location of the culvert is revised, such revision will be an alteration of plans or details of construction in accordance with Article 104-3.

Where it is necessary to provide backfill material from sources other than excavated areas or borrow sources used in connection with other work in the contract, payment for furnishing and hauling such backfill material will be paid as extra work in accordance with Article 104-7. Placing and compacting such backfill material is not extra work but is incidental to the work being performed.

Payment will be made under:

Pay Item	Pay Unit
Box Culvert Excavation, Sta. ____	Lump Sum
Foundation Conditioning Material, Box Culvert	Ton

SECTION 416
CHANNEL EXCAVATION

416-1 DESCRIPTION

Excavate any material outside of the pay limits of foundation excavation, unclassified structure excavation or box culvert excavation, which is classified as channel excavation in the plans. Place suitable excavated material as directed by the Engineer, drain and divert water, pump, blast, haul, dispose of materials and backfill.

Do not deposit excavated materials, nor construct earth dikes or other temporary earth structures in rivers, streams or impoundment or so near to such waters that they are carried into any river, stream or impoundment by stream flow or surface runoff.

416-2 CONSTRUCTION METHODS

Notify the Engineer a sufficient time before beginning the excavation so measurements may be taken of the undisturbed ground. Do not disturb the existing ground without permission.

Remove and dispose of boulders, vegetative material and any other objectionable material.

Use and place suitable excavated material in accordance with Articles 410-7 and 410-8.

416-3 MEASUREMENT AND PAYMENT

Channel Excavation will be measured and paid on a cubic yard basis. Materials will be measured in their original position within the limits described below and computed by the average end area method, that are acceptably excavated in accordance with the contract or as directed by the Engineer. The upper limits for measurement are the actual ground surface at

the time of starting work. The lower limits for measurement are established by the plans or as directed in writing by the Engineer.

No measurement is made of the following excavation:

(A) Mud, muck or similar semi-solid material which can be drained away or pumped without the use of a jet or nozzle.

(B) Excavation before the Engineer makes measurements of the undisturbed ground.

(C) Excavation that is within the pay limits of other excavation.

(D) Excavation that is outside of the limits shown in the plans or as directed in writing by the Engineer.

Where the item *Channel Excavation* is not included in the contract, no measurement or payment is made of any channel excavation, as payment at the contract unit or lump sum price for the various items in the contract will be full compensation for the work covered by this section.

This price and payment will be full compensation for all items required to complete channel excavation.

Payment will be made under:

Pay Item	Pay Unit
Channel Excavation	Cubic Yard

SECTION 420
CONCRETE STRUCTURES

420-1 DESCRIPTION

Construct CIP concrete structures and the CIP concrete portions of composite structures in conformity with the lines, grades and dimensions shown in the contract. Furnish and place concrete, joint filler and sealer, curing materials, epoxy protective coating, deck drains, expansion or adhesive anchors and any other material; erect and remove all falsework and forms; protect concrete in wind, rain, low humidity, high temperatures or other unfavorable weather; construct joints and weep holes; finish and cure concrete; protect concrete from rust stains; and groove bridge floors. For reinforced concrete deck slabs, in addition to the above, furnish and place reinforcing steel and bridge scuppers; and design, furnish, erect and remove all bridge deck forms including any appurtenances required by the Engineer to stabilize exterior girders during overhang construction.

420-2 MATERIALS

Refer to Division 10.

Item	Section
Calcium Nitrite Corrosion Inhibitor	1000-3(J)
Curing Materials	1026
Deck Drains	1054-1
Epoxy Protective Coating	1080-10
Adhesive Anchors	1081
Expansion Anchors	1074-2
Grout, Type 2	1003
Joint Fillers	1028-1
Low Modulus Silicone Sealant	1028-3
Metal Stay-in-Place Forms	1074-12
Portland Cement Concrete	1000
Reinforcing Steel	1070

420-3 FALSEWORK AND FORMS

(A) General

Submit detailed drawings for falsework or forms for bridge superstructure and other components as required by the contract for review, comments and acceptance before beginning construction of the falsework or forms. This review does not relieve the Contractor of full responsibility for the safety, alignment, quality or finish of the work.

Design falsework and forms to carry the full loads upon them, including a dead load of 150 pcf for concrete, loads caused by equipment and personnel, and for lateral pressures resulting from rate of pours, setting times and effects of vibration on the concrete, so the finished concrete surface conforms to the proper dimensions and contours and has an even appearance.

Use lumber and other material for forms and falsework that is sound and in good condition.

Set falsework and forms to give the correct elevation shown on the drawings making proper allowance for shrinkage, deflections and settlement, and maintain true to lines and grades designated until the concrete sufficiently hardens.

Where falsework or forms appear to be unsatisfactorily built in any respect either before or during placing of concrete, the Engineer will order the work stopped until the defects are acceptably corrected.

Keep the falsework and forms in place after placing of concrete for the periods specified in Article 420-16. Remove falsework and forms in an acceptable manner. Do not leave forms or falsework permanently in place without written approval by the Engineer.

Provide a means, satisfactory to the Engineer, to check any settlement or deflection that may occur during the placing of concrete in the various portions of the work.

(B) Falsework

Build falsework on foundations of sufficient strength to carry the applied loads without appreciable settlement. Support falsework that cannot be founded on solid footings on ample falsework piling.

Use an acceptable method to compensate for shrinkage, deflection and settlement. Use jacks to readily effect adjustment, if necessary, before or during placing of concrete, if required by the Engineer.

(C) Forms

(1) General

Use forms made of wood or steel except where other materials are specified by the contract or accepted by the Engineer.

(2) Wood Forms

Build forms mortar-tight of material sufficient in strength with ample studding, walling and bracing to effectively prevent any appreciable horizontal and vertical deflection.

Provide forms with interior dimensions such that the finished concrete is of the form and dimensions shown in the plans.

Line forms, except for surfaces permanently in contact with earth fill, with plywood or other approved material. Provide a lining with a smooth and uniform texture and of such thickness and rigidity that a concrete surface of uniform texture and even appearance results. Provide joints between form liners that are mortar tight and even and maintain to prevent the opening of joints due to the shrinkage of the lumber.

Fillet forms at all sharp corners unless otherwise noted in the plans. Mill wood chamfer strips from straight grained lumber and surface on all sides. Maintain an acceptable alignment and no broken edges on all chamfer strips.

Give forms for all projections a bevel or draft to insure easy removal.

At all times, maintain the shape, strength, rigidity, watertightness and surface smoothness of reused forms. Resize any warped or bulged lumber before reusing. Do not reuse any forms that are unsatisfactory in any respect. Do not use plywood sheets showing torn grain, worn edges, patches, holes from previous use or other defects that impair the texture of concrete surfaces exposed to view.

Thoroughly clean forms previously used of all dirt, mortar and foreign material before reusing. Before placing concrete in forms to be removed, thoroughly coat all inside surfaces of the forms with commercial quality form oil or other equivalent coating which permits the ready release of the forms and does not discolor the concrete.

Construct or install metal spacers or anchorages, required within the forms for their support or to hold them in correct alignment and location, in such a way that the metal work can be removed to a depth of at least 1 inch from the exposed surface of the concrete without injury to such surface by spalling or otherwise. Limit the diameter to not greater than 1.5 times its depth for the recess formed in the concrete. Cut back all such metal devices in exposed surfaces, upon removal of the forms, to a depth of at least 1 inch from the face of the concrete. Carefully fill cavities produced by the removal of metal devices with cement mortar of the same mix used in the body of the work immediately upon removal of the forms, and leave the surface smooth, even and as nearly uniform in color as possible. As an option, break off flush with the concrete surface those metal devices with cross-sectional area not exceeding 0.05 square inches on surfaces permanently in contact with earth fill. Where removable through ties are utilized, the cavity created shall be constructed so as to minimize the area. Sleeves shall be removed or cut back a minimum of 1 inch from the surface and cavities filled entirely with a cementitious mortar.

Do not weld metal devices to either reinforcing steel or structural steel that is a permanent part of the structure without written approval.

(3) Steel Forms

Apply Subarticle 420-3(C)(2) in regards to design, mortar tightness, filleted corners, beveled projections, bracing, alignment, texture and evenness of appearance of the resulting concrete surface, removal, re-use and oiling to steel forms. Use steel for forms of such thickness that the forms remain true to shape. Counter-sink bolt and rivet heads. Design clamps, pins or other connecting devices to hold the forms rigidly together and allow removal without injury to the concrete. Do not use steel forms that do not present a smooth surface or line up properly. Exercise care to keep steel forms free from rust, grease or other foreign matter that will tend to discolor the concrete.

(D) Forms for Concrete Bridge Decks

In addition to Subarticles 420-3(C)(1) through 420-3(C)(3), the following requirements apply to falsework and forms used to construct reinforced concrete bridge decks on girders. Furnish all materials, labor, equipment and incidentals necessary for the proper installation of falsework and forms for concrete bridge deck slabs.

For prestressed girder spans, the plans for the concrete deck slab are detailed for the use of a CIP slab using either precast prestressed concrete panels or fabricated metal stay-in-place forms. Optionally, construct a CIP slab using removable forms.

For structural steel spans, plans for the concrete deck slab are detailed for the use of metal stay-in-place forms. Optionally, construct a CIP slab using removable forms. Do not use precast prestressed concrete panels on structural steel spans.

Where reinforced concrete deck slab with sand lightweight concrete is required by the contract, do not use precast prestressed concrete panels.

If using a form system other than that detailed in the plans, do so at no additional cost to the Department. Changes in slab design to accommodate the use of optional forms are the responsibility of the Contractor. Submit these changes for review and approval. Before using optional forms, submit detailed checked plans of the system and checked design calculations for the composite slab complying with the *AASHTO LRFD Bridge Construction Specifications, AASHTO LRFD Bridge Design Specifications* and *NCDOT's Structures Management Design Manual*. After the drawings are reviewed and, if necessary, the corrections made, submit final drawings of the deck system to become the revised plans. Ensure that the plans and design calculations are checked and sealed by an engineer licensed by the State of North Carolina.

Unless otherwise shown in the plans, use the same forming system for all of the same type superstructure spans within the bridge. Construct the slab overhang from the exterior girder to the outside edge of superstructure using removable forms.

(1) Precast Prestressed Concrete Panels

Prestressed concrete panels are subject to the requirements for prestressed concrete members as specified in Section 1078 and the plans.

Design prestressed panels subject to review by the Engineer. Before using prestressed panels, submit detailed plans of the panels for review. Submit with the checked plans a set of checked design calculations for the panels complying with the *AASHTO LRFD Bridge Design Specifications*, requirements detailed herein and the plans. Ensure the plans and design calculations are checked and sealed by an engineer licensed by the State of North Carolina. If corrections to the drawings are necessary, submit a set of corrected drawings. The drawings become part of the plans.

Design the prestressed concrete panels in accordance with the following criteria:

(a) Design details to provide a mating surface joint or a draft not exceeding 1/8 inch resulting in a joint that is closed at the top and no more than 1/4 inch open at bottom of panel. Detail the joints filled with grout or other methods approved by the Engineer to prevent leakage of the concrete. Place a chamfer or fillet, with a 3/4 inch horizontal width, along the top edges of the panel parallel with the prestressed girder.

(b) Design panels to support the dead load of the panel, reinforcement, plastic concrete and a 50 psf construction load. Design the panel and slab acting compositely to support design live loads and dead loads acting on the composite section. Include in the design dead load acting on the composite section an additional load of 30 psf for a future asphalt wearing surface. For bridges up to 44 feet in width, distribute equally to all deck panels superimposed dead loads for such permanent bridge items as barrier rails, medians or any dead load which is applied after the deck is cast. In the case of bridges over 44 feet wide, distribute these loads equally to the first 2 1/2 panels adjacent to each side of the load.

(c) The design span of the prestressed concrete panel is the clear distance between edges of girders plus 2 inches measured parallel to the panel edges.

(d) Limit tension in the precompressed tensile zone to 424 psi unless the plans require 0 psi tension.

(2) Fabricated Metal Stay-In-Place Forms

Furnish metal stay-in-place forms with closed tapered ends to form the concrete deck slabs as shown in the plans. Submit complete fabrication and erection drawings for review, comments and acceptance. Indicate on these plans the grade of steel, the physical and section properties for all permanent steel bridge deck form sheets and a clear indication of locations of form supports. Do not fabricate the forming material until drawings are accepted by the Engineer.

When required by the design plans, detail stay-in-place forms with excluder plates to exclude concrete from the valleys in the forms. Foam insulation void fillers may be used in stay-in-place metal forms. Adhesive shall be used on all 3 contacting sides of the foam insulation void fillers rather than on the bottom only. The adhesive shall be compatible with the foam insulation material to not cause decomposition. Duct tape shall not be used to hold the foam insulation in place. Foam insulation shall be placed in one piece across each bay and be trimmed to not extend over the girder. Foam insulation damaged during placement of reinforcing steel shall be replaced.

Design metal stay-in-place forms in accordance with the following criteria:

(a) Accommodate the dead load of the form, reinforcement and the plastic concrete, including the additional weight of concrete due to the deflection of the metal forms, plus 50 psf for construction loads. Do not allow the unit working stress in the steel sheet to exceed 72.5% of the specified minimum yield strength of the material furnished nor 36 ksi.

(b) Limit the horizontal leg of the support angle to 3 inches. Design the support angle as a cantilever.

(c) Limit the deflection under the weight of the forms, the plastic concrete and reinforcement to 1/180 of the form span or 1/2 inch whichever is less. Do not design for a total loading less than 120 psf.

(d) Base the permissible form camber on the actual dead load condition. Do not use camber to compensate for deflection in excess of the foregoing limits.

(e) The design span of the form sheets is the clear distance between edges of beam or girder flanges minus 2 inches measured parallel to the form flutes. Design and provide form sheets with a length at least the design span of the forms.

(f) Compute physical design properties in accordance with requirements of the American Iron and Steel Institute *Specification for the Design of Cold-Formed Steel Structural Members*.

(g) Provide a minimum concrete cover of 1 1/4 inches clear above metal stay-in-place form to the bottom mat of reinforcement.

(h) Maintain the plan dimensions of both layers of primary deck reinforcement from the top of the concrete deck.

(i) Do not weld to flanges in tension or to structural steel bridge elements fabricated from non-weldable grades of steel.

(j) Do not weld metal stay-in-place forms to flanges in link slab regions.

(k) Weld metal stay-in-place forms for prestressed concrete girders to embedded clips in the girder flanges. The embedded clips shall be at least 2 inches x 3 inches and 2 inches long. The clips shall be galvanized, 10 gauge ASTM A653 steel and have a 3/4 inch or 1 inch diameter hole in the 2 inch leg. The spacing of the clips shall be 12 inches. All submitted metal stay-in-place form designs shall be able to use the standard size and spacing of the clip described above.

Do not unload or handle fabricated metal stay-in-place forming materials so as to damage or alter the configuration of the forms. Replace damaged materials at no additional cost to the Department.

Store fabricated metal stay-in-place forms that are stored at the project site at least 4 inches above the ground on platforms, skids or other suitable supports and protect against corrosion and damage from any source.

Install all forms in accordance with detailed fabrication plans submitted to the Engineer for review. Clearly indicate on the fabrication plans the locations where the forms are supported by steel beam flanges subject to tensile stresses. Do not weld to the flanges within these locations. Do not allow form sheets to rest directly on the top of the beam or girder. Securely fasten sheets to form supports with a minimum bearing length of 1 inch at each end. Center sheets between the form supports. Place form supports in direct contact with the flange of girder or beam. Make all attachments by permissible welds, bolts, clips or other approved means. Weld in accordance with Article 1072-18 except 1/8 inch fillet welds are permitted.

In the areas where the form sheets lap, securely fasten the form sheets to one another by screws at a maximum spacing of 18 inches. Securely attach the ends of the form sheets to support angles with screws at a maximum spacing of 18 inches.

Where the galvanized coating is damaged, repair in accordance with Article 1076-7. Minor heat discoloration in areas of welds is not damage and does not require the above repair.

Locate transverse construction joints at the bottom of a flute and field drill 1/4 inch weep holes at not more than 12 inches on center along the line of the joint.

Use a saw for all cuts. Do not flame cut forms.

(E) Falsework and Forms Over or Adjacent to Traffic

In addition to the applicable sections in Subarticle 420-3(A) through 420-3(D), the following requirements apply to falsework and forms including metal stay-in-place forms and precast concrete deck panels erected over vehicular, pedestrian or railroad traffic, or vessel traffic on navigable waterways. It also covers falsework and forms for those parts of a substructure unit constructed within 20 feet of the edge of a travelway or railroad track and more than 25 feet above the ground line at the time of substructure construction.

(1) Submittals

Submit detailed drawings as required by the contract and a set of design calculations for falsework and forms for review and acceptance before beginning construction of the falsework or forms. Ensure the drawings and design calculations are prepared, signed and sealed by an engineer licensed by the State of North Carolina. These submittal requirements apply to all falsework and form systems covered by this section.

(2) Design

Design falsework and forms for the combined effects of dead load and live load and with appropriate safety factors in accordance with this section and the respective design codes of the materials used. Include the weight of concrete, reinforcing steel, forms and falsework in the dead load. Live load includes the actual weight of any equipment the falsework supports, applied as concentrated loads at the points of contact and a uniform load of at least 20 psf applied over the supported area. In addition, apply a line load of 75 lb/ft along the outside edge of deck overhangs.

(3) Inspection

Before the form or falsework system is loaded, inspect the erected falsework and forms and submit a written statement certifying that the erected falsework system complies with the accepted detailed drawings. Submit a separate certification for each span, unit or bridge component. Any condition that does not comply with the accepted drawings, or any other condition deemed unsatisfactory by the Engineer, is cause for rejection until corrections are made.

420-4 PLACING CONCRETE

Do not place concrete until the depth of the excavation, character of the foundation material, adequacy of the forms and falsework, placement of reinforcement and other embedded items are inspected and approved. Do not place concrete without the Department's inspector present.

Place concrete in daylight or obtain approval for an adequate lighting system for construction and inspection of the work.

In preparation for the placing of concrete, remove all sawdust, chips and other construction debris and extraneous matter from the interior of forms. Remove hardened concrete and foreign matter from tools, screeds and conveying equipment.

Ensure that the concrete temperature at the time of placement in the forms is at least 50°F and no more than 95°F, except where other temperatures are required by Articles 420-7 and 420-14.

Do not use concrete that does not reach its final position in the forms within the time stipulated in Subarticle 1000-3(E).

Thoroughly clean and wet surfaces, other than foundation surfaces, immediately before placing concrete to help bonding to those surfaces.

Regulate the placement of concrete so the pressures caused by the wet concrete do not exceed those used in the design of the forms.

Thoroughly work the external surface of all concrete during the placing with approved tools. During the placing of concrete, take care to use methods of compaction that result in a surface of even texture free from voids, water or air pockets, and that force the coarse aggregate away from the forms to leave a mortar surface.

Place concrete to avoid segregation of the materials and the displacement of the reinforcement.

Equip chutes on steep slopes with baffle boards or provide chutes in short lengths that reverse the direction of movement.

Use all chutes, troughs and pipes made from suitable materials other than aluminum and keep them clean and free from coating of hardened concrete by thoroughly flushing with water after each run. Discharge the water used for flushing clear of the structure.

Confine concrete dropped more than 5 feet by closed chutes or pipes, except in walls of box culverts or retaining walls unless otherwise allowed by the Engineer.

Take care to fill each part of the form by depositing the concrete as near to its final position as possible. Work the coarse aggregate back from the forms and around the reinforcement without displacing the bars. After initial set of the concrete, do not jar the forms and do not place strain on the projecting reinforcement or other items embedded in the concrete.

Compact all concrete required to be vibrated with approved high frequency internal vibrators or other approved type of vibrators immediately after depositing concrete in the forms. In all cases, have available at least 2 vibrators in good operating condition and 2 sources of power at the site of any structure in which more than 25 cubic yard of concrete is required. Do not attach or hold the vibrators against the forms or the reinforcing steel. When vibrating concrete containing epoxy coated reinforcing steel, use a vibrator with a protective rubber head as approved by the Engineer. Vibrate with care and avoid displacement of reinforcement, ducts or other embedded elements. Vibrate in the appropriate location, manner and duration to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate and without causing water to flush to the surface. When placing concrete to a depth in excess of 12 inches and containing one or more horizontal layers of reinforcing steel, place the concrete in horizontal layers not more than 12 inches thick. Place and compact each layer before the preceding layer takes initial set such that there is no surface of separation between layers. Do not taper layers of concrete in wedge-shaped slopes but instead place them with reasonably square ends and level tops.

If placing additional concrete against hardened concrete, take care to remove all laitance and to roughen the surfaces of the concrete to ensure that fresh concrete is deposited upon sound concrete surfaces and an acceptable bond is obtained. Thoroughly wet the existing concrete for at least 2 hours before placing additional concrete.

Deposit and compact to form a compact, dense, impervious concrete of uniform texture which shows smooth faces on exposed surfaces. Repair, remove and replace in whole or in part as directed by the Engineer and at no additional cost to the Department, any section of concrete found to be porous, cracked, plastered or otherwise defective.

Protect beams and girders during concreting operations. Remove any concrete that gets on beams or girders immediately by an approved method to restore the surface to the specified condition.

Any concrete placed in contact with aluminum or aluminized coatings shall have a barrier coat applied to the faying surfaces and edges of those steel components. Surface preparation and barrier coat paint systems are found in the *Thermal Spray Coatings (Metallization) Program*.

420-5 PUMPING CONCRETE

Placement of concrete by pumping is permitted only when approved. Use and locate suitable pumping equipment that is adequate in capacity for the work and so no vibrations result which might damage freshly placed concrete. Do not use pumping equipment, including the conduit system, which contains any aluminum or aluminum alloy that comes in contact with the concrete.

Waste all grout used to lubricate the inner surfaces of the conduit system.

Pump so a continuous stream of concrete without air pockets is delivered. For test purposes, take concrete from the discharge end of the pump.

420-6 SLUMP TESTS

The slump of the concrete is determined in accordance with AASHTO T 119.

When a slump test is made and the results of the test exceed the specified maximum allowed in Table 1000-1, a check test is made immediately from the same batch or truck load of concrete. If a passing result cannot be produced on the check test the load will be rejected.

420-7 PLACING CONCRETE IN COLD WEATHER

(A) General

Do not place concrete when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is below 35°F without permission. When such permission is granted, uniformly heat the aggregates and water to a temperature not

higher than 150°F. Place the concrete when the temperature of the heated concrete is at least 55°F and not more than 80°F.

Use aggregates that are free of ice, frost and frozen particles. Do not place concrete on frozen foundation material.

Protect all concrete with heated enclosures or by insulation whenever any of the following conditions occur:

(1) The concrete is placed when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is below 35°F.

(2) The air temperature, measured at the location of the freshly placed concrete in the shade away from artificial heat, is below 35°F and the concrete has not yet attained an age of 72 hours or an age of 48 hours when using high early strength Portland cement concrete. If the mix contains fly ash or ground granulated blast furnace slag, protect the concrete for 7 days.

Provide and place, at locations directed by the Engineer, a sufficient number of maximum-minimum recording thermometers to provide an accurate record of the temperature surrounding the concrete during the entire protection period.

Assume all risks connected with the placing of concrete under the cold weather conditions referred to herein. Permission given to place concrete when the temperature is below 35°F and the subsequent protection of the concrete as required herein does not relieve the Contractor in any way of the responsibility for obtaining the required results.

(B) Heated Enclosures

Immediately enclose concrete that is placed when the air temperature is below 35°F and concrete that has not yet attained an age of 72 hours. Enclose the concrete before the air temperature falls below 35°F with a housing consisting of canvas or other approved material supported by an open framework. Maintain the air surrounding the concrete at a temperature of at least 50°F and no more than 90°F for the remainder of the 72-hour period. Apply these same requirements to high early strength concrete except reduce the 72-hour period to 48 hours. Do not begin these time periods until completing manipulation of each separate mass of concrete.

Provide such heating apparatuses as stoves, salamanders or steam equipment and the necessary fuel. When using dry heat, provide means of preventing loss of moisture from the concrete.

(C) Insulation

As an alternate to the heated enclosure specified in Subarticle 420-7(B), use insulated forms or insulation meeting all requirements of this subarticle to protect concrete. Use insulation under the same conditions that require heated enclosures. Place the insulation on the concrete as soon as initial set permits.

When using insulation for cold weather protection, batch concrete for sections 12 inches or less in thickness or diameter as outlined below. Use Type III cement without any increase in cement content, or use Type I or II cement with the cement content increased to 677 lb/cy. When the mix includes fly ash, use a mix containing 572 lb/cy of cement and at least 143 lb/cy of fly ash. When the mix includes ground granulated blast furnace slag, use a mix containing 465 lb/cy of cement and 250 lb/cy of ground granulated blast furnace slag.

Use insulated materials with a minimum thickness of 1 inch. Insulate overhang forms both on the outside vertical faces and on the underside with a 1 inch minimum thickness of either rigid or blanket type insulation. Use insulating materials which provide a minimum system R value of 4.0 in the up mode as determined by ASTM C1363 with a 15 mph wind over the cold side of the material and a minimum differential of 50°F. Furnish results of tests

conducted in accordance with ASTM C1363 by an accredited commercial testing laboratory for review, comments and acceptance by the Engineer. Obtain such acceptance before use of the material. Face or cover insulating blankets, top and bottom, with polyethylene or similar waterproofing material meeting Article 1026-3 except for the length and color requirements. Place blankets on the concrete to form a waterproof surface for the protected concrete. Do not use blankets with rips and tears in the waterproofing material unless acceptably repaired. When the anticipated low temperature expected during the protection period is less than 10°F, provide 2 inches of insulation. Overlap blanket insulation mats at the edges by at least 6 inches. Tightly butt rigid type insulation sheets together and seal. Take particular care to provide effective protection of curbs, corners and around protruding reinforcing steel.

Should the air under the insulation fall below 50°F during the protection period, immediately cover the concrete with canvas and framework or other satisfactory housing and apply heat uniformly at a rate such that the air surrounding the concrete is at least 50°F for the remainder of the protection period.

If insulating materials are removed from the concrete before the expiration of the curing period, cure the concrete for the remainder of the period in accordance with Article 420-15.

420-8 CONSTRUCTION JOINTS

Provide construction joints only where located in the plans or shown in the placing schedule, unless otherwise approved in writing.

Place the concrete in each integral part of the structure continuously. Do not start work on any such part unless the concrete supply, forces and equipment are sufficient to complete the part without interruption in the placing of the concrete.

In case of emergency, make construction joints or remove the concrete as directed by the Engineer.

Make construction joints without keys, except when required in the plans. Rough float surfaces of fresh concrete at horizontal construction joints sufficiently to thoroughly consolidate the concrete at the surface.

After placing concrete to the construction joint and before placing fresh concrete, thoroughly clean the entire surface of horizontal and vertical construction joints of surface laitance, curing compound and other materials foreign to the concrete. Thoroughly clean and wet concrete surfaces for at least 2 hours before placing additional concrete to help bonding.

420-9 WIDENING EXISTING STRUCTURES

Where plans call for widening existing concrete structures or otherwise require bonding new concrete to old, remove portions of the existing structures as indicated in the plans and in accordance with Subarticle 402-2(C).

When extending an existing culvert, remove the following portions of the existing culvert: the portions that interfere with the proposed extension, headwalls only as necessary to clear proposed subgrade by at least 18 inches and wingwalls to square surfaces the full thickness of the new sidewalls. Cut existing wingwall reinforcing steel off flush with the concrete surface.

Thoroughly roughen, clean off loose material and wet connecting surfaces of the old concrete at least 2 hours before placing new concrete.

420-10 EXPANSION JOINTS

(A) General

Locate and construct all joints as shown in the plans.

Chamfer or edge the edges of joints as shown in the plans or as directed by the Engineer.

Immediately after removing the forms, inspect the expansion joint carefully. Neatly remove any concrete or mortar in the joint.

(B) Filled Joints

Use cork, bituminous fiber, neoprene or rubber in accordance with Article 1028-1 in all expansion joint material. Use an optional second layer to obtain the required thickness, when a thickness of more than 1 inch is required.

Cut the joint filler to the same shape and size as the area to be covered except cut it 1/2 inch below any surface that is exposed to view in the finished work. As an option, cut the joint filler the same size and shape as that of the adjoining surfaces and neatly cut back the material 1/2 inch on the surfaces that are exposed to view after the concrete hardens. Cut the joint filler out of as few pieces as practical and, except as noted above, completely fill the space provided. Fasten the pieces in any one joint together in an approved manner. Do not use loose fitting or open joints between sections of filler or between filler and forms. Do not use joints made up with small strips. Place 2-ply roofing felt over all joints in the filler material in vertical expansion joints below top of curbs. Place the felt on the side of the joint adjacent to the new pour.

In accordance with Article 1028-3, seal all expansion joints with a low modulus silicone sealant.

420-11 DRAINS IN WALLS AND CULVERTS

Construct drain holes and weep holes in abutment walls, wing walls, retaining walls and the exterior walls of culverts as shown in the plans unless otherwise directed by the Engineer and backfill in accordance with Articles 414-7 and 414-8.

Cover drain holes and weep holes at the back face of the wall with hardware cloth of commercial quality, approximately No. 4 galvanized steel wire reinforcement.

420-12 ANCHOR BOLTS AND BEARING AREAS

(A) Anchor Bolts

Accurately set all necessary anchor bolts in piers, abutments or pedestals either while placing concrete, in formed holes or in holes cored or drilled after the concrete sets.

If set in the concrete, position the bolts with templates and rigidly hold in position while placing the concrete.

Form holes by inserting in the fresh concrete oiled wooden plugs, metal pipe sleeves or other approved devices, and withdrawing them after the concrete partially sets. Provide holes formed in this manner that are at least 4 inches in diameter.

Core holes at least 1 inch larger in diameter than the bolt used. Use approved equipment for coring concrete. Do not use impact tools. Place reinforcing steel to provide adequate space to core bolt holes without cutting the reinforcing steel.

During freezing conditions, protect anchor bolt holes from water accumulation at all times.

Completely fill the holes with an approved grout compatible with the concrete.

(B) Bearing Areas

Finish bridge seat bearing areas to a true level plane to not vary perceptibly from a straightedge placed in any direction across the area.

Place bearing plates in accordance with Article 440-4.

420-13 ADHESIVELY ANCHORED ANCHOR BOLTS OR DOWELS

(A) Description

The work covered by this section consists of furnishing all necessary labor, equipment and materials and performing all operations necessary for installing anchor bolts/dowels in concrete using an adhesive anchor system in accordance with the details shown in the plans and with Section 1081.

The use of adhesive anchors for overhead installments is not permitted.

Submit the Manufacturer's Printed Installation Instructions (MPII) and a description of the proposed adhesive anchor system for review, comments and acceptance by the Engineer. Include in the description the bolt type and its deformations, equipment, manufacturer's recommended hole diameter, embedment depth, material specifications and any other material, equipment or procedure not covered by the contract. List the properties of the adhesive, including density, minimum and maximum temperature application, setting time, shelf life, pot life, shear strength and compressive strength. If bars/dowels containing a corrosion protective coating are required, provide an adhesive that does not contain any chemical elements that are detrimental to the coating and include a statement to this effect in the submittal concerning the contents as required by Federal or State laws and regulations.

(B) Procedure

Always follow the MPII during adhesive anchor installation.

(1) Drilling of Holes into Concrete

When directed by the Engineer, use a jig or fixture to ensure the holes are positioned and aligned correctly during the drilling process. Upon approval by the Engineer, adjusting hole locations to avoid reinforcing steel is permitted.

Drill the holes with a pneumatic drill unless another drilling method is approved by the Engineer. Follow the manufacturer's recommendations regarding the diameter of the drilled hole.

Immediately after completion of drilling, blow all dust and debris out of the holes with oil-free compressed air using a wand extending to the bottom of the hole. Remove all dust from the sides of the holes by brushing the holes with a stiff-bristled brush of a sufficient size and then blow the hole free of dust. Repeat this procedure until the hole is completely clean. Check each hole with a depth gauge to ensure proper embedment depth.

Repair spalled or otherwise damaged concrete using approved methods.

(2) Inspection of Holes

Inspect each hole immediately before placing the adhesive and the anchor bolts/dowels. Ensure all holes are dry and free of dust, dirt, oil and grease. Rework any hole that does not meet the requirements of the contract.

(3) Mixing of Adhesive

Mix the adhesive in strict conformance with the MPII.

(4) Embedment of Anchor Bolt/Dowel

Clean each anchor bolt/dowel so it is free of all rust, grease, oil and other contaminants in accordance with the MPII.

Unless otherwise shown in the plans, the minimum anchor bolt/dowel embedment depth is such that the adhesive anchor system develops at least 125% of the anchor

bolt/dowel yield load as listed in the plans and in accordance with Subarticle 1081-1(C).

Installation of the adhesive anchors shall be in accordance with the MPII and shall occur when the concrete is above 40°F (unless the MPII requires a higher temperature) and has reached its 28 day strength. The anchors shall be installed before the adhesive's initial set (gel time).

Insert the anchor bolt/dowel the specified depth into the hole and slightly agitate it to ensure wetting and complete encapsulation. After insertion of the anchor bolt/dowel, strike off any excessive adhesive flush with the concrete face. Should the adhesive fail to fill the hole, adding additional adhesive to the hole is not allowed. In such cases, remove the anchor and submit a repair procedure to the Engineer. Do not disturb the anchor bolts/dowels while adhesive is hardening.

(C) Field Testing

When specified in the plans, test the installed anchor bolts/dowels for adequate adhesive as specified below. Inform the Engineer when the tests will be performed at least 2 days before testing. Conduct the tests in the presence of the Engineer.

Use a calibrated hydraulic centerhole jack system for testing. Place the jack on a plate washer that has a hole at least 1/8 inch larger than the hole drilled into the concrete. Position the plate washer on center to allow an unobstructed pull. Position the anchor bolts/dowels and the jack on the same axis. Ensure an approved testing agency calibrates the jack within 12 months before testing. Supply the Engineer with a certificate of calibration.

In the presence of the Engineer, field test the anchor bolt or dowel in accordance with the test level shown in the plans and the following:

(1) Level 1 Field Testing

Test a minimum of 1 anchor but at least 10% of all anchors to 50% of the yield load shown in the plans. If less than 60 anchors are to be installed, install and test the required number of anchors before installing the remaining anchors. If more than 60 anchors are to be installed, test the first 6 anchors before installing the remaining anchors, then test 10% of the number in excess of 60 anchors.

(2) Level 2 Field Testing

Test a minimum of 2 anchors but at least 10% of all anchors to 80% of the yield load shown in the plans. If less than 60 anchors are to be installed, install and test the required number of anchors before installing the remaining anchors. If more than 60 anchors are to be installed, test the first 6 anchors before installing the remaining anchors, then test 10% of the number in excess of 60 anchors.

Testing should begin only after the manufacturer's recommended cure time has been reached. For testing, apply and hold the test load for 3 minutes. If the jack experiences any drop in gauge reading, the test shall be restarted. For the anchor to be deemed satisfactory, the test load shall be held for 3 minutes with no movement or drop in gauge reading.

Record data for each anchor bolt or dowel tested on the report form entitled Installation Test Report of Adhesively Anchored Anchor Bolts or Dowels. Obtain this form from the Department's Materials and Tests Engineer. Submit a copy of the completed report form to the Engineer.

Final acceptance of the adhesively anchored system is based on the conformance of the pull test. Failure to meet the criteria of this specification is grounds for rejection.

Remove all anchors or dowels that fail the field test without damage to the surrounding concrete. Redrill holes to remove adhesive bonding material residue and clean the hole in accordance with specifications. For reinstalling replacement anchors or dowels, follow the same procedures as new installations. Do not reuse failed anchors or dowels unless approved by the Engineer.

420-14 PLACING AND FINISHING BRIDGE DECKS

(A) Placing Concrete

Unless otherwise noted in the plans, use Class AA CIP concrete conforming to Section 1000. When noted in the plans, use sand lightweight concrete conforming to Section 1000.

Place concrete in accordance with these specifications. Properly vibrate concrete to avoid honeycombs and voids. Ensure pouring sequences, procedures and mixes are approved by the Engineer.

For metal stay-in-place forms, do not place concrete on the forms to a depth greater than 12 inches above the top of the forms. Do not drop concrete more than 3 feet above the top of the forms, beams or girder. Keep the top surface of prestressed concrete panels clean. Thoroughly inspect panels and remove any foreign matter, oil, grease or other contaminants either with a high pressure water blast or sand blast. Saturate the top surface of the prestressed concrete panels and concrete girders by thoroughly wetting the top surface with water for at least 2 hours before placing the CIP concrete slab. Do not allow the wetted concrete surfaces to dry. Remove all puddles and ponds of water from all surfaces before placing the CIP concrete slab.

Obtain a smooth riding surface of uniform texture, true to the required grade and cross section, on all bridge decks.

Do not place bridge deck concrete until the Engineer is satisfied that adequate personnel and equipment are present to deliver, place, spread, finish and cure the concrete within the scheduled time; that experienced finishing machine operators and concrete finishers are employed to finish the deck; and that weather protective equipment and all necessary finishing tools and equipment are on hand at the site of the work and in satisfactory condition for use. Between April 15 and October 15, begin placing the bridge deck concrete as early as practical to allow the work to be accomplished during the cooler hours when forms, beams and reinforcing steel are at ambient air temperatures.

Unless otherwise permitted, set the rate of concrete placement and use a set retarder such that the concrete remains workable until the entire operation of placing, screeding, rescreeding, surface testing and corrective measures where necessary are complete. Use of a set retarder may be waived by the Engineer when conditions clearly indicate it is not needed.

Place concrete in the deck when the concrete temperature at the time of placement is at least 50°F and no more than 90°F, except where other temperatures are required by Article 420-7.

Place concrete at a minimum rate of 35 cubic yards per hour.

Place and firmly secure supports for screeds or finishing machines before beginning placement of concrete. Set supports to elevations necessary to obtain a bridge roadway floor true to the required grade and cross section, and make allowance for anticipated settlement. Use supports of a type that upon installation, no springing or deflection occurs under the weight of the finishing equipment. Locate the supports such that finishing equipment operates without interruption over the entire bridge deck.

Immediately before placing bridge deck concrete, check all falsework and make all necessary adjustments. Provide suitable means such as telltales to permit ready

measurement by the Engineer of deflection as it occurs. Unless otherwise permitted, do not adjust the profile grade-line for any of the forming types used.

Cast the concrete in accordance with the pour sequence shown in the plans, unless otherwise approved by the Engineer. Place concrete in a continuous manner between headers. Use approved screeds, screed supports and screeding methods.

(B) Finishing

Unless otherwise specified or permitted, use self-propelled mechanically operated longitudinal or transverse screeds for finishing bridge deck. Do not use vibratory screeds unless specifically approved. Use readily adjustable screeds with sufficient rigidity and width to strike-off the concrete surface at the required grade. Do not use aluminum strike-off elements of screeds and hand tools used for finishing concrete.

Furnish personnel and equipment necessary to verify the screed adjustment and operation before beginning concrete placement.

When using a longitudinal screed, place sufficient concrete ahead of the screeded area to assure all dead load deflection occurs before final screeding. Unless otherwise permitted by the Engineer, do not use longitudinal screeds for pours greater than 85 feet in length.

When using a transverse screed, position the strike-off parallel to the centerline of bridge and make the leading edge of concrete placement parallel to the skew. On a span with a skew angle less than 75° or more than 105°, orient and operate the truss or beam supporting the strike-off mechanism parallel to the skew. If approved by the Engineer, operate at a reduced skew angle on very wide or heavily skewed spans where the distance between screed supports exceeds 100 feet. Orient and operate transverse screeds used on spans with skew angles between 75° and 105° either parallel to the skew or perpendicular to the centerline of bridge. For crowned decks that are finished on a skew, use the manufacturer's recommended skew correction device and procedures.

Before placing concrete, verify the adjustment and operation of the screed as directed by the Engineer by operating the screed over the entire area and across all end bulkheads. Check the floor thickness and cover over reinforcing steel shown in the plans and make adjustments as necessary.

During the screeding operation, keep an adequate supply of concrete ahead of the screed and maintain a slight excess immediately in front of the screed. Operate the screed to obtain a substantially uniform surface finish over the entire bridge deck. Do not allow workmen to walk on the concrete after screeding. Use at least 2 approved work bridges to provide adequate access to the work for finishing, testing, straightedging, making corrections, fogging, applying curing medium and for other operations requiring access to the bridge deck. Support the work bridges outside the limits of concrete placement.

The Engineer will take random depth checks of deck thickness and cover over reinforcing steel over the entire placement area and directly behind the screed in the fresh concrete. If depth checks indicate variations from plan dimensions in excess of 1/2 inch, take corrective action immediately.

Immediately following the screed and while the concrete is still workable, test the floor surface for irregularities with a 10 foot straightedge. Test by holding the straightedge in successive positions parallel to the centerline of bridge and in contact with the floor surface. Test the surface approximately 18 inches from the curb line, at the centerline of each lane and at the centerline of 2 lane bridges. Advance along the bridge in stages of not more than half the length of straightedge. Test the surface transversely at the ends, quarter points and center of the span as well as other locations as directed by the Engineer.

Immediately correct areas showing depressions or high spots of more than 1/8 inch in 10 feet by filling depressions with fresh concrete or by striking off high spots. Make corrections with hand tools or a combination of hand tools and rescreeding. Do not use the

straightedge as a finishing tool. Give surfaces adjacent to expansion joints special attention to assure they meet the required smoothness.

Provide on-site fogging equipment which is capable of applying water to the concrete in the form of a fine fog mist in sufficient quantity to curb the effects of rapid evaporation of mixing water from the concrete on the bridge deck resulting from wind, high temperature, low humidity or a combination of these factors. Do not apply the moisture from the nozzle under pressure directly upon the concrete and do not allow it to accumulate on the surface in a quantity sufficient to cause a flow or wash the surface. Maintain responsibility for determining when to apply the fog mist but apply it when directed by the Engineer.

Keep readily available on site an adequate supply of suitable coverings that will protect the surface of the freshly placed bridge deck from rain. After the water sheen disappears from the surface and before the concrete becomes non-plastic, finish the surface of the floor further by burlap dragging, fine bristle brooming, belting or other acceptable method which produces an acceptable uniform texture.

Do not use membrane curing compound unless approved. Cure the concrete using the water method in accordance with Subarticle 420-15(B), with the following exceptions. Before reaching initial set, place a curing medium consisting of burlap under polyethylene sheets or another approved material on the deck and keep moist for at least 7 curing days. Wet the burlap or other approved curing medium before placing on the deck. Apply water to the curing medium through soaker hoses or another approved method. Apply water in amounts to keep the medium moist but do not allow the water to flow or pond on the deck.

After curing the concrete, test the finished surface with an approved rolling straightedge designed, constructed and adjusted to accurately indicate or mark all floor areas which deviate from a plane surface by more than 1/8 inch in 10 feet. If required by the Engineer, further test any areas of concern using a 10 foot stationary straightedge furnished by the Contractor. Remove all high areas in the hardened surface in excess of 1/8 inch in 10 feet with an approved grinding or cutting machine. Where variations are such that the corrections will extend below the limits of the top layer of grout, seal the corrected surface with an approved sealing agent as required. Submit proposed corrective measures to the Engineer for approval for all low areas in excess of 1/8 inch in 10 feet. Produce corrected areas that have a rough, uniform texture and present neat patterns. In all cases, maintain at least 2 inches of concrete cover over reinforcement.

Unless otherwise indicated in the plans, groove bridge decks. Produce grooves perpendicular to the centerline of bridge. Do not start grooving until final straightedging and, when necessary, acceptable corrective measures are complete. Cut grooves into the hardened concrete using a mechanical saw device, which leaves rectangular grooves 1/8 inch wide and 3/16 inch deep. Produce grooves that have a center to center spacing of 3/4 inch. Do not groove the deck surface within 18 inches of the gutter lines and 2 inches of expansion joints or elastomeric concrete in expansion joint blockouts. On skewed bridges, ungrooved triangular areas adjacent to the joint are permitted, provided the distance from the centerline joint to the nearest groove, as measured parallel to the centerline of roadway, does not exceed 18 inches. Between expansion joints on horizontally curved bridges, periodically adjust the grooving operation such that adjacent grooves are separated by no more than 3 inches along the outer radius of the bridge deck.

Continuously remove all slurry or other residue resulting from the grooving operation from the bridge deck by vacuum pick-up or other approved methods. Prevent slurry from flowing into deck drains or onto the ground or body of water under the bridge. Dispose of all residue by an approved method.

(C) Inspection

After the deck concrete is in place for a minimum period of 2 days, test the concrete for soundness and bonding of the metal stay-in-place forms by sounding with a hammer as

directed by the Engineer. For at least 25% of the individual form panels, as selected by the Engineer, hammer test over the entire area of the panel. If areas of doubtful soundness are disclosed by this procedure, remove the forms from such areas for visual inspection after the pour attains a minimum compressive strength of 2,400 psi. Remove the stay-in-place forms.

At locations where sections of the forms are removed, do not replace the forms, but repair the adjacent metal forms and supports to present a neat appearance and assure their satisfactory retention. As soon as the forms are removed, allow the Engineer to examine for cavities, honeycombs and other defects. If irregularities are found, and in the opinion of the Engineer these irregularities do not justify rejection of the work, repair the concrete as directed by the Engineer. If the concrete where the forms are removed is unsatisfactory, remove additional forms, as necessary, to inspect and repair the slab. Modify the methods of construction as required to obtain satisfactory concrete in the slabs. Remove and repair all unsatisfactory concrete as directed by the Engineer.

Provide all facilities as are reasonably required for the safe and convenient conduct of the Engineer's inspection procedures.

420-15 CURING CONCRETE

(A) General

Unless otherwise specified in the contract, use any of the following methods except for membrane curing compounds on bridge deck and approach slab, or on concrete which is to receive epoxy protective coating in accordance with Article 420-18. Advise the Engineer before using the proposed method. Ensure all material, equipment and labor necessary to promptly apply the curing are on the site before placing any concrete. Cure all patches in accordance with this article. Improperly cured concrete is considered defective.

Define "curing temperature" as the atmospheric temperature taken in the shade away from artificial heat, with the exception that it is the temperature surrounding the concrete where the concrete is protected in accordance with Article 420-7.

Define a "curing day" as any consecutive 24-hour period, beginning when the manipulation of each separate mass is complete, during which the air temperature adjacent to the mass does not fall below 40°F.

After placing the concrete, cure it for 7 full curing days.

Take all reasonable precautions to prevent plastic shrinkage cracking of the concrete, including the use of wind screens, fogging, application of an approved temporary liquid moisture barrier or the early application of temporary wet coverings to minimize moisture loss.

Repair, remove or replace, as directed by the Engineer, concrete containing plastic shrinkage cracks.

(B) Water Method

Keep the concrete continuously wet by the application of water, through soaker hoses or another approved method, for a minimum period of 7 curing days after placing the concrete.

When using cotton mats, rugs, carpets, earth blankets or sand blankets to retain the moisture, keep the entire surface of the concrete damp by applying water with a nozzle that so atomizes the flow that a mist and not a spray is formed, until the surface of the concrete is covered with the curing medium. Do not apply the moisture from the nozzle under pressure directly upon the concrete and do not allow it to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface. At the expiration of the curing period, clear the concrete surfaces of all curing mediums.

(C) Membrane Curing Compound Method

Spray the entire surface of the concrete uniformly with a curing compound that is on the NCDOT APL. Use clear curing compound to which a fugitive dye is added for color contrast on bridge superstructures, substructures and retaining walls. Use either white pigmented or clear curing compound on culverts.

Apply the membrane curing compound after the surface finishing is complete and immediately after the free surface moisture disappears. During the finishing period, protect the concrete by applying water with the fogging equipment specified in Subarticle 420-15(B).

Seal the surface with a single uniform coating of the specified type of curing compound applied at the rate of coverage recommended by the manufacturer or as directed, but at least one gallon per 150 square feet of surface area.

At the time of use, thoroughly mix the compound with the pigment uniformly dispersed throughout the vehicle. If the application of the compound does not result in satisfactory coverage, stop the method and begin water curing, as set out above, until the cause of the defective work is corrected.

At locations where the coating shows discontinuities, pinholes or other defects, or if rain falls on the newly coated surface before the film dries sufficiently to resist damage, apply an additional coat of the compound at the same rate specified herein immediately after the rain stops.

Completely remove any curing compound adhering to a surface to which new concrete is to be bonded by sandblasting, steel wire brushes, bush hammers or other approved means.

Protect the concrete surfaces to which the compound is applied from abrasion or other damage that results in perforation of the membrane film for 7 curing days after placing the concrete. If the film of membrane compound is damaged or removed before the expiration of 7 curing days, immediately cure the exposed concrete by the water method until the expiration of the 7 curing days or until applying additional curing compound.

If the application of curing compound is delayed, immediately start applying water as provided in Subarticle 420-15(B) and continue until resuming or starting application of the compound.

(D) Polyethylene Sheeting Method

Wet the exposed finished surface of concrete with water, using a nozzle that so atomizes the flow to form a mist and not a spray, until the concrete sets, after which place the white opaque polyethylene sheeting. Continue curing for 7 curing days after the concrete is placed. If the sheeting is damaged or removed before the expiration of 7 curing days, immediately cure the exposed concrete by the water method until placing additional sheeting or until after 7 curing days.

Use sheeting which provides a complete continuous cover of the entire concrete surface. Lap the sheets at least 12 inches and securely weigh down or cement them together to provide a waterproof joint.

If any portion of the sheets is broken or damaged before the expiration of the curing period, immediately repair the broken or damaged portions with new sheets properly secured in place.

Do not use sections of sheeting damaged to such an extent as to render them unfit for curing the concrete.

(E) Forms-in-Place Method

As an option, cure surfaces of concrete by retaining the forms in place for at least 7 curing days after placing the concrete.

If electing to leave forms in place for a part of the curing period and using one of the other methods of curing included in this article for the remainder of the curing period, keep the concrete surfaces wet during transition between curing methods.

420-16 REMOVAL OF FORMS AND FALSEWORK

Do not remove forms and falsework for the portions of structures listed in Table 420-1 until the concrete attains the compressive strength shown, as evidenced by approved, nondestructive test methods or by conducting compressive strength tests in accordance with AASHTO T 22 and T 23. Furnish approved equipment used for nondestructive tests.

TABLE 420-1
MINIMUM CONCRETE STRENGTH
FOR REMOVAL OF FORMS AND FALSEWORK

Portion of Structure	Minimum Compressive Strength, psi
Bridge deck slabs and overhangs for beam and girder bridges	3,000
Arch culverts, top slabs of box culverts, walls of box culverts when cast monolithically with the top slab or when the wall is 10 ft or more in height, caps and struts of substructures, diaphragms and other members subject to dead load bending	2,400

Remove forms for ornamental work, railing, parapets, walls less than 10 feet in height, curb faces on bridge superstructures and vertical surfaces that do not carry loads, any time after 3 hours if the concrete is set sufficiently to permit form removal without damage to the member.

Do not remove forms used for insulation before the expiration of the minimum protective period required in Article 420-7.

Do not remove formwork for bent diaphragms until after casting deck concrete and allowing the concrete to attain a strength of 2,400 psi. As an option, to remove support from bent diaphragms before casting deck concrete, submit for approval a method to prevent the possibility of bent diaphragms slipping downward.

When removing forms before the end of the required curing period, use other curing methods to complete the required curing. When removing forms from underneath slabs before the end of the curing period, complete the curing in accordance with Subarticle 420-15(C).

420-17 SURFACE FINISH

(A) General

Finish all concrete as required by this article except for bridge decks. Use the type of finish called for in Subarticles 420-17(B) through 420-17(D), except where the contract requires a Class 1 or Class 2 surface finish. Apply epoxy protective coating as required by Article 420-18.

(B) Ordinary Surface Finish

Apply ordinary surface finish to all formed concrete surfaces either as a final finish or preparatory to a higher class finish. On surfaces backfilled or otherwise covered, or enclosed surfaces, the removal of fins and form marks, the rubbing of grouted areas to a uniform color, and the removal of stains and discoloration, is not required. Use an ordinary surface finish, unless otherwise required, as final finish on all surfaces.

During the placing of concrete, take care to use methods of compaction that result in a surface of even texture free from voids, water or air pockets, and that the coarse aggregate is forced away from the forms to leave a mortar surface.

Immediately after removing the forms, clean and fill with grout all pockets, depressions, honeycombs and other defects as directed. Remove all form ties or metal spacers to a depth of at least 1 inch below the surface of the concrete then clean and fill the resulting holes or depressions with grout. As an option, break off flush with the concrete surface those metal devices with exposed cross-sectional area not exceeding 0.05 square inches on surfaces permanently in contact with earth fill. Unless otherwise required, remove fins and other projections flush with the concrete surface. Remove stains and discoloration.

Use grout for patching which contains cement and fine aggregate from the same sources and in the same proportions as used in the concrete. Cure the grout in accordance with Article 420-15. After the grout has thoroughly hardened, rub the surface with a carborundum stone as required to match the texture and color of the adjacent concrete.

Obtain the final finish for railing in one of the following ways:

(1) Brush Finish

After striking off the concrete as described above, have skilled and experienced concrete finishers thoroughly work and float the surface with a wooden, canvas or cork float. Before this last finish sets, lightly stroke the surface with a fine brush to remove the surface cement film, leaving a fine grained, smooth, but sanded texture.

(2) Float Finish

Finish the surface with a rough carpet float or other suitable device leaving the surface even, but distinctly sandy or pebbled in texture.

(C) Unformed Surfaces Not Subjected to Wear

Finish all unformed surfaces not subjected to wear by placing an excess of material in the forms and removing or striking off such excess with a wooden template, forcing the coarse aggregate below the mortar surface. Do not use mortar topping for concrete railing caps and other surfaces falling under this classification.

(D) Sidewalk, Islands or Stairways on Bridges

Strike off and compact fresh concrete until a layer of mortar is brought to the surface. Finish the surface to grade and cross section with a float, trowel smooth and finish with a broom. If water is necessary, apply it to the surface immediately before brooming. Broom transverse to the line of traffic.

(E) Class 1 Surface Finish

In addition to Subarticle 420-17(B), as soon as the pointing sets sufficiently to permit, thoroughly wet the entire surface with a brush and rub with a coarse carborundum stone or other equally good abrasive, bringing the surface to a paste. Continue rubbing to remove all form marks and projections, producing a smooth dense surface without pits or irregularities.

Carefully spread or brush uniformly over the entire surface the material ground to a paste by rubbing and allowing it to take a reset. After rubbing, cure the surface for 7 curing days. Obtain the final finish by thoroughly rubbing with a fine carborundum stone or other equally good abrasive. Continue this rubbing until the entire surface is of a smooth texture and uniform color.

(F) Class 2 Surface Finish

In addition to Subarticle 420-17(B), after the pointing sets sufficiently to permit, thoroughly wet and rub the entire surface with a coarse carborundum stone or other equally

good abrasive to bring the surface to a smooth texture and remove all form marks. Finish the paste formed by rubbing as described above by carefully stroking with a clean brush, or spread it uniformly over the surface and allow it to take a reset, then finish it by floating with a canvas, carpet-faced or cork float; or rub down with dry burlap.

420-18 EPOXY COATING

(A) General

Use a waterproofing epoxy coating in accordance with Article 1080-10. Provide a Type 3 material certification in accordance with Article 106-3 showing the proposed epoxy meets the requirements of Article 1080-10.

(B) Surfaces

Apply the epoxy protective coating to the top surface area, including chamfer area of bent caps under expansion joints and of end bent caps, excluding areas under elastomeric bearings. For cored slab and box beam bridges, do not apply the epoxy protective coating to the bent or end bent caps.

Use extreme care to keep the area under the elastomeric bearings free of the epoxy protective coating. Thoroughly clean all dust, dirt, grease, oil, laitance and other objectionable material from the concrete surfaces to be coated. Air blast all surfaces immediately before applying the protective coating.

Use only cleaning agents approved by the Engineer.

(C) Application

Apply epoxy protective coating only when the air temperature is at least 40°F and rising, but less than 95°F and the surface temperature of the area to be coated is at least 40°F, and in accordance with the manufacturer's recommendations. Surfaces shall be dry before applying the coating. Apply one coat of epoxy protective coating, per the manufacturer's application procedures, at a rate such that it covers between 100 and 200 square feet per gallon.

Under certain combinations of circumstances, the cured epoxy protective coating may develop an oily condition on the surface due to amine blush. This condition is not detrimental to the applied system.

Apply the coating so the entire designated surface of the concrete is covered and all pores are filled. To provide a uniform appearance, use the exact same material on all visible surfaces.

420-19 PROTECTION OF SUBSTRUCTURE CONCRETE FROM RUST STAINS

To prevent unpainted structural steel from staining substructure concrete, protect all final exposed areas of the concrete from rust stains until casting the bridge deck and sealing the expansion joints. Use an approved method for protecting the concrete.

Instead of the above, remove the stains by approved methods and cleaning agents.

420-20 PLACING LOAD ON STRUCTURE MEMBERS

Do not place beams or girders on concrete substructures until the concrete in the substructure develops a minimum compressive strength of 2,400 psi.

In addition to Article 410-8, do not place backfill or fill for retaining walls, abutments, piers, wing walls or other structures that will retain material to an elevation higher on one side than the other until the concrete develops the minimum specified strength for the class of concrete required for the structure as listed in Table 1000-1.

In addition to Article 414-7, do not place backfill or embankment behind the walls of culverts to an elevation higher than one foot above the top of footing or bottom slab until after placing

the top slab and until the concrete develops the minimum required strength for the class of concrete specified as listed in Table 1000-1.

Do not pour walls of culverts until floor slabs develop a minimum compressive strength of 2,400 psi. Unless independently supported, do not pour roof slabs of culverts until the concrete in the culvert walls develops a minimum compressive strength of 2,400 psi.

Do not operate heavy equipment over any culvert type until properly backfilling with a minimum cover of 3 feet.

Adhere to the following time and strength requirements for erection of forms and construction of superimposed bridge substructure elements:

(A) Wait at least 12 hours between placing footing or Drilled Pier concrete and erecting column forms.

(B) Wait at least 24 hours between placing footing or Drilled Pier concrete and placing column concrete.

(C) Wait at least 72 hours between placing column concrete and beginning erection of cap forms or until column concrete attains a compressive strength of at least 1,500 psi.

(D) Wait at least 96 hours between placing column concrete and placing cap concrete or until column concrete attains a compressive strength of at least 2,000 psi.

Do not place vehicles or construction equipment on a bridge deck until the deck concrete develops the minimum specified 28 day compressive strength and attains an age of at least 7 curing days. The screed may be rolled across a previously cast bridge deck if the entire pour has not achieved initial set. If any portion of the deck concrete has achieved initial set, the screed cannot be rolled across the bridge deck until the concrete develops a compressive strength of at least 1,500 psi. Construction equipment is allowed on bridge approach slabs after the slab concrete develops a compressive strength of at least 3,000 psi and attains an age of at least 7 curing days. See Subarticle 420-15(A) for the definition of "curing day."

Provide evidence that the minimum compressive strengths referred to above are satisfied by nondestructive test methods approved in writing or by compressive strength tests made in accordance with AASHTO T 22 and T 23. Furnish approved equipment for use in nondestructive tests.

Do not place construction equipment, materials or other construction loads on any part of the structure without permission. Submit the proposed plans for placing construction loads on the structure for review, comments and acceptance.

Do not abruptly start or stop concrete trucks on bridge deck. Do not mix concrete in the truck while on the deck. While machine forming concrete barrier rail or parapet, do not place any equipment on the deck except one concrete truck and the equipment necessary to place the concrete. Allow concrete barrier rail and parapet to attain a compressive strength of 3,000 psi before placing any traffic on the deck other than equipment referenced above necessary to construct any remaining barrier rail or parapet.

420-21 MEASUREMENT AND PAYMENT

Class ____ Concrete will be measured and paid as the number of cubic yards of each class that is incorporated into the completed and accepted structure except as indicated below. The number of cubic yards of concrete is computed from the dimensions shown in the plans or from revised dimensions authorized by the Engineer. When the foundation material is rock, the number of cubic yards of footing concrete is computed by the average end area method using the lower limits established for foundation excavation. The volume of concrete displaced by piles other than steel piles is not included in the quantity to be paid.

Grooving Bridge Floors will be measured and be paid as the actual number of square feet shown in the plans. Where the plans are revised, the quantity to be paid is the quantity shown on the revised plans.

Reinforced Concrete Deck Slab and *Reinforced Concrete Deck Slab* (*Sand Lightweight Concrete*) will be measured and paid as the number of square feet shown in the plans. No separate payment will be made for furnishing and incorporating calcium nitrite corrosion inhibitor when required by the plans.

The plan quantity is determined from the horizontal surface area using the nominal dimensions and configuration shown in the Layout Sketch for computing surface area as shown in the plans. Measure the transverse dimension out to the slab including raised median and sidewalk sections. Consider concrete diaphragms a portion of the slab. When required by the plans, consider curtain walls, raised medians, sidewalks, pavement brackets, end posts, sign mounts, luminaire brackets and any other concrete appurtenances or expansion joint material a portion of the slab. Concrete barrier rail (including curved end blocks for the concrete barrier rail, when used) is not considered a portion of the slab.

For structural steel spans, the quantities of concrete and reinforcing steel shown in the plans are based on a metal stay-in-place forming method. These quantities include amounts for 1 inch additional concrete due to the corrugation of the metal forms, concrete diaphragms and, when required by the plans, curtain walls, pavement brackets, end posts, raised medians, sidewalks and other required attachments based on the profile grade and plan camber of the girders.

For prestressed concrete girder spans, the quantities of concrete and reinforcing steel shown in the plans are based on the forming method detailed in the plans. These quantities include concrete diaphragms, and, when required by the plans, curtain walls, pavement brackets, end posts, raised medians, sidewalks and other required attachments based on the profile grade and plan camber of girders. The quantities include either CIP slab concrete when the plans are detailed for the prestressed concrete panel forming method or amounts for 1 inch additional concrete due to the corrugation of the metal forms when the plans are detailed for the fabricated metal stay-in-place form forming method and based on the profile grade and plan camber of the girders.

No measurement will be made for concrete or reinforcing steel due to a variation in camber of the girders from the plan camber or for additional quantities required by optional methods of forming.

No separate measurement or payment will be made for furnishing, installing and testing anchor bolts or dowels. Payment at the contract unit prices for the various pay items will be full compensation for all materials, equipment, tools, labor and incidentals necessary to complete the work.

These prices and payments will be full compensation for all items required to construct concrete structures. Remove forms and repair, remove or replace, as directed, concrete containing plastic shrinkage cracks or other defects at no cost to the Department.

Payment will be made under:

Pay Item	**Pay Unit**
Class ____ Concrete	Cubic Yard
Grooving Bridge Floors	Square Foot
Reinforced Concrete Deck Slab	Square Foot
Reinforced Concrete Deck Slab (Sand Lightweight Concrete)	Square Foot

SECTION 422
BRIDGE APPROACH SLABS

422-1 DESCRIPTION

Construct reinforced concrete slabs at bridge approaches, including curbs and sidewalks; furnish and place temporary slope drains; remove existing pavement or approach slab; furnish and place concrete, reinforcing steel, joint filler, sealer and other materials; finish and cure concrete.

Construct the approach slabs after the adjacent bridge deck is cast and before constructing concrete barrier rails or sidewalks.

422-2 MATERIALS

Refer to Division 10.

Item	Section
Curing Materials	1026
Joint Filler	1028-1
Low Modulus Silicone Sealant	1028-3
Portland Cement Concrete	1000
Reinforcing Steel	1070

422-3 CONSTRUCTION METHODS

Construct the subgrade and approach fills in accordance with the contract.

Apply Section 420 to all concrete except as otherwise provided herein. Use Class AA concrete.

Finish and groove the reinforced concrete bridge approach slabs in accordance with Article 420-14; however, for approach slabs with a length of 15 feet or less, the contractor may submit an alternate screed type for approval. Do not groove the approach slabs when grooving the bridge deck is not required.

When grooving is not required, apply a broomed texture to the approach slabs before the concrete becomes non-plastic. Cure bridge approach slabs in the same manner as specified for bridge decks in Subarticle 420-15(B).

Temporarily cover or fill the opening in the joint at the end bent until installation of the joint seal, if applicable. Make sure that the covering or filler provides for drainage off the bridge deck and keeps debris out of the joint and off the end bent cap.

When shown in the plans, construct sidewalks on bridge approach slabs in accordance with plan details. Do not construct sidewalks until sawing the joint at the end bent. Finish the concrete in accordance with Subarticle 420-17(D).

Construct temporary slope drains in accordance with Section 1622. Locate this erosion control item as shown in the Structure plan detail.

Backfill around the approach slabs as soon as practical to prevent erosion adjacent to the slab.

422-4 MEASUREMENT AND PAYMENT

The price and payment below will be full compensation for all items required to construct bridge approach slabs including, but not limited to, those items contained in Article 422-1.

Temporary Slope Drains will be paid in accordance with Article 1622-4.

Bridge Approach Slabs, Sta. ____ will be paid at the contract lump sum price.

Grooving bridge approach slabs will be paid at the contract unit price per square foot for *Grooving Bridge Floors* as provided in Article 420-21.

Payment will be made under:

Pay Item	Pay Unit
Bridge Approach Slabs, Sta. ____	Lump Sum

SECTION 425
FABRICATING AND PLACING REINFORCEMENT

425-1 DESCRIPTION

Furnish, fabricate and place steel reinforcement other than wire reinforcement, including all related materials such as tie wire, separators, wire bar supports, mechanical butt splices for reinforcing steel, and other material for fastening the reinforcing steel in place; galvanize and/or coat where required; and fabricate, cut, bend, place and splice the reinforcement in conformity with the shape and dimensions shown in the plans and as specified in these specifications. Provide epoxy coated reinforcing steel where indicated in the plans.

425-2 MATERIALS

Refer to Division 10.

Item	Section
Epoxy Coated Reinforcing Steel	1070-7
Epoxy Coated Spiral Column Reinforcing Steel	1070-7, 1070-8
Mechanical Butt Splices for Reinforcing Steel	1070-9
Reinforcing Steel Bar Supports	1070-4
Spiral Column Reinforcing Steel	1070-8
Steel Bar Reinforcement	1070-2
Wire Reinforcement	1070-3

425-3 PROTECTION OF MATERIALS

Protect steel reinforcement at all times from damage and make sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials at the time of placement in the work.

Store epoxy coated reinforcing steel bars at the project site at least one foot above the ground on wooden or padded supports placed 10 feet apart, and completely cover with an opaque cloth, canvas or woven fiber reinforced polyethylene white tarp. Do not use solid plastic sheeting. Cover the bars such that adequate ventilation is provided to prevent condensation from forming on the material during storage, and completely protect the bars from direct sunlight. Do not allow water to pond under the epoxy coated reinforcing steel.

Store epoxy coated bars as close as possible to their final location in the structure to prevent coating damage from unnecessary handling.

Do not store epoxy coated bars at the project site from one construction season until the following construction season unless stored in a waterproof enclosure.

425-4 PLACING AND FASTENING

Accurately place reinforcement as shown in the plans and secure firmly in position by wiring at intersections and using metal bar supports, precast mortar blocks or other approved devices of sufficient strength and location to resist distortion.

Tie reinforcing bars at all intersections except where spacing is less than one foot in both the longitudinal and transverse directions, in which case tie at alternate intersections, as an option. Securely cross tie each intersection of vertical reinforcing steel and spiral reinforcement for drilled piers with double wire. Use plastic or epoxy coated spiral spacers with epoxy coated spiral column reinforcing steel.

Provide wire bar supports for reinforcing steel in accordance with Article 1070-4 of the proper height to provide the distance from the forms and the proper spacing between rows of steel as indicated in the plans. When required by the plans, epoxy coat bar supports in accordance with Article 1070-7. Provide rust-proofed supporting legs for wire bar supports that rest on the forms as provided in Article 1070-4. When providing rust proofing by plastic protection, make sure that the dipped plastic coating or premolded plastic tips are intact on each bar support leg while concrete is placed.

Cast blocks, of approved shape and dimensions, for holding vertical reinforcement in position from 1:2 mortar or concrete of the same mix used in the member being cast. Cure precast blocks in accordance with Article 420-15 for the water method or the polyethylene sheeting method. To hold vertical bars in position, use precast blocks which have embedded wires extending from the block a sufficient distance to tie to the bar.

Roll wire reinforcement flat before placing concrete, unless otherwise shown in the plans. Hold wire reinforcement firmly in place against vertical and transverse movement by acceptable means.

Weld reinforcing steel in accordance with the American Welding Society's *Reinforcing Steel Welding Code AWS D1.4* and only where required in the contract. Obtain written approval for additional welding. Do not use tack welds unless approved.

Exercise extreme care when transporting, handling, placing and tying epoxy coated reinforcing steel to prevent damage to the coating.

Immediately before placing epoxy coated reinforcing steel bars in the forms, visually inspect each bar for coating damage. Ensure that all coating damaged by any cause is satisfactorily repaired, including hairline cracks and that each bar, including bar ends, is completely encapsulated in epoxy coating or patching material at the time of concrete placement. Make coating repairs as described in Subarticle 1070-7. Do not coat more than 5% of surface area on each bar with patching material including patching due to damage to the coating by the coater, fabricator, transporter or contractor. The patching limits do not include holiday repairs, overspray and coated ends of bars.

Do not expose epoxy coated reinforcing steel to the weather for more than 30 days after placing in the forms. If the concrete is not placed within 30 days, cover the epoxy coated reinforcing steel as required by Article 425-3.

Place, allow sufficient time for inspection and obtain approval from the Engineer for reinforcement in any member before placing concrete. Do not place reinforcement while placing concrete in the member involved.

425-5 SPLICING

(A) General

Furnish all reinforcement in the full lengths indicated in the plans.

Do not splice bars without written approval except where shown in the plans.

Provide splice lengths as shown in the plans.

Overlap sheets of wire reinforcement with each other as shown in the plans or approved working drawings to maintain a uniform strength and securely fastened to each other at the ends and edges. Lap at least the dimension of one wire reinforcement.

(B) Mechanical Butt Splices

Provide mechanical butt splices for reinforcing steel in accordance with Article 1070-9 when called for in the plans.

Splice the bars in accordance with the manufacturer’s recommendations using the manufacturer’s required accessories as approved by the Engineer. Use mechanical butt

splices only where specified in the plans. Any additional splices require approval by the Engineer.

425-6 MEASUREMENT AND PAYMENT

Reinforcing Steel or *Epoxy Coated Reinforcing Steel* will be measured and paid as the number of pounds of steel bar reinforcement, reinforcing wire and plain rods shown in the plans as being necessary to complete the work. Where the plans are revised, the quantity to be paid is the quantity shown on the revised plans. Where directed to deviate from the plans; changing the quantities of steel bar reinforcement, reinforcing wire and plain rods necessary to complete the project; the quantity shown in the plans is increased or decreased by the theoretical computed weight of reinforcing steel added or subtracted by the change.

Spiral Column Reinforcing Steel or *Epoxy Coated Spiral Column Reinforcing Steel* will be measured and paid as the number of pounds of spiral column reinforcing shown in the plans as being necessary to complete the work. Where the plans are revised, the quantity to be paid is the quantity shown on the revised plans. Where directed to deviate from the plans; changing the quantities of steel bar reinforcement, reinforcing wire and plain rods necessary to complete the project; the quantity shown in the plans is increased or decreased by the theoretical computed weight of spiral column reinforcing steel added or subtracted by the change.

The quantity of reinforcing steel or spiral column reinforcing steel shown in the plans is an estimate based on the theoretical computed weight of the steel necessary to complete the work and will be used for pay purposes. No revision in this pay quantity nor any adjustment in the contract unit price for *Reinforcing Steel* or *Spiral Column Reinforcing Steel* will be made except where revisions in the plans affect the quantity of reinforcing steel or spiral column reinforcing steel necessary to complete the work or where an error has been found in the estimate of steel shown in the plans.

If the elevation of the top of a footing or the tip of a drilled pier is raised by a distance not exceeding 3 feet, and the reinforcing steel or spiral column reinforcing steel for the substructure unit has been fabricated before the elevation was raised, no decrease in the quantity of steel to be paid will be made from the theoretical weight of steel shown in the plans for the original substructure unit. Under the above circumstances the provisions of Article 109-6 will not apply as the steel not used in the work shall remain the property of the Contractor and payment for such steel will be made as provided above. No separate payment will be made for the cost of cutting off reinforcing steel or spiral column reinforcing steel as payment at the contract unit price per pound for the item of *Reinforcing Steel* or *Spiral Column Reinforcing Steel* will be full compensation for cutting the steel.

There will be no direct payment for reinforcing steel when the basis of payment or compensation clause applicable to a particular section of the specifications states that payment at the contract unit or lump sum prices for the work covered by such section will be full compensation for furnishing and placing reinforcing steel.

No separate payment will be made for the work of furnishing and placing wire reinforcement as payment at the contract unit price for the item or items covering the structure containing the wire reinforcement will be full compensation for such work.

These prices and payments will be full compensation for all items required to fabricate and place reinforcement.

Payment will be made under:

Pay Item	**Pay Unit**
Reinforcing Steel	Pound
Epoxy Coated Reinforcing Steel	Pound
Spiral Column Reinforcing Steel	Pound
Epoxy Coated Spiral Column Reinforcing Steel	Pound

SECTION 430
ERECTING PRESTRESSED CONCRETE MEMBERS

430-1 DESCRIPTION

Furnish and erect precast-prestressed concrete bridge members other than piling. Furnish, galvanize, place and paint, as applicable, bearing components, anchor bolts, washers, nuts, structural and reinforcing steel, miscellaneous hardware, bearing assemblies and all other materials; handle, transport and store materials; furnish erection drawings; set bearings and anchorage; grout and erect and install the bridge members and all other items necessary to complete the erection in accordance with the contract.

When used in this section, the term “prestressed concrete” refers to precast, pretensioned, prestressed concrete.

430-2 MATERIALS

Refer to Division 10.

Item	Section
Bearing Plate Assemblies	1072-3
Elastomeric Bearings	1079-2
Grout, Type 3	1003
Organic Zinc Repair Paint	1080-7
Precast-Prestressed Members	1078
Structural Steel	1072

430-3 HANDLING AND STORAGE

Take special care in handling, transporting and storing prestressed members. Members damaged while handled or transported will be rejected unless repaired to the satisfaction of the Engineer.

Handle members at the bearings or at pick-up points designated in the plans unless using other methods approved in writing.

Transport prestressed concrete bridge girders in a horizontal upright position. Provide support and bracing for each girder during transportation and storage that matches girder support locations in the final position within the structure.

430-4 METHODS AND EQUIPMENT

Use methods and equipment to install prestressed members that result in safe and satisfactory installation.

430-5 BEARINGS AND ANCHORAGES

Supply elastomeric bearings, when required by the plans, meeting Section 1079.

Set steel sole plates level in exact position with full and even bearing on the bearing pad.

Accurately set anchor bolts in accordance with Subarticle 420-12(A).

When welding the sole plate to the embedded plate in the girder, use temperature indicating wax pens or other suitable means, to ensure that the temperature of the sole plate does not exceed 300°F. Temperatures above this may damage the elastomer.

Before welding, grind the galvanized surface of the portion of the embedded plate and sole plate that require welding. After welding, repair damaged galvanized surfaces in accordance with Article 1076-7.

430-6 ERECTION AND INSTALLATION

(A) General

Erect prestressed concrete members by methods that satisfy the handling requirements specified in Article 430-3.

Perform field welding in accordance with Article 1072-18 only when required in the plans.

When concrete is cast in contact with prestressed members, thoroughly clean and wet the surface of the prestressed member which contacts the fresh concrete for at least 2 hours just before casting the fresh concrete.

After casting and finishing all concrete, thoroughly clean the prestressed members.

(B) Cored Slabs and Box Beams

Prior to setting cored slabs or box beams, check the top of cap with a straightedge to ensure full and even bearing of the bearing pads. Correct any deviations by grinding or other approved methods before setting prestressed members. When erecting prestressed cored slabs and box beams, use methods that ensure a tight fit between adjacent slabs.

The post tensioning system shall use 0.6 inch diameter strands. Transverse post tensioning strands shall be tensioned to a final load of 43,950 lbs. Strands shall be greased and placed in a non-corrosive 0.6 inch diameter, 1/16 inch minimum wall thickness black polyethylene pipe meeting ASTM D2239. Cut and remove the black polyethylene pipe and thoroughly clean off all grease from the strands in the area of the recesses at the ends of the strands where the strand vise is located and grout is applied. Position the jack and tension along the same axis as the strand. Utilize a double acting jack which tensions the strand and properly seats the wedges after achieving tension. Ensure an approved testing facility calibrates the jack within 12 months of the testing date and provide the Engineer a certificate of calibration. Tension the strands in the diaphragm nearest mid-span first to approximately 50% of the final tension load. Proceed to tension strands to 50% in the adjacent diaphragms. Continue the tensioning operation in a systematic manner along the length of the span until all strands are tensioned to approximately 50%.

After all tensioning in a span is completed to approximately 50% of the final tension load, fill the shear key with an approved Type 3 grout. After the grout has cured and reaches design strength, complete the tensioning of each strand to 43,950 lbs, utilizing the same systematical order. Prior to release of the jack on each strand, hold the pressure for 2 minutes to ensure no loss in tension occurs. Finally, cut ends of strands and grout the recesses at the ends of the transverse strands and dowel holes with an approved Type 3 grout. Flame cutting of the strands is not allowed.

After tensioning, grouting and curing, obtain approval before placing material and equipment on the cored slab or box beam spans. Support cranes or other equipment exceeding the legal load limit on mats. Submit to the Engineer for review a detailed drawing for the mats that are intended for use on the spans and a complete description of the equipment that is intended for placement on the mats. Supply and construct mats at no additional cost to the Department.

430-7 PAINTING

Clean, by hand or with power tools, and paint with 2 coats of non-aerosol organic zinc repair paint all ungalvanized steel surfaces or damaged coated surfaces, not encased in concrete in accordance with Section 442. Provide a minimum dry thickness of each coat of paint of 1.5 mils.

430-8 MEASUREMENT AND PAYMENT

__" *Prestressed Concrete Girders* will be measured and paid as the number of linear feet of prestressed concrete girders estimated in the plans as being necessary to complete the project.

Modified __" Prestressed Concrete Girders will be measured and paid as the number of linear feet of Modified Bulb-Tee prestressed concrete girders estimated in the plans as being necessary to complete the project.

FIB __" Prestressed Concrete Girders will be measured and paid as the number of linear feet of Florida I-Beam prestressed concrete girders estimated in the plans as being necessary to complete the project.

3'-0" x __'-__" Prestressed Concrete Cored Slabs will be measured and paid as the number of linear feet of prestressed concrete cored slabs estimated in the plans as being necessary to complete the project.

3'-0" x __'-__" Prestressed Concrete Box Beams will be measured and paid as the number of linear feet of prestressed concrete box beams estimated in the plans as being necessary to complete the project.

Elastomeric Bearings will be paid at the contract lump sum price.

These prices and payments will be full compensation for all items required to erect prestressed concrete members, including, but not limited to, those items contained in Article 430-1.

Payment will be made under:

Pay Item	Pay Unit
__" Prestressed Concrete Girders	Linear Foot
Modified __" Prestressed Concrete Girders	Linear Foot
FIB __" Prestressed Concrete Girders	Linear Foot
3'-0" x __'-__" Prestressed Concrete Cored Slabs	Linear Foot
3'-0" x __'-__" Prestressed Concrete Box Beams	Linear Foot
Elastomeric Bearings	Lump Sum

SECTION 440
STEEL STRUCTURES

440-1 DESCRIPTION

Construct steel structures and steel structure portions of composite structures in conformity with the lines, grades and dimensions shown in the plans and as specified in the specifications.

Furnish, fabricate, galvanize, deliver, place, erect, clean, shop paint and field paint structural metals and all other materials; furnish, erect and remove falsework; set bearings and anchorage; weld and furnish all materials for and assemble all structural joints. Structural metals include structural steels, metallic electrodes, steel forgings and castings, gray iron and malleable iron castings, drain pipes and any incidental metal construction.

Before starting work, inform the Engineer as to the proposed method of erection.

440-2 MATERIALS

Refer to Division 10.

Item	Section
Anchor Bolts	1072-4
Bearing Plate Assemblies	1072-3
Elastomeric Bearings	1079-2
High Strength Bolts, Nuts, Washers and Direct Tension Indicators	1072-5
Organic Zinc Repair Paint	1080-7
Preformed Bearing Pads	1079-1
Steel Pipe	1074-6
Structural Steel	1072
Welded Stud Shear Connectors	1072-6

440-3 HANDLING AND STORING MATERIALS

Move, handle and store all structural steel, in the shop, in the field and while being transported in accordance with Article 1072-9.

440-4 BEARINGS AND ANCHORAGES

Supply preformed bearing pads and elastomeric bearings, as required by the plans and in accordance with Section 1079.

Set steel masonry plates level in exact position with full and even bearing on the preformed bearing pad.

Accurately set anchor bolts in accordance with Subarticle 420-12(A).

Make sure that the location of anchors and setting of bearings take into account any variation from mean temperature at time of setting and anticipated lengthening of bottom flange due to dead load after setting, so at mean temperature and under full dead load the bearings are in a vertical position and anchor bolts at expansion bearings center in their slots. Mean temperature is 60°F unless otherwise stipulated in the plans. Do not restrict full and free movement of the superstructure at the movable bearings by improperly setting or adjusting bearings or anchor bolts and nuts.

440-5 STRAIGHTENING BENT MATERIAL, HEAT CURVING AND HEAT CAMBERING

Straighten bent material, heat curve and heat camber as approved and in accordance with Article 1072-10.

440-6 FIELD ERECTION

The Contractor is responsible for the safe erection of steel girders, diaphragms, and cross-frames, including the structural adequacy and stability of the bridge system during all phases of erection. Girders shall be stabilized with falsework, temporary bracing, holding cranes, or a combination thereof until a sufficient number of adjacent girders are erected with diaphragms or cross-frames connected to provide necessary local and global stability, and make the structure self-supporting. When required in the contract documents, the Contractor shall submit Erection Plans and Procedures, including associated Erection Engineering Calculations to the Department for review and approval.

Report immediately any error in the shop fabrication or deformation resulting from handling and transporting, which prevents the proper assembling and fitting up of parts by more than the moderate use of drift pins or by more than a moderate amount of reaming, chipping or cutting. Correct errors in the presence of the Engineer by approved methods. Do not perform hammering which injures or distorts the members.

Before assembling the members, clean and dry to touch all bearing surfaces and permanently contacting surfaces.

For bolted splices and field connections, initially fill 50 percent of the holes with a combination of erection bolts and full size erection pins but at least half (25% of the holes) shall be bolts. Sufficient pins shall be used near outside corners of splice plates, at member ends near splice plate edges, and in corners of diaphragm or cross-frame connections to ensure proper vertical and horizontal alignment. Filled holes shall be uniformly distributed between the web and flange connections such that approximately 50 percent of the web connections are filled and approximately 50 percent of the flange connections are filled. For diaphragms or cross-frames, the filled holes should be uniformly distributed between all the bolt groups connecting the diaphragm or cross-frame to the primary member. Ensure all splices are brought to the correct elevations before permanent fastening. For bolted connections use erection bolts with the same nominal diameter as the permanent fasteners, and use cylindrical erection pins which are 1/32 inch larger. Use permanent bolts as erection bolts if desired. Do not reuse permanent bolts for

final installation unless the nut is easily turned onto the bolt for the full threaded length by hand and without the use of tools.

Permanent bolts shall be installed in all the remaining holes of the connection and the entire connection brought to a snug condition prior to permanent tensioning or crane release. Snug tight is defined as being attained after a few impacts of an impact wrench or the full effort of an ironworker with an ordinary spud wrench. Snugging shall progress systematically from the most rigid part of the connection to the free edges. After all bolts have been snugged, every bolt in the connection should be revisited and resnugged if necessary, since snugging of an adjacent bolt may relieve tension on an earlier snugged bolt. As an option, fully tensioned temporary fit up bolts may be used to help bring the plies in full contact prior to permanent fastening. The requirement for 100% connection prior to crane release may be reduced if calculations submitted with the approved erection procedure support a reduced percentage of bolts. However, the minimum of 50% combination of erection pins and bolts will still be required.

Primary member splice connections that are made up on the ground (prior to erection) shall be 100% complete and fully tensioned, in the no-load condition, prior to any lifting operation.

Cross-frames and lateral bracing on curved girder bridges shall be fully tensioned before crane release to ensure stability during erection, unless otherwise allowed on the approved erection plans.

Use temporary bolts, including, but not limited to, erection and fit-up bolts, supplied with square or hexagon heads and square or hexagon nuts. The use of hexagon head temporary bolts and nuts is allowed, but paint both the head and nut with a durable yellow paint before installation.

Field reaming may be used to correct minor misfits, without prior approval of the Engineer, subject to the following limitations:

(A) Ream no more than 10 percent of the holes in a connection.

(B) Ream no single hole more than 1/16” larger than the plan nominal hole diameter.

(C) Assemble and securely hold connecting parts together.

(D) Perform reaming with twist reams placed perpendicular to connecting parts.

(E) Remove burrs on the outside surfaces.

(F) Repair coatings in accordance with Section 442 of the specifications.

For members with defects that cannot be corrected by reaming within these limits or that prevent the proper assembly of parts, the Contractor shall submit proposed corrective methods to the Engineer for review and approval. All field reaming shall be documented and performed in the presence of the Engineer. Upon completion, documentation of field reaming shall be submitted to the Engineer for record purposes.

The use of erection bolts for field welded joints is allowed. Use erection bolts that are galvanized when the finish paint is applied in the structural steel fabrication shop and meet ASTM F3125 Grade A325. Supplement these bolts with clamps as necessary to meet the AWS Specifications. Where unpainted AASHTO M 270 Grade 50W structural steel is used, use erection bolts meeting ASTM F3125 Grade A325.

After field welding the connection, leave the erection bolt in place with at least the minimum bolt tension shown in Table 440-1. Use holes that are 3/16 inch larger than the nominal erection bolt diameter.

440-7 FIELD WELDING

Perform field welding only when called for in the plans and in accordance with Article 1072-18.

Remove paint, galvanizing or other coating from the weld heat affected zone at the location of field welds by blast cleaning (SSPC SP-6 finish) or power tool cleaning to bare metal, (SSPC SP-11 finish) just before welding. Clean sufficiently to bare metal to prevent contamination of the weld by the coating.

440-8 CONNECTIONS USING HIGH STRENGTH BOLTS

(A) General

This article covers the assembly of structural joints using plain or galvanized high strength carbon steel bolts with suitable nuts and washers tightened to a high tension. Use bolt holes that conform to Article 1072-16.

Protect bolts, nuts and washers from moisture during storage and so they show no signs of rust at the time of installation.

Make sure that plain bolts and washers have a thin coat of lubricant at the time of installation.

Use nuts that are pre-waxed by the producer or supplier before shipping to the project.

Apply beeswax, stick paraffin or other approved lubricant to the threads of galvanized bolts just before installing the bolts.

Use bolt, nut and washer (when required) combinations from the same rotational-capacity lot.

Perform the rotational-capacity test described in Subarticle 1072-5(D)(4) on each rotational-capacity lot before the start of bolt installation. Use hardened steel washers as required by the test.

(B) Bolted Parts

Make sure that the slope of surfaces of bolted parts in contact with the bolt head and nut does not exceed 1:20 with respect to a plane normal to the bolt axis. Make sure bolted parts fit solidly together when assembled and are not separated by gaskets or any other interposed compressible material. Provide contact surfaces, including those adjacent to the bolt heads, nuts or washers, that are free of scale, dirt, burrs, oil, lacquer, loose rust, rust inhibitor, other foreign material and other defects that prevent solid seating of the parts.

(C) Installation

(1) Bolt Tensions

Tighten each fastener to provide at least the minimum bolt tension shown in Table 440-1. Tighten fasteners with direct tension indicators in accordance with Subarticle 440-8(C)(5), or if permitted, by the use of load indicating bolts as provided in Subarticle 440-8(C)(3).

TABLE 440-1
REQUIRED BOLT TENSION

Bolt Size, Inches	Minimum Bolt Tension, Pounds
1/2	12,050
5/8	19,200
3/4	28,400
7/8	39,250
1	51,500
1 l/8	64,900
1 1/4	82,400
1 3/8	98,200
1 1/2	119,500

In situations where the nut cannot be properly accessed due to lack of clearance, tighten by turning the bolt while preventing the nut from rotating. Use impact wrenches, if necessary, with adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.

(2) Washers

Make sure all fasteners have a hardened washer under the element, nut or bolt head, turned in tightening. Use galvanized washers when galvanized nuts and bolts are required. As an exception to the above, use special washers for oversize, short-slotted and long-slotted holes in accordance with Subarticle 1072-16(H).

Where an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, use a smooth beveled washer to compensate for the lack of parallelism.

(3) Load Indicating Bolts

Tightening by use of a load indicating bolt system is permitted provided it can be demonstrated by an accurate direct measurement procedure that the bolt is tightened in accordance with Table 440-1. Tighten by approved methods and procedures.

(4) Galvanized High Strength Bolts

Use mechanically galvanized high strength bolts in all bolted connections for painted structural steel.

Install galvanized high strength bolts carefully so shop painted surfaces are not scarred or otherwise damaged.

Repair galvanized surfaces that are abraded or damaged by thoroughly wire brushing the damaged area and removing all loose and cracked coating, after which give the cleaned area 2 coats of non-aerosol organic zinc repair paint, in accordance with Article 1076-7.

Galvanized or coated bolts of any grade that have been previously tensioned up to and including snug tight and subsequently loosened shall not be reused.

(5) Direct Tension Indicators (DTI's)

Supply DTI's in accordance with ASTM F959 and Article 1072-5.

Furnish the Engineer with at least four 0.005 inch metal feeler gauges for each container of DTI's shipped before beginning installation.

Make sure that the lot number on the containers of DTI's is for the same lot number tested as indicated on the test documents.

Furnish to the Engineer 3 samples of load indicating washers from each lot number, each size and type for tests and 4 each of the metal feeler gauges required for performing the tests.

Install the DTI under the bolt head. If it is necessary to install the DTI under the nut, or if the bolt head shall be turned, install additional hardened washers between the nut or bolt head and the DTI.

Provide a calibrated Skidmore-Wilhelm Tension Indicating Device (or an acceptable equivalent device) on the project for determining the tension imposed on a fastener when the protrusions on the DTI are properly compressed. Ensure an AASHTO accredited testing facility calibrates the device within 12 months of the testing date and provide the Engineer a certificate of calibration.

Test 3 samples from each lot of DTI's in the presence of the Engineer. Achieve a minimum bolt tension of 5% greater than that required by Table 440-1.

Do not substitute DTI's for hardened steel washers required with short slotted or oversized holes. If desired, use direct tension indicators in conjunction with hardened steel washers.

Install DTI's initially to a snug tight condition in accordance with Article 440-6. After snug tightening of all bolts, such that the plies of steel members are brought into full contact, fully tighten beginning at the most rigid part of the joint and continuing toward its free edges. Ensure that DTI's have not been partially compressed during the snugging process.

For tightening fasteners containing DTI's, use a clean and lubricated wrench. Maintain air supply and hoses in good condition and provide air pressure of at least 100 psi at the wrench.

When tightening the fasteners, ensure that the part of the fastener being restrained from turning does not rotate during the tightening process. Ensure that no portion of the DTI protrusions is accidentally partially flattened before installing in the structural steel joints.

Do not reuse direct tension indicators. If it is necessary to loosen a bolt previously tensioned, discard and replace the DTI.

(D) Inspection

Allow the Engineer the opportunity to observe installation of bolts to determine that the selected tightening procedure is properly used. The Engineer determines when bolts are properly tightened and in the case of direct tension indicator bolts that the correct indication of tension is achieved. After properly tightening bolts, make sure that the end of the bolt is flush with or extended beyond the outer face of the nut.

Do not begin painting in the area of tightened bolts until after bolt inspection is complete.

When using direct tension indicators, proper tension of bolts is inspected by the Engineer by inserting a 0.005 inch thickness feeler gauge provided by the Contractor into the openings between adjacent flattened protrusions of the direct tension indicator. Proper tension is obtained when the number of spaces for which the gauge is refused is equal to or greater than the value shown in Table 440-2.

TABLE 440-2
DIRECT TENSION INDICATOR GAP REFUSAL

Number of Spaces in Washer	Number of Spaces Gauge is Refused
4	2
5	3
6	3
7	4

The gauge shall be refused in all spaces when the direct tension indicator is used under the turned element.

When using direct tension indicators, do not tighten bolts to a no visible gap condition.

At least 10%, but no less than 2 of the bolts in each connection are inspected with feeler gauges. Additionally, all remaining bolts in each connection are visually inspected for proper tightening.

440-9 SURFACE PREPARATION AND PROTECTION OF WEATHERING STEEL

After fabrication, shop clean all weathering steel remaining in the unpainted condition in the completed structure to a SSPC SP-6 finish. Provide a contact surface condition in accordance with Subarticle 442-7(B) at the time of bolt installation.

Protect the structural steel during concreting and any other operations that are particularly hazardous with respect to soiling the steel. Remove any foreign matter which gets on the steel as soon as possible by either solvent cleaning, hand tool cleaning, power tool cleaning, blast cleaning or a combination thereof, as necessary to restore the surfaces to the specified condition.

440-10 MEASUREMENT AND PAYMENT

Approx. ____ Lbs. Structural Steel will be measured and paid at the contract lump sum price. The approximate quantity shown in the contract pay item is an estimate based on the computed weight of the structural steel necessary to complete the work. No measurement for payment will be made for this pay item, and no adjustment in the contract lump sum price will be made for any variation from the approximate quantity shown except for revisions in the plans which affect the quantity of structural steel necessary to complete the work.

When revisions in the plans have been made which affect the quantities of structural steel, adjustments in compensation will be made by supplemental agreement.

When the contract includes the item of *Painting of Structural Steel*, all work of painting except for shop painting will be paid as provided in Article 442-15 and payment for shop painting will be included in the contract lump sum price for *Approx. ____ Lbs. Structural Steel*. When the contract excludes the item of Painting of Structural Steel, payment at the contract lump sum price for *Approx. ____ Lbs. Structural Stee*l will be full compensation for both shop and field painting.

Elastomeric Bearings will be paid as provided in Article 430-8.

The price and payment will be full compensation for all items required to construct steel structures including, but not limited to, those items contained in Article 440-1.

Payment will be made under:

Pay Item	Pay Unit
Approx. ____ Lbs. Structural Steel	Lump Sum

SECTION 442
PAINTING STEEL STRUCTURES

442-1 DESCRIPTION

Paint steel structures and properly prepare metal surfaces; apply, protect and dry paint coatings; protect pedestrian, vehicular, water or other traffic upon or underneath the structure; protect all portions of the structure and adjacent work against disfigurement by splatters, splashes, overspray and smirches of paint or of paint materials; apply paint in the shop and field; and furnish blast cleaning equipment, paint spraying equipment, brushes, rollers, paint cleaning abrasives, cleaning solvents, tools, tackle, scaffolding, labor and any other materials, hand or power tools, inspection equipment and personal protective and safety equipment necessary for the entire work.

442-2 MATERIALS

Refer to Division 10.

Item	Section
Abrasive Materials for Blast Cleaning	1080-12
Paint and Paint Materials	1080

442-3 DEFINITIONS

Define “corner” as the intersection of 2 surfaces that are not in the same plane. Define “inaccessible areas” as partially or completely enclosed surfaces, the majority of which are not visible without the use of special devices such as mirrors. Define “sharp edge” as a corner on a steel section that ends in a point or edge and appears able to cut human flesh. Define “raised

weld" as fillet welds or groove welds that have not been ground flush. Define "stripe coat" as an additional coat of paint applied to the edges, raised welds, outside corners and areas difficult to coat by spray before or after a full coat is applied to the surface.

442-4 SUBMITTALS

Submit the facilities quality control plan for process control that identifies the material stage, inspection ratio, production verification, inspection interval, minimum acceptable level of quality, quality control verification documentation, and work schedule. Submit blast media certificates of conformance in accordance with the requirements of SSPC AB-1 and or SSPC AB-3 as supplied by the abrasive supplier or the laboratory, including results of testing to substantiate the certification.

Submit Department test reports for each batch of paint to be used on the project, product data sheets and SDS sheets for paint and solvents used.

Submit repair procedures conforming to the coating manufacturer's written recommendations for the Owner's approval. Repairs to the final coat must result in acceptable, uniform gloss and color on visible surfaces. The Owner shall have final authority concerning the coating's uniformity and acceptable appearance.

These submittals may be generic in nature to address in-process non-conforming findings and should address at a minimum the following conditions: excessive surface profile, excessive millage, low millage, pinholing, runs, drips, sags, curtains and physically damaged areas.

All repair procedures shall comply with the requirements of SSPC PA-1 and SSPC PA-2 as applicable and distinguish between localized (one square foot or less) and non-localized areas.

442-5 PROTECTION OF WORK

Protect all parts of the structure against disfigurement by splatters, splashes, overspray and smirches of paint or of paint materials. Assume responsibility for any damage or disfigurement caused by operations to vehicles, persons or property, including plants and animals; and provide protective measures to prevent such damage.

Thoroughly clean and restore any surface or surfaces disfigured by splatter, overspray, splashes, smirches or other defects to its original condition.

Restore any damaged structure or surface to its original condition.

If traffic dust or other airborne particulates originating from earthen and/or gravel shop floors, abrasive blasting equipment and/or as determined by the Engineer is considered to be detrimental to the work; the shop shall take necessary precautions to prevent the accumulation of dust and dirt on blasted and freshly painted surfaces.

442-6 QUALITY CONTROL (QC)

Shop and field applicators are required to conduct and document quality control inspection of the painting, including measurements of temperature, dew point, surface profile and paint thickness. Quality control personnel shall have access to applicable project specific requirements applicable to the coating system being applied. Personnel performing or overseeing the QC tests for this work shall be qualified in accordance with the *Structural Steel Shop Coatings Program*. All referenced standards outlined in the *Structural Steel Shop Coatings Program* including appendices (as determined by the Engineer) are considered mandatory for shop and field applications.

442-7 SURFACE PREPARATION

(A) Blast Cleaning

The blast profile shall be angular and between 1.0 and 3.0 mils when measured on a smooth steel surface. The degree of cleaning required shall be SSPC SP-10 unless otherwise noted. SSPC VIS-1 shall be used as a visual standard. In any dispute, the written definition set

forth in the SSPC SP-10 standard shall take precedence over reference photographs and comparators shown in SSPC VIS-1.

Check abrasives daily for contaminants or as otherwise directed by the Engineer. Prior to any surface preparation the Quality Control inspector shall verify that abrasive material meets the cleanliness requirements of SSPC AB-1, SSPC AB-2 and or SSPC AB-3 depending on the abrasive material used.

Blast clean by centrifugal or forced air blasters. When using forced air blasters use blast nozzles with a minimum 5/16" orifice and operate at no less than 100 psi when measured with a needle gauge at the nozzle. Use dry blasting for all blast cleaning. Select a size or grade of abrasive that provides the specified finish and profile meeting Article 1080-12.

Perform blast cleaning operations so no damage is done to partially or entirely completed portions of the work.

After blasting, brush the surface with clean brushes made of hair, bristle or fiber; blow off with compressed air; or clean by vacuum so any traces of blast products from the surface and any abrasive from pockets and corners are removed. Perform surface inspection once all blast abrasive and dust is removed from surface to be coated.

Use compressed air for nozzle blasting that is free of detrimental amounts of water or oil. Provide adequate separators and traps. Verify cleanliness of air before blasting operations in accordance with ASTM D4285.

Examine the blast cleaned surface for any traces of oil, grease or smudges deposited in the cleaning operations. If present, remove them by SSPC SP-1 or an approved method. Ensure the degree of cleanliness and profile are approved by the Engineer before painting. Verify the removal of oil and grease in accordance with ASTM F22.

Seal all journals, bearings, motors and moving parts to the Engineer’s satisfaction against entry of abrasive dust before blast cleaning near bridge machinery.

Prime all blast cleaned surfaces to be painted no later than 8 hours after blast cleaning is complete. Re-clean the cleaned surfaces that contain rust or are contaminated with foreign material before painting or bolting to the original surface preparation specifications.

(B) Hand or Power Tool Cleaning

Thoroughly remove loose paint, rust, scale, dirt, oil, grease and other detrimental substances by hand cleaning (SSPC SP-2), power tool cleaning (SSPC SP-3) or any combination of these methods. Hand cleaning includes the use of metal brushes, grinders, sanders or any approved combination of these tools. Use bristle or wood fiber brushes to remove loose dust.

442-8 PAINT SYSTEMS

Department approved paint systems are found in the *Structural Steel Shop Coatings Program*.

Use all paints and solvents for shop and field application that are produced by the same manufacturer.

Use approved/qualified paint products found in Section 1080. Apply the paint system required by the plans.

442-9 APPLICATION OF PAINT

(A) General

Unless otherwise permitted, apply all paint by spraying, except apply the stripe coat by brush or roller. The use of a brush or roller is permitted to make minor repairs to the primer.

Make sure each coat of paint is in a proper state of cure or dryness before applying the succeeding coat.

Before successive coating application remove all contaminates, dry spray/overspray, paint splatter and other non-adherent paint shall be removed before applying successive coating layers. When necessary, clean each coat of paint in accordance with Subarticle 442-7(B).

When a stripe coat is required, apply a 2 inch stripe by brush or roller to all exposed edges of steel before applying the finish coat. Locate the edge or corner in the approximate center of the paint stripe.

Mechanically or hot dip-galvanized fasteners that exhibit damage during installation or coating operations shall be spot primed with a Department approved zinc rich coating compatible with subsequent coatings.

If personnel performing the coating operations does not exhibit reasonable conformance to protect the work during application, storage and/or construction, the Engineer may require a finish coat at no additional cost to the Department. The final acceptances of all repairs, to include aesthetics, will be approved at the Engineer's discretion.

(B) Application Conditions

Unless the paint manufacturer's application instructions are more restrictive, obtain written permission to apply paint if the following conditions exist: temperature of the air or metal is not at least 40°F and rising for inorganic zinc primers or 50°F and rising for acrylic paint or coal tar epoxies, when freezing weather is forecast during the drying period, or when the metal is hot enough to cause the paint to blister or produce a porous paint film.

Do not apply paint or perform any surface preparation without the Engineer's approval when the air is misty; in the rain, snow, fog, when wind velocity is continuously greater than 10 mph or when the steel surface temperature is less than 5°F above the dew point. The humidity shall be less than 85% and lower when applying acrylic paints or until the paint is dry and/or cured or until weather conditions permit its exposure in the open.

Obtain written permission from the Engineer to apply field coats of paint between November 15 of one year and April 15 of the following year inclusive. Do not apply any coating above or below the manufacturers recommended application temperatures or during a period when an ambient temperature outside the recommended range is predicted during the drying and curing period of the paint.

Harsh environments as determined by the Engineer may necessitate recleaning during or between paint applications.

(C) Storage Conditions

Provide adequate and safe storage for all paint and equipment. Do not expose paint materials to rain, excessive condensation, long periods of direct sunlight or temperatures above 110°F or below 40°F. Follow the manufacturer's storage requirements if more restrictive. In addition, the Quality Control inspector shall place a device which records the high, low and current temperatures inside the storage location and maintain a daily record and made available to the Engineer. Replace paint damaged by any cause.

Coating material shall arrive at the coating facility in sealed containers clearly marked with the type, batch and/or lot numbers properly labeled on the container. There shall be no modification of the coating except upon and in accordance with the express written stipulation by an authorized representative of the coating manufacturer and with specific approval of the Engineer. At the Department's option, the inspector may randomly collect a sample of the coating used on the project if the material has been exposed to extremely high/low temperatures and/or exhibits excessive skinning in the container.

(D) Mixing Paint

Mix paint in accordance with the manufacturer's instructions and Article 1080-1. Do not mix partial kits.

(E) Thinning

Thinning of zinc and coal tar products shall be in accordance with the coating manufacturer's recommendations. For acrylic applications, there shall be no thinning of coating products. The paint products specified in Section 1080 do not require thinning when applied under normal conditions. Obtain written approval for any thinning necessitated by weather conditions or other causes. Only those thinners approved by the paint manufacturer as described in the application instructions are permitted.

(F) Spray Application

Use equipment for spray application of paint that is suitable for the intended purpose, capable of properly atomizing the paint, and equipped with suitable pressure regulators and gauges. Use air caps, nozzles and needles recommended by the manufacturer of the equipment for the material being sprayed. Keep the equipment in satisfactory condition to permit proper paint application. In closed or recirculating paint spray systems where gas under pressure is used over the liquid, use an inert gas, such as nitrogen.

Provide and drain periodically during operations. Use adequately sized traps or separators to remove oil and water from the compressed air. Make sure that the air from the spray gun impinging against the surface shows no water or oil.

Use a continuously agitated spray pot. Adjust the agitator to reach within 2 inches of the bottom of the spray pot and be in motion at all times during paint application. Provide sufficient motion to keep the paint well mixed.

(G) Stripe Coat

When a stripe coat is required, apply a 2 inch stripe by brush or roller to all exposed edges of steel before applying the finish coat. Locate the edge or corner in the approximate center of the paint stripe. Brush apply stripe coat application on bolts, nuts, raised welds and other obstructed locations. Roller apply stripe coat only on structural shape edges.

442-10 SHOP PAINTING

Shop painting is the painting of structural steel in an enclosed shop or plant before shipment to the site of erection. Use only NCDOT approved shop coating facilities meeting the requirements outlined in the current edition of the *Structural Steel Shop Coatings Program*. This program is available on the Materials and Tests website. The work in this section applies to previously uncoated steel and includes the proper preparation of the metal surfaces and the application, protection and cure/drying of coatings. Complete all shop fabrication, including welding and attachment of shear connectors, before painting is started.

442-11 THERMAL SPRAYED COATINGS

Thermal sprayed coatings (TSC) and sealer are those coatings applied to metal surfaces in a shop environment. Use only NCDOT approved shop coating facilities meeting the requirements outlined in the current edition of the *Thermal Sprayed Coatings (Metallization) Program*. This program is available on the Materials and Tests website.

Connection angles, plate washers, piles and other steel components that have been thermal spray coated (metallized) with aluminum that will be used on a concrete bridge shall have a barrier coat applied to the faying surfaces and edges of those steel components coming into contact with concrete. Surface preparation and barrier coat paint systems are found in the *Thermal Spray Coatings (Metallization) Program*.

442-12 FIELD PAINTING

(A) General

Field painting is conducted after erection, or when damage to a shop applied coating system is repaired or when steel is otherwise painted outside an enclosed shop environment. The

Structural Steel Shop Coatings Program shall be considered in conjunction with the Project Special Provisions for field applications.

Preconstruction meetings as determined by the Engineer may be required prior to beginning field painting operations.

When blast cleaning structures open to traffic, provide suitable protective enclosures to prevent damage to public and private property. Do not blast directly over traffic without prior approval of the Engineer. If the containment system is not effective in restricting blasting emissions, blasting operations shall cease and deficiencies corrected before work resuming.

(B) Submittals

Prior to beginning work, the Contractor shall furnish the Engineer for review and approval a containment plan for bridge washing, coating inspection plan, bridge protection plan, surface preparation and coating operations.

Disposal of construction materials to include but not limited to paint products, abrasives and wash water shall be in accordance with all current Federal and State regulations. Refer to *NCDOT Guidelines for Managing Bridge Wash Water.*

Do not apply paint over traffic without prior written approval from the Engineer.

Touch-up of painted steel consists of painting with primer and finish paint over all the previously uncoated exposed metal surfaces. When the repair area exceeds one square foot, clean, prime and topcoat damaged areas in accordance with Subarticle 442-7(A); otherwise, clean, prime and topcoat damaged areas in accordance with Subarticle 442-7(B). For systems with shop applied topcoats, apply an additional field appearance coat of finish paint to the outside surface of all exterior beams on steel bridges over highways and navigable waterways.

When an appearance coat of finish paint is required, paint the portion of galvanized high strength bolts on the outside face of exterior beams or girders with primer and appearance coat of the finish paint. Apply the primer to the galvanized high strength bolts by brush, so the primer is not applied to the adjacent finish paint.

At the location of field welds, satisfactorily remove all paint or galvanizing in accordance with SSPC SP-6 (Commercial Blast Cleaning) or SSPC SP-11 (Power Tool Cleaning to Bare Metal). The surface profile after cleaning and prior to coating application shall be a minimum of 1.0 mil.

Clean all contaminants such as soil, concrete, weld splatter, grease or any other deleterious material from bare steel, shop or field coated surfaces before coating operations begin, during coating operations and after the coating is complete. Harsh environments may necessitate re-cleaning during or between paint applications.

(C) Certification

SSPC QP-1 certified contractor shall perform work that is not associated with Hazardous Coating Removal operations.

(D) Quality Control

Field applicators are required to conduct and document quality control inspection as specified in Article 442-6. Personnel performing the QC tests for this work shall possess one of the following minimum qualifications of an Association for Materials Protection and Performance (AMPP) Basic Coating Inspector certification, SSPC Bridge Coating Inspector (BCI) Level I certification, the Department's Bridge Coating Inspection Level I certification or show experience and/or competency in performing these duties.

Quality Control inspectors are required to maintain and record inspections that are required by the contract and as outlined in the *Structural Steel Shop Coatings Program*.

These records shall be available for review and submitted to the Engineer or their representative at the end of each work week or as directed.

442-13 PREPARATION FOR PAINTING GALVANIZED SURFACES

When painting galvanized surfaces is required in the plans, smooth, clean and prepare in accordance with Section 1080 and this section. Provide shop certification in accordance with *Structural Steel Shop Coatings Program* (Shop facilities that are currently certified and in good standing with the American Institute Steel Construction (AISC) /Sophisticated Paint Endorsement (SPE) and/or the Society of Protective Coatings (SSPC) Qualification Procedure Three (QP-3).

Do not paint portions of galvanized piles encased in concrete below ground.

Prior to coating operations submit for review and approval to the Engineer the specific procedure to be utilized for this work. This procedure at a minimum shall address the surface preparation outlined below and meet the ASTM D6386 standard.

Smooth high spots and rough edges, such as metal drip lines, of galvanized surfaces in accordance with ASTM D6386. Clean galvanized surfaces to be painted with a 2,500 psi pressure washer. Allow surfaces to dry completely before beginning surface preparation.

Prepare galvanized surfaces to be painted by sweep blasting in accordance with ASTM D6386. Use an abrasive material and technique that roughens the surface while leaving base zinc layers intact. After sweep blasting, blow down blasted surfaces with clean, dry, compressed air free of contamination.

Apply paint to clean, dry surfaces free of visible zinc oxides or zinc hydroxides within 8 hours of surface preparation.

442-14 REPAINTING OF EXISTING STEEL STRUCTURES

(A) Pollution Control

During field painting operations, use all necessary precautions to prevent dispersion of surface preparation debris, paint or any other material outside the work area due to wind or any other reason.

(B) Hazardous Paint Removal

Should the existing paint system include toxic substances such as red lead oxide, which is considered hazardous if improperly removed, furnish a containment and spill control plan for surface preparation and painting operations and await review and approval of said plan before beginning work. This plan shall meet Class 2A in accordance with SSPC Guide 6. This work shall be performed by a SSPC QP-2 certified contractor.

Monitor air quality. Any visible emissions outside the containment structure or air quality monitoring results exceeding the permissible OSHA action level are justification for suspension of the work. Monitor air quality at random locations within 1 foot to 5 feet from the enclosure in accordance with National Institute of Occupational Safety and Health (NIOSH) Method 7082.

Immediately collect and retain any spilled dust or paint debris in approved containers. If a spill results in soil or water contamination, take all necessary actions to remediate the site to its original state.

(C) Waste Handling

Clean and dispose of any incidental material or equipment that is contaminated as the result of work performed.

(D) Health and Safety Responsibility

In addition to Article 105-11 and Sections 106 and 107, provide effective engineering and work practice controls to insure adequate protection.

Before beginning work, certify to the Engineer that all personnel involved with lead paint removal operations (including rigging and material handling personnel) are properly trained and understand the applicable parts of EPA, 40 CFR Part 745, OSHA Standards, 29 CFR Part 1910 and 29 CFR Part 1926 including any amendments in force at the time of this contract.

442-15 MEASUREMENT AND PAYMENT

When the contract excludes the item of *Painting of Structural Steel*, there will be no direct payment for the work covered by this section.

When the contract includes the item of *Painting of Structural Steel*, all work covered by this section, except for shop painting, will be paid at the contract lump sum price for this item. Payment at the contract lump sum price for *Approx. ____ Lbs. Structural Steel* as provided in Article 440-10 will be full compensation for the work of shop painting.

Repair or replacement of paint damaged by any cause will be incidental to the work of this section.

These prices and payments will be full compensation for all items required to paint steel structures including, but not limited to, those items contained in Article 442-1.

Pollution Control will be paid as the contract lump sum price.

When provided for in the contract, payment will be made under:

Pay Item	Pay Unit
Painting of Structural Steel	Lump Sum
Pollution Control	Lump Sum

SECTION 450
PILES

450-1 DESCRIPTION

Furnish and install piles in accordance with the contract and accepted submittals. Provide steel and prestressed concrete piles and composite piles with both concrete and steel sections shown in the plans. Drive and drill in piles and use pile tips and accessories as shown in the plans. Galvanize, metallize, restrike, redrive, splice, cut off and build up piles and perform predrilling, spudding and high-strain dynamic pile testing (dynamic pile testing) as necessary or required.

Define “pile embedment” as the required pile embedment in the cap or footing and “pile penetration” as the minimum required pile tip elevation or penetration into natural ground, whichever is deeper. Define “natural ground” as below the ground or mud line before constructing any embankments. Define “spudding” as driving or dropping a steel H-pile and then removing it. Define “dynamic pile testing” as high-strain dynamic pile testing.

The estimated pile lengths shown in the plans are sufficient for the minimum required pile embedment and penetration and are estimates of the pile lengths needed for required driving resistance. For prestressed concrete piles, use estimated pile lengths for pile order lengths or the Engineer will provide pile order lengths based on testing prestressed concrete piles with the dynamic pile testing equipment. For bridges with staged construction and pile order lengths based on testing prestressed concrete piles with the dynamic pile testing equipment, order lengths for latter stages will not be provided until pile driving for the previous stage of construction is complete.

450-2 MATERIALS

Refer to Division 10.

Item	Section
Flowable Fill, Non-Excavatable	1000-7
Neat Cement Grout, Type 1	1003
Portland Cement Concrete, Class A	1000
Reinforcing Steel	1070
Steel and Prestressed Concrete Piles	1084-1
Steel Pipe Pile Plates	1072

For drilled-in piles, Class A concrete shall meet Article 1000-3 except as modified herein. Provide concrete with a slump of 6 inches to 8 inches. Use an approved high-range water reducer to achieve this slump.

For composite piles with both prestressed concrete and steel H-pile sections, use prestressed concrete piles and steel H-piles that meet Section 1084. Use steel pile points and splicers that are on the NCDOT APL.

450-3 CONSTRUCTION METHODS

(A) Handling and Storing Piles

Handle, transport and store piles so piles are kept clean and undamaged. Do not use chains, cables or hooks that can damage or scar piles. Do not damage coatings on steel piles. When handling prestressed concrete piles, support and lift piles at pick-up points shown in the plans.

Protect steel piles from corrosion. Store piles horizontally above ground upon platform skids, or other supports, and keep free from standing water, dirt, grease, vegetation and other foreign material.

(B) Pile Installation

If applicable, completely excavate for caps or footings before installing piles. If applicable and unless noted otherwise in the plans, construct embankments to bottom of cap or footing elevations for a horizontal distance of 50 feet from any pile except where fill slopes are within 50 feet of a pile.

Install piles with the following tolerances:

(1) Axial alignment within 1/4 in/ft of vertical or batter shown in the plans,

(2) Horizontal alignment within 3 inches of plan location, and

(3) Pile embedment within 3 inches more and 2 inches less of the embedment shown in the plans.

If necessary, build up prestressed concrete piles or splice steel piles as shown in the plans. Do not use more than 3 sections (2 splices) of steel piling per pile. Cut off piles at required elevations along a plane normal to the axis of the pile as necessary. Do not damage or spall piles when cutting off prestressed concrete piles.

(C) Pile Accessories

When required, use pile accessories including pipe pile plates and steel pile points and splicers shown in the plans. Steel pile points for steel pipe piles include pipe pile cutting shoes and conical points. Use "inside fit" pipe pile cutting shoes, i.e., cutting shoes with an outside diameter equal to the pipe pile diameter. Use pipe pile plates with a diameter equal to the pipe pile diameter.

Attach steel pile points to steel piles in accordance with the manufacturer's instructions and approved welding procedures. Weld a minimum length of twice the flange width for steel H-piles.

Use steel pile tips with prestressed concrete piles as shown in the plans. Use steel pile splicers for splicing steel H-pile tips and composite piles. Attach steel pile splicers in accordance with the manufacturer's instructions and approved welding procedures.

(D) Driven Piles

Do not drive piles within 50 feet of CIP concrete until the concrete cures for at least 3 days. Do not use vibratory hammers to install prestressed concrete piles.

When predrilling, spudding and installing the initial portions of steel piles with vibratory hammers, submit these pile installation methods with the proposed pile driving methods and equipment for acceptance. The Engineer will review and approve the spudding depth and H-pile size, predrilling depth and diameter and depth of pile installation with a vibratory hammer. When using vibratory hammers to install steel piles, drive at least the last 15 feet with an impact hammer.

Limit driving stresses in accordance with the *AASHTO LRFD Bridge Design Specifications*. Use AASHTO driving stress limits for severe corrosive environments when calcium nitrite corrosion inhibitor is required for prestressed concrete piles. If a tip elevation is noted in the plans, drive steel and prestressed concrete piles to the minimum required driving resistance and tip elevation. Otherwise, drive steel and prestressed concrete piles to the minimum required driving resistance and at least 10 feet into natural ground. Drive composite piles to the minimum required driving resistance and the prestressed concrete and steel H-pile sections to their respective minimum required tip elevations noted in the plans.

Redrive piles raised or moved laterally due to driving adjacent piles. For initial drive of prestressed concrete piles below a depth of 10 ft or 20% of pile length, whichever is greater, drive each pile continuously except to pause driving for one hour or less to change pile cushions and remove templates. Design and construct templates so prestressed concrete piles can be driven to pile cut-off without exceeding the one-hour time limit. When a prestressed concrete pile attains the required resistance and pile penetration, do not drive the pile any further to avoid cutting off the pile. If a prestressed concrete pile does not have the minimum required driving resistance when the pile head is 1 ft above pile cut-off, stop driving the pile.

Protect coatings in an approved manner when driving coated steel piles through templates. Repair damaged galvanizing in accordance with Article 1076-7.

(1) Predrilling and Spudding

Perform predrilling and spudding as noted in the plans and in accordance with the accepted submittals. Predrill pile locations to elevations noted in the plans or approved by the Engineer. When noted in the plans and at the Contractor's option, spudding may be used instead of predrilling. Do not perform spudding below predrilling elevations noted in the plans or approved by the Engineer.

When noted in the plans or predrilling in water or wetlands, use temporary steel casings that meet Subarticle 450-3(E)(1), except use steel casings with inside diameters no more than 2 inches larger than predrilling diameters. Use temporary casings from at least 2 feet above the static water elevation or ground line, whichever is higher, to at least 5 feet below the ground or mud line. More than 5 feet embedment may be necessary if temporary casings are not stable or predrilling or spudding disturbs material outside casings.

Perform predrilling and spudding so spoils are minimized, large ground movements and voids below ground do not occur and piles can be driven to the required resistance

and pile penetration. Do not deposit spoils in water or wetlands. Remove all temporary casings before driving piles.

(2) Driving Equipment

Submit the proposed pile driving methods and equipment (*pile driving equipment data form*) including the pile driving hammer, hammer cushion, pile helmet and cushion for all piles for acceptance by the Engineer in accordance with Article 105-2 at least 30 days before driving piles. Do not submit more than 2 pile driving hammers per pile type per submittal. All equipment is subject to satisfactory field performance.

Drive piles with accepted driving equipment and operate pile driving hammers in accordance with the manufacturer's recommendations. Use hammers that will not overstress piles and will attain the required driving resistance between 30 and 150 blows per foot. Use variable energy air, steam, hydraulic or open end diesel hammers to drive piles. Closed end diesel hammers are not allowed.

Operate air and steam hammers within 10% of the manufacturer's rated speed or a rate approved by the Engineer. Use a plant and equipment for air or steam hammers with sufficient capacity to maintain, under working conditions, the manufacturer's recommended volume and pressure. Equip the plant and equipment with accurate pressure gauges that are easily accessible.

Equip open-end (single acting) diesel hammers with a graduated scale (jump stick) extending above the ram cylinder, graduated rings or grooves on the ram or an electric sound activated remote measuring instrument to determine the hammer stroke during driving.

Expose and inspect the hammer cushion prior to beginning any pile driving and periodically during pile driving on the project. Replace or repair any hammer cushion that is less than 25% of its original thickness.

Hold pile heads in position with pile helmets that fit over pile heads and extend down the sides of piles a sufficient distance. Protect pile heads of prestressed concrete piles from direct impact with the helmet. Size the helmet so prestressed concrete pile will not touch pile sides and will allow adequate pile cushion thickness to control driving stresses. Use pile cushions made of new pine plywood with a thickness of at least 6 inches. Provide a new pile cushion for each prestressed concrete pile. Replace pile cushions during driving when a cushion is compressed more than 50% of its original thickness, begins to smoke or burn, or as directed by the pile driving criteria.

(3) Required Driving Resistance

The Engineer will determine if the proposed pile driving methods and equipment are acceptable and will provide the blows per foot (or blows per inch) and equivalent set for the required driving resistance noted in the plans, i.e., "pile driving criteria" except for structures with dynamic pile testing. For structures with dynamic pile testing, provide pile driving criteria for any bents and end bents with piles in accordance with Subarticle 450-3(F)(4).

Stop driving piles if "refusal" is reached. Refusal occurs at 240 blows per foot (20 blows per inch) or any equivalent set (maximum set of 1/2 inch in 10 blows) with the required stroke as per the pile driving criteria.

(4) Restriking and Redriving Piles

If piles do not attain the required resistance with the estimated or order lengths, the Engineer may require the Contractor to stop driving piles, wait and restrike or redrive piles to attain the required resistance. When the Engineer requires restrikes or redrives, the Engineer will determine the number of restrikes or redrives and the time

to wait after stopping driving and between restrikes and redrives. The time to wait will range from 4 to 24 hours.

Use the same pile driving methods, equipment and compressed pile cushion from the previous driving to restrike or redrive piles. Do not use cold diesel hammers for restrikes or redrives. Warm up hammers by applying at least 20 blows to a previously driven pile or timber mats on the ground.

(E) Drilled-in Piles

Perform pile excavation to elevations shown in the plans or approved by the Engineer. Excavate holes at pile locations with diameters that will result in at least 3 inches of clearance all around piles. Before filling holes, support piles in their planned location within excavations and when noted in the plans, drive piles to the required driving resistance. Remove any fluids from excavations and, at the Contractor's option, fill holes with concrete, grout or flowable fill unless required otherwise in the contract.

(1) Pile Excavation

Use equipment with sufficient capacity to drill through soil, rock, boulders, timbers, man-made objects and any other materials encountered to a depth of at least 5 feet deeper than the maximum pile excavation length shown on the plans. Do not use blasting to advance pile excavations. Blasting for core removal is only permitted when approved by the Engineer. Contain and dispose of drilling spoils as directed and in accordance with Section 802. Drilling spoils consist of all materials and fluids removed from pile excavations.

If unstable, caving or sloughing soils are anticipated or encountered, use slurry or temporary steel casings to stabilize holes. When using slurry, submit slurry details including product information and additives, manufacturer's recommendations for use, slurry equipment details and documentation that mixing water is suitable for slurry before beginning drilling. When using temporary casings, use smooth non-corrugated clean watertight steel casings of ample strength to withstand handling and installation stresses and pressures imposed by concrete, earth, backfill and fluids. Use steel casings with an outside diameter equal to the hole size and a wall thickness of at least 1/4 inch.

(2) Filling Holes

Check the water inflow rate at the bottom of holes after all pumps have been removed. If the water inflow rate is greater than 6 inches per half hour or holes are stabilized with slurry, place concrete, grout or flowable fill with a method that meets Subarticle 411-4(E)(2) except use a pump hose or tremie with a diameter small enough to fit between the pile and side walls. Otherwise, remove any fluids and free fall concrete, grout or flowable fill into holes. Ensure that concrete, grout or flowable fill flows completely around piles. Place concrete, grout or flowable fill continuously and remove all temporary casings.

(F) High-Strain Dynamic Pile Testing (Dynamic Pile Testing)

When required, test piles in accordance with ASTM D4945 using dynamic pile testing equipment with external transducers manufactured by Pile Dynamics, Inc. or another approved vendor. Approved vendors can be found on the Geotechnical Engineering Unit's website. Analyze collected data using signal matching software (CAse Pile Wave Analysis Program (CAPWAP) manufactured by Pile Dynamics, Inc. or equivalent by another approved vendor). Use a prequalified consultant to perform dynamic pile testing and signal matching analyses and provide dynamic pile testing reports. Use a dynamic pile testing operator approved as a Field Engineer (key person) for the dynamic pile testing consultant. Provide dynamic pile testing reports signed and sealed by an engineer approved as a Project Engineer (key person) for the same dynamic pile testing consultant.

Test piles in accordance with the plans or as directed by the Engineer. Provide piles for dynamic pile testing with lengths shown in the plans. Do not drive piles until the proposed pile driving methods and equipment have been preliminarily accepted. Notify the Engineer of the pile driving schedule at least 7 days in advance.

The Engineer will complete the review of the proposed pile driving methods and equipment within 7 days of receiving dynamic pile testing reports and pile driving criteria. Do not place concrete for caps or footings on piles until dynamic pile testing reports and pile driving criteria have been accepted by the Engineer and the piles have been successfully driven to this criteria.

(1) Dynamic Pile Testing

If necessary, provide a shelter to protect the dynamic pile testing operator and equipment from conditions of sun, water, wind and temperature. The shelter should have a floor size of at least 6 feet x 6 feet and a roof height of at least 8 feet. If necessary, heat or cool the shelter to maintain a temperature between 50°F and 85°F. Place the shelter within reach of the dynamic pile testing cables and clear view of piles being driven.

Drill holes for dynamic pile testing transducers as directed by the Engineer. Place piles in leads and templates before attaching dynamic pile testing transducers. Use only preliminarily accepted pile driving methods and equipment to drive piles. Drive piles as directed by the Engineer and in accordance with Subarticle 450-3(D). The dynamic pile testing operator or Engineer may require modified pile installation procedures during driving, including but not limited to driving piles deeper or to a higher driving resistance than stated in the plans. Dynamic measurements will be recorded and used to evaluate the hammer performance, driving resistance and stresses, energy transfer, pile integrity and various soil parameters such as quake and damping.

If required, reattach dynamic pile transducers and restrike or redrive piles in accordance with Subarticle 450-3(D)(4). Obtain the required stroke and at least 6 inches of pile movement as directed by the Engineer. Dynamic measurements will be recorded during restriking and redriving. The Engineer will determine when dynamic pile testing has been satisfactorily completed.

(2) Signal Matching (CAPWAP or equivalent) Analysis

Non-automated, independent signal matching analysis is required for at least a hammer blow near the end of initial drive and each restrike and redrive. Additional signal matching analyses may be required as determined by the dynamic pile testing consultant or Engineer.

(3) Dynamic Pile Testing Reports

Submit a copy of each dynamic pile testing report within 7 days of completing dynamic pile testing. The dynamic pile testing report format shall be in accordance with NCDOT dynamic pile testing format requirements. Include the following in dynamic pile testing reports:

(a) Title Sheet

(i) Department's TIP number and WBS element number
(ii) Project description
(iii) County
(iv) Bridge station number
(v) Pile location
(vi) Personnel
(vii) Report date

(b) Introduction

(c) Site and Subsurface Conditions (including water table elevation)

(d) Pile Details (including driving dates and times)

(i) Pile type and length
(ii) Required driving resistance and resistance factor
(iii) Concrete compressive strength or steel yield strength
(iv) Pile splice type and locations
(v) Pile batter
(vi) Installation methods including use of predrilling, spudding, vibratory hammer, template, barge, etc.

(e) Driving Details

(i) Hammer make, model and type
(ii) Hammer and pile cushion type and thickness
(iii) Pile helmet weight
(iv) Hammer efficiency and operation data including fuel settings, bounce chamber pressure, blows per minute, equipment volume and pressure
(v) Driving data (ram stroke, blows/ft and set for last 10 hammer blows)
(vi) Ground or mud line, template reference and final pile tip elevations
(vii) Restrike and redrive information

(f) Dynamic Pile Testing Field Work Details

(g) Signal Matching Analysis Results

(i) Table showing percent skin and tip, skin and toe damping, skin and toe quake and match quality.

(h) Pile Driving Criteria

Analyze pile driving with the GRL Wave Equation Analysis Program (GRLWEAP) manufactured by Pile Dynamics, Inc. or another approved Wave Equation Analysis Program (WEAP) developed by the approved dynamic pile testing equipment vendor. Use the same dynamic pile testing consultant that provides dynamic pile testing reports to perform GRLWEAP/WEAP analyses and develop pile driving criteria. Provide driving criteria sealed by an engineer approved as a Project Engineer (key person) for the same dynamic pile testing consultant.

Analyze pile driving so driving stresses, energy transfer, ram stroke and blows per foot from dynamic pile testing and resistances from signal matching analyses correlate to GRLWEAP/WEAP models. Provide pile driving criteria for each combination of required driving resistance and pile length installed for all pile types and sizes. Submit a copy of pile driving criteria with dynamic pile testing reports. Include the following for driving criteria.

(i) Table showing blows per foot and equivalent set vs. either stroke for multiple strokes in increments of 6 inches

(ii) Maximum stroke or blows per foot or pile cushion requirements to prevent overstressing piles as needed

(iii) GRLWEAP/WEAP software version information

(iv) PDF copy of all pile driving criteria and executable GRLWEAP/WEAP input and output files

(v) Attachments

A) Boring log(s)
B) *Pile driving equipment data form* (from Contractor)
C) Field pile driving inspection data (from Engineer)
D) Accelerometer and strain gauge serial numbers, calibration and locations
E) Dynamic pile testing hardware model and signal matching (CAPWAP or equivalent) software version information
F) PDF copy of all dynamic pile testing data and executable signal matching (CAPWAP or equivalent) input and output files

450-4 MEASUREMENT AND PAYMENT

No additional payment will be made for subsurface investigations to determine required pile lengths or larger caps or footings due to piles out of position.

Pile Driving Equipment Setup for ____ Prestressed Concrete Piles, *Pile Driving Equipment Setup for ____ Steel Piles* and *Pile Driving Equipment Setup for ____ Galvanized Steel Piles* will be measured and paid in units of each. Setting up equipment to drive piles will be measured as one per pile. No payment will be made for pile driving equipment setup for installed piles that are not driven. The contract unit price for *Pile Driving Equipment Setup for ____ Prestressed Concrete Piles*, *Pile Driving Equipment Setup for ____ Steel Piles* and *Pile Driving Equipment Setup for ____ Galvanized Steel Piles* will be full compensation for mobilizing and demobilizing pile driving equipment, personnel, supplies and incidentals, setting up and breaking down pile driving equipment, e.g., pile hammer, crane, template, etc. and submitting the proposed pile driving methods and equipment.

____ *Prestressed Concrete Piles,* ____ *Steel Piles* and ____ *Galvanized Steel Piles* will be measured and paid in linear feet. Steel piles will be measured as the pile length before installation minus any pile cut-offs. Prestressed concrete piles will be measured as the authorized pile length before installation. No payment will be made for pile cut-offs or cutting off piles. No payment will be made for damaged, defective or rejected piles or any piles for false work, bracing, templates or temporary work bridges. The contract unit prices for ____ *Prestressed Concrete Piles,* ____ *Steel Piles* and ____ *Galvanized Steel Piles* will be full compensation for furnishing and installing piles except for the items paid for separately in this article.

Composite piles will be measured as the pile length of the prestressed concrete and steel H-pile sections before installation minus any pile cut-offs. The concrete and steel sections will be measured and paid at the contract unit prices for ____ *Prestressed Concrete Piles* and ____ *Steel Piles*, respectively. No payment will be made for portions of steel H-pile sections embedded in prestressed concrete sections or steel pile splicers and any associated hardware or welding.

After steel piles attain the required resistance and pile penetration and at the Contractor's option, drive piles to grade instead of cutting off steel piles provided the remaining portions of steel piles do not exceed 5 feet and steel piles can be driven without damage or exceeding the maximum stroke or refusal. When this occurs, the additional pile length driven will be measured and paid at the contract unit prices for ____ *Steel Piles* and ____ *Galvanized Steel Piles*.

For prestressed concrete piles that are built up, the build-up will be measured and paid at the contract unit price for ____ *Prestressed Concrete Piles*. Steel pile tips are not included in the measurement of prestressed concrete piles. No separate payment will be made for steel pile tips or splicers and any associated hardware or welding. Steel pile tips and steel pile splicers will be incidental to the contract unit price for ____ *Prestressed Concrete Piles*.

Steel Pile Points and *Pipe Pile Plates* will be measured and paid in units of each. *Steel Pile Points* and *Pipe Pile Plates* will be measured as one per pile.

Predrilling for Piles will be measured and paid in linear feet. For bents with a predrilling pay item shown in the plans, predrilling will be paid as *Predrilling for Piles* and measured per pile

location as the depth from the ground or mud line to the specified predrilling elevation or revised elevation approved by the Engineer. The contract unit price for *Predrilling for Piles* will also be full compensation for using temporary casings. For bents without a predrilling pay item shown in the plans, predrilling will be incidental to the contract unit prices for ____ *Prestressed Concrete Piles,* ____ *Steel Piles* and ____ *Galvanized Steel Piles.*

No direct payment will be made for spudding. Spudding will be incidental to the contract unit prices for ____ *Prestressed Concrete Piles,* ____ *Steel Piles* and ____ *Galvanized Steel Piles.*

Pile Redrives will be measured and paid in units of each. *Pile Redrives* will be measured as the number of restrikes or redrives required by the Engineer. No payment will be made for restrikes or redrives when the Contractor chooses to restrike or redrive piles.

Pile Excavation in Soil and *Pile Excavation Not in Soil* will be measured and paid in linear feet. Pile excavation will be measured as the depth from the ground line to the specified pile excavation elevation or revised elevation approved by the Engineer. Define "not in soil" as material with a rock auger penetration rate of less than 2 inches per 5 minutes of drilling at full crowd force. When not in soil is encountered, seams, voids and weathered rock less than 3 feet thick with a rock auger penetration rate of greater than 2 inches per 5 minutes of drilling at full crowd force will be paid at the contract unit price for *Pile Excavation Not in Soil*. Seams, voids and weathered rock greater than 3 feet thick will be paid at the contract unit price for *Pile Excavation in Soil* where not in soil is no longer encountered. The contract unit prices for *Pile Excavation in Soil* and *Pile Excavation Not in Soil* will be full compensation for stabilizing and filling holes with concrete, grout or flowable fill.

Dynamic Pile Testing will be measured and paid in units of each. *Dynamic Pile Testing* will be measured as one per pile. The contract unit price for *Dynamic Pile Testing* will be full compensation for performing dynamic pile testing the first time a pile is tested, performing non-automated signal matching (CAPWAP or equivalent) analysis on data collected during initial drive, restrikes and redrives, providing dynamic pile testing reports, performing GRLWEAP/WEAP analysis and developing and providing pile driving criteria. Subsequent dynamic pile testing of the same piles will be incidental to the contract unit price for *Pile Redrives*. The contract unit price for *Dynamic Pile Testing* will also be full compensation for the Contractor's assistance to perform dynamic pile testing during initial drive, restrikes and redrives.

Payment will be made under:

Pay Item	**Pay Unit**
Pile Driving Equipment Setup for ___ Prestressed Concrete Piles	Each
Pile Driving Equipment Setup for ___ Steel Piles	Each
Pile Driving Equipment Setup for ___ Galvanized Steel Piles	Each
____ Prestressed Concrete Piles	Linear Foot
____ Steel Piles	Linear Foot
____ Galvanized Steel Piles	Linear Foot
Steel Pile Points	Each
Pipe Pile Plates	Each
Predrilling for Piles	Linear Foot
Pile Redrives	Each
Pile Excavation in Soil	Linear Foot
Pile Excavation Not in Soil	Linear Foot
Dynamic Pile Testing	Each

SECTION 452
SHEET PILE RETAINING WALLS

452-1 DESCRIPTION

Construct sheet pile retaining walls consisting of steel sheet piles for permanent applications. Provide CIP reinforced concrete coping as required. Construct sheet pile retaining walls based on actual elevations and wall dimensions and with the required embedment below bottom of wall elevations in accordance with the contract and accepted submittals. Define "sheet pile wall" as a sheet pile retaining wall.

452-2 MATERIALS

Refer to Division 10.

Item	Section
Joint Filler	1028-1
Low Modulus Silicone Sealant	1028-3
Portland Cement Concrete, Class A	1000
Reinforcing Steel	1070
Steel Sheet Piles	1084-1

452-3 SHEET PILE WALL SURVEYS

The plans typically show a plan view, typical sections, details, notes and an elevation or profile view (wall envelope) for each sheet pile wall. Before beginning sheet pile wall construction, survey existing ground elevations along wall face locations and other elevations in the vicinity of sheet pile wall locations as needed. For proposed slopes above or below sheet pile walls, survey existing ground elevations to at least 10 feet beyond slope stake points. Based on these elevations, finished grades and actual sheet pile wall dimensions and details, submit wall envelopes for acceptance. Use accepted wall envelopes for construction.

452-4 CONSTRUCTION METHODS

(A) Sheet Pile Installation

Install sheet piles with tolerances that meet Subarticles 450-3(B)(1) and 450-3(B)(2). Install sheet piles with the minimum required pile tip elevations in accordance with Subarticle 450-3(D).

(B) Concrete Coping

Construct CIP concrete coping in accordance with Section 420. Do not remove falsework until concrete attains a compressive strength of at least 2,400 psi. Provide a Class 2 surface finish for coping that meets Subarticle 420-17(F).

Construct coping joints at a maximum spacing of 10 feet. Make 1/2 inch thick expansion joints that meet Article 420-10 for every third joint and 1/2 inch deep grooved contraction joints that meet Subarticle 825-10(B) for the remaining joints. Stop coping reinforcement 2 inches on either side of expansion joints.

(C) Backfilling and Sealing Joints

When concrete coping is required, do not backfill behind sheet pile walls until concrete attains a compressive strength of at least 3,000 psi. Backfill for sheet pile walls in accordance with Article 410-8.

Seal joints above and behind sheet pile walls between coping and concrete slope protection with silicone sealant.

452-5 MEASUREMENT AND PAYMENT

Sheet Pile Retaining Walls will be measured and paid in square feet. Sheet pile walls will be measured as the square feet of wall face area with the pay height equal to the difference between top and bottom of wall elevations. Define "top of wall" as top of coping or top of piles for sheet pile walls without coping. Define "bottom of wall" as where finished grade intersects the front of sheet piles and no measurement will be made for portions of sheet pile walls below bottom of wall elevations.

The contract unit price for *Sheet Pile Retaining Walls* will be full compensation for providing submittals, labor, tools, equipment and sheet pile wall materials, installing sheet piles, excavating, hauling and removing excavated materials, placing and compacting backfill material and supplying sheet piles, backfill, coping and any incidentals necessary to construct sheet pile walls.

The contract unit price for *Sheet Pile Retaining Walls* does not include the cost for ditches, fences, handrails, guardrail or barriers associated with sheet pile walls as these items will be paid for elsewhere in the contract.

Where it is necessary to provide backfill material from sources other than excavated areas or borrow sources used in connection with other work in the contract, payment for furnishing and hauling such backfill material will be paid as extra work in accordance with Article 104-7. Placing and compacting such backfill material is not considered extra work but is incidental to the work being performed.

Payment will be made under:

Pay Item	Pay Unit
Sheet Pile Retaining Walls	Square Foot

SECTION 453
CIP GRAVITY RETAINING WALLS

453-1 DESCRIPTION

Construct CIP gravity retaining walls consisting of CIP concrete supported by and connected to concrete footings. Construct CIP gravity retaining walls based on actual elevations and wall dimensions in accordance with the contract, accepted submittals and if included in the plans, standard CIP gravity wall detail. Define "CIP gravity wall" as a CIP gravity retaining wall.

453-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextiles, Type 1	1056
Joint Fillers	1028-1
Low Modulus Silicone Sealant	1028-3
Masonry	1040
Portland Cement Concrete, Class A	1000
Reinforcing Steel	1070
Subdrain Coarse Aggregate	1044-2
Subdrain Fine Aggregate	1044-1

Use geotextiles and subdrain aggregate for subsurface drainage at weep holes and reinforcing steel for dowels.

453-3 GRAVITY WALL SURVEYS

The plans typically show a plan view, typical sections, details, notes and an elevation or profile view (wall envelope) for each CIP gravity wall. Before beginning CIP gravity wall

construction, survey existing ground elevations along wall face locations and other elevations in the vicinity of CIP gravity wall locations as needed. For proposed slopes above or below CIP gravity walls, survey existing ground elevations to at least 10 feet beyond slope stake points. Based on these elevations, finished grades and actual CIP gravity wall dimensions and details, submit wall envelopes for acceptance by the Engineer. Use accepted wall envelopes for construction.

453-4 CONSTRUCTION METHODS

Control drainage during construction in the vicinity of CIP gravity walls. Direct run off away from CIP gravity walls and backfill. Contain and maintain backfill and protect material from erosion.

Excavate as necessary for CIP gravity walls in accordance with the plans. Embed bottom of footings at least 2 feet below bottom of walls shown in the plans. If applicable and at the Contractor's option, use temporary shoring for wall construction instead of temporary slopes to construct CIP gravity walls. Define "temporary shoring for wall construction" as temporary shoring not shown in the plans or required by the Engineer including shoring for OSHA reasons or the Contractor's convenience.

Notify the Engineer when foundation excavation is complete. Do not place concrete for footings until excavation depth and foundation material are approved by the Engineer.

Construct CIP gravity walls at elevations and with dimensions shown in the plans and in accordance with Section 420. Use dowels for construction joints at top of footings as shown in the plans. Extend top of walls at least 6 inches above where finished grade intersects back of CIP gravity walls.

Provide a Class 2 surface finish for exposed surfaces of CIP gravity walls that meets Subarticle 420-17(F). Construct wall joints at a maximum spacing of 10 feet. Make 1/2 inch thick expansion joints that meet Article 420-10 for every third joint and 1/2 inch deep grooved contraction or sawed joints that meet Subarticle 825-10(B) or 825-10(E) respectively for the remaining joints.

Construct 3 inch diameter weep holes on 10 foot centers along CIP gravity walls. Provide subsurface drainage at weep holes in accordance with Article 414-8. Exit weep holes just above finished grade and slope holes at 1 in/ft through CIP gravity walls so water drains out of front of walls. When single faced precast concrete barrier is required in front of and against CIP gravity walls, extend weep holes through barrier at the same slope.

Do not remove forms or backfill behind CIP gravity walls until concrete attains a compressive strength of at least 2,400 psi. Backfill for CIP gravity walls in accordance with Article 410-8.

If a brick veneer is required, construct brick masonry in accordance with Section 830. Anchor brick veneers to CIP gravity walls with approved brick to concrete type anchors in accordance with the manufacturer's instructions. Space anchors no more than 16 inches apart in the vertical direction and no more than 32 inches apart in the horizontal direction with each row of anchors staggered 16 inches from the row above and below.

453-5 MEASUREMENT AND PAYMENT

CIP Gravity Retaining Walls will be measured and paid in square feet. CIP gravity walls will be measured as the square feet of wall face area with the pay height equal to the difference between top of wall and top of footing elevations. Define "top of wall" as top of CIP concrete.

The contract unit price for *CIP Gravity Retaining Walls* will be full compensation for providing submittals, labor, tools, equipment and CIP gravity wall materials, excavating, hauling and removing excavated materials, placing and compacting backfill material and supplying concrete, dowels, subsurface drainage, weep holes and any incidentals necessary to construct CIP gravity walls. The contract unit price for *CIP Gravity Retaining Walls* will also be full compensation for brick veneers, if required.

No separate payment will be made for temporary shoring for wall construction. Temporary shoring for wall construction will be incidental to the contract unit price for *CIP Gravity Retaining Walls*.

The contract unit price for *CIP Gravity Retaining Walls* does not include the cost for ditches, fences, handrails, guardrail or barriers associated with CIP gravity walls as these items will be paid for elsewhere in the contract.

Where it is necessary to provide backfill material from sources other than excavated areas or borrow sources used in connection with other work in the contract, payment for furnishing and hauling such backfill material will be paid as extra work in accordance with Article 104-7. Placing and compacting such backfill material is not considered extra work but is incidental to the work being performed.

Payment will be made under:

Pay Item	Pay Unit
CIP Gravity Retaining Walls	Square Foot

SECTION 454
SEGMENTAL GRAVITY RETAINING WALLS

454-1 DESCRIPTION

Construct segmental gravity retaining walls consisting of segmental retaining wall (SRW) units supported by aggregate footings. Provide CIP concrete slope protection as required. Design, if required, and construct segmental gravity retaining walls based on actual elevations, wall dimensions and batter in accordance with the contract, accepted submittals and if included in the plans, standard segmental gravity wall detail.

Define “block wall” as a segmental gravity retaining wall and “standard block wall” as a block wall that meets the standard segmental gravity retaining wall details. Define “blocks” as SRW units, “cap blocks” as SRW cap units and “Block Vendor” as the vendor licensing the block producer. Define “slope protection” as CIP concrete slope protection.

454-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextiles, Type 2	1056
Joint Fillers	1028-1
Low Modulus Silicone Sealant	1028-3
Portland Cement Concrete, Class B	1000
Segmental Retaining Wall Units	1040-4
Select Materials	1016
Subsurface Drainage Materials	1044

Provide Type 2 geotextile for separation geotextiles. Use Class VI select material for No. 57 stone and Class B concrete for slope protection. Provide PVC pipes, fittings, outlet pipes and concrete pads for subsurface drainage materials. For PVC pipes behind block walls, use pipes with perforations that meet AASHTO M 278.

Provide cap blocks that meet the material requirements for blocks. Use blocks from producers approved by the Department and licensed by the Block Vendor. Notify the Engineer of the name and NCDOT ID number of the SRW unit production facility before beginning block production. Provide blocks with a depth (front to back) of at least 12 inches and cap blocks with a depth of at least 8 inches.

Use approved SRW units for standard block walls. Blocks for standard block walls are approved for either 2 foot or 5 foot maximum wall heights with the wall height as shown in the

standard segmental gravity wall details. The list of approved SRW units with maximum wall heights is available from the Geotechnical website.

Do not mix blocks from different Block Vendors on the same block wall. Damaged blocks with excessive discoloration, chips or cracks as determined by the Engineer will be rejected.

Provide adhesives recommended by the Block Vendor. Store adhesives in accordance with the manufacturer's instructions. Load, transport, unload and store block wall materials so materials are kept clean and free of damage.

454-3 PRECONSTRUCTION REQUIREMENTS

(A) Block Wall Surveys

The plans typically show a plan view, typical sections, details, notes and an elevation or profile view (wall envelope) for each block wall. Before beginning block wall design or construction, survey existing ground elevations along wall face locations and other elevations in the vicinity of block wall locations as needed. For proposed slopes above or below block walls, survey existing ground elevations to at least 10 feet beyond slope stake points. Based on these elevations, finished grades and actual block wall dimensions, details and batter, submit wall envelopes for acceptance by the Engineer. Use accepted wall envelopes for design, if required, and construction.

(B) Block Wall Designs

If the plans do not include standard segmental gravity wall details, submit design calculations and working drawings for block wall designs at least 30 days before starting block wall construction. Do not begin block wall construction until a design submittal is accepted by the Engineer.

Design block walls in accordance with the plans and Article 11.11 of the *AASHTO LRFD Bridge Design Specifications* unless otherwise required. Neglect material above top of footing for stability computations. Design block walls for the wall batter required by the Block Vendor and clearances shown in the plans. Do not locate blocks or footings outside right-of-way or easement limits.

Use No. 57 stone for aggregate footings beneath blocks. Use 10 inch thick footings that are continuous at steps and extend at least 6 inches in front of and at least 9 inches behind bottom row of blocks. Embed bottom of footings at least 18 inches below bottom of walls shown in the plans. When noted in the plans, locate a 4 inch diameter continuous perforated PVC drain pipe in the No. 57 stone in back of footings.

Fill block core spaces with No. 57 stone and between and behind blocks with No. 57 stone for a horizontal distance of at least 12 inches so stone is continuous in all directions. Assume a unit weight of 100 pcf for No. 57 stone. Separation geotextiles are required between No. 57 stone and backfill or natural ground, and between stone and overlying fill or pavement section except when concrete pavement, full depth asphalt or cement treated base is placed directly on stone.

Use cap blocks at top of walls. Step top of walls as shown in the plans and double stack cap blocks at steps so cap blocks are continuous at steps. Extend top of walls 4 inches to 12 inches above where finished grade intersects back of blocks or cap blocks. When single faced precast concrete barrier is required in front of and against block walls, fill voids between barrier and wall faces with Class V select material.

Submit working drawings and design calculations for acceptance in accordance with Article 105-2. Submit working drawings showing plan views, wall profiles with required resistances, typical sections, No. 57 stone and geotextile locations and details of footings, blocks, cap blocks, etc. If necessary, include details on working drawings for slope protection and obstructions extending through walls or interfering with footings. Submit design calculations for each wall section with different geometry or material parameters to the Engineer. When

designing block walls with computer software, a hand calculation is required for the tallest wall section. Provide block wall designs sealed by an engineer licensed in the state of North Carolina.

454-4 CONSTRUCTION METHODS

Control drainage during construction in the vicinity of block walls. Direct run off away from block walls, No. 57 stone and backfill. Contain and maintain stone and backfill and protect material from erosion.

Excavate as necessary for block walls in accordance with the plans and accepted submittals. Notify the Engineer when foundation excavation is complete. Do not place No. 57 stone for footings until excavation dimensions and foundation material are approved by the Engineer.

Construct aggregate footings at elevations and with dimensions shown in the plans and accepted submittals. If a drain is required, install wall drainage systems consisting of drains and outlet components as shown in the plans and accepted submittals and in accordance with Section 815. Compact No. 57 stone for footings with a vibratory compactor to the satisfaction of the Engineer.

Stack blocks with no negative wall batter (wall face leaning forward) so the final wall position is as shown in the plans and accepted submittals. Place blocks with a maximum vertical joint width of 3/8 inch. Stagger blocks to create a running bond by centering blocks over joints in the row below as shown in the plans and accepted submittals. Construct block walls with the following tolerances:

A. Blocks are level from front to back and between units when checked with a 4 foot long level,

B. Final wall face is within 2 inches of horizontal and vertical alignment shown in the plans and accepted submittals, and

C. Wall batter is within 2 degrees of batter required by the Block Vendor.

Overlap adjacent separation geotextiles at least 18 inches at seams and hold geotextiles in place with wire staples or anchor pins as needed. Place No. 57 stone between and behind blocks in 8 inch to 10 inch thick lifts. Compact stone with hand operated compaction equipment to the satisfaction of the Engineer. Backfill for block walls behind No. 57 stone in accordance with Article 410-8.

Set cap blocks with a 1/2 inch to 1-1/2 inch overhang as shown in the plans and accepted submittals. Place cap blocks using adhesive in accordance with the manufacturer's instructions. Do not place cap blocks if surfaces caps will be attached to are wet or frozen or the air temperature measured at the wall location in the shade away from artificial heat is below 40°F. Before applying adhesive, clean surfaces cap blocks will adhere to and ensure surfaces are dry and free of oil, grease, dust and debris.

Pave slopes above and behind block walls with slope protection as shown in the plans and accepted submittals and in accordance with Article 462-3. Construct slope protection joints at a maximum spacing of 10 feet. Make 1/2 inch thick expansion joints that meet Article 420-10 for every third joint and 1/2 inch deep grooved contraction joints that meet Subarticle 825-10(B) for the remaining joints.

454-5 MEASUREMENT AND PAYMENT

Segmental Gravity Retaining Walls will be measured and paid in square feet. Block walls will be measured as the square feet of wall face area with the pay height equal to the difference between top of wall and top of footing elevations. Define "top of wall" as top of cap blocks.

The contract unit price for *Segmental Gravity Retaining Walls* will be full compensation for providing designs, if required, submittals, labor, tools, equipment and block wall materials, excavating, hauling and removing excavated materials, placing and compacting backfill

material and supplying footings, blocks, select material, wall drainage systems, geotextiles, cap blocks, slope protection and any incidentals necessary to construct block walls.

The contract unit price for *Segmental Gravity Retaining Walls* does not include the cost for ditches, fences, handrails, guardrail or barriers associated with block walls as these items will be paid for elsewhere in the contract.

Where it is necessary to provide backfill material behind No. 57 stone from sources other than excavated areas or borrow sources used in connection with other work in the contract, payment for furnishing and hauling such backfill material will be paid as extra work in accordance with Article 104-7. Placing and compacting such backfill material is not considered extra work but is incidental to the work being performed.

Payment will be made under:

Pay Item	Pay Unit
Segmental Gravity Retaining Walls	Square Foot

SECTION 455
PRECAST GRAVITY RETAINING WALLS

455-1 DESCRIPTION

Construct precast gravity retaining walls consisting of precast retaining wall (PRW) units supported by concrete footings. Provide CIP concrete slope protection as required. Design and construct precast gravity retaining walls based on actual elevations, wall dimensions and batter in accordance with the contract and accepted submittals. Define "precast gravity wall" as a precast gravity retaining wall and "PRW Unit Vendor" as the vendor licensing the precaster. Define "slope protection" as CIP concrete slope protection.

455-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextiles, Type 2	1056
Joint Fillers	1028-1
Low Modulus Silicone Sealant	1028-3
Portland Cement Concrete	1000
Select Materials	1016
Precast Retaining Wall Units	1077
Subsurface Drainage Materials	1044

Provide Type 2 geotextile for separation geotextiles. Use Class A concrete for footings, Class B concrete for slope protection and Class VI select material for No. 57 stone. Provide PVC pipes, fittings, outlet pipes and concrete pads for subsurface drainage materials. For PVC pipes behind precast gravity walls, use pipes with perforations that meet AASHTO M 278.

Provide PRW cap and top units that meet the material requirements for PRW units. Use PRW units from producers approved by the Department and licensed by the PRW Unit Vendor. Produce PRW units with a final finish that meets Article 1077-11 except for unit faces. Provide PRW units with a vertical rock like face and a concrete gray color with no tints, dyes or pigments. Do not begin unit production until sample PRW units of the type, face and color proposed for the project are approved by the Engineer.

Do not mix PRW units from different PRW Unit Vendors on the same precast gravity wall. Damaged PRW units with excessive discoloration, chips or cracks as determined by the Engineer will be rejected. Load, transport, unload and store precast gravity wall materials so materials are kept clean and free of damage.

455-3 PRECONSTRUCTION REQUIREMENTS

(A) Precast Gravity Wall Surveys

The Retaining Wall Plans show a plan view, typical sections, details, notes and an elevation or profile view (wall envelope) for each precast gravity wall. Before beginning precast gravity wall design, survey existing ground elevations shown in the plans and other elevations in the vicinity of precast gravity wall locations as needed. For proposed slopes above or below precast gravity walls, survey existing ground elevations to at least 10 feet beyond slope stake points. Based on these elevations, finished grades and actual precast gravity wall dimensions, details and batter, submit revised wall envelopes for acceptance. Use accepted wall envelopes for design.

(B) Precast Gravity Wall Designs

For precast gravity wall designs, submit design calculations and working drawings to the Engineer at least 30 days before the preconstruction meeting. Note name and NCDOT ID number of the PRW unit production facility on the working drawings. Do not begin precast gravity wall construction until a design submittal is accepted by the Engineer.

Design precast gravity walls in accordance with the plans and Article 11.11 of the *AASHTO LRFD Bridge Design Specifications* unless otherwise required. Neglect material above top of footing for stability computations. Design precast gravity walls for the wall batter required by the PRW Unit Vendor and clearances shown in the plans. Do not locate PRW units or footings outside right-of-way or easement limits.

When noted in the plans, design precast gravity walls for a live load (traffic) surcharge of 250 psf in accordance with Figure C11.5.6-3(a) of the *AASHTO LRFD Bridge Design Specifications*. For steel beam guardrail with 8 foot posts above precast gravity walls, analyze walls for a nominal horizontal load (P_{HI}) of 300 lb/ft of wall in accordance with Figure 3.11.6.3-2(a) of the *AASHTO LRFD Bridge Design Specifications*. For concrete barrier rail above precast gravity walls, analyze walls for a nominal P_{HI} of 500 lb/ft of wall in accordance with Figure 3.11.6.3-2(a).

Use 12 inch thick CIP unreinforced concrete footings beneath PRW units that are continuous at steps and extend at least 6 inches in front of and behind bottom row of PRW units. Embed bottom of footings at least 2 feet below bottom of walls shown in the plans.

Fill PRW unit core spaces with No. 57 stone and between and behind units with No. 57 stone for a horizontal distance of at least 18 inches so stone is continuous in all directions. For adjacent PRW units with different depths (front to back), it may be necessary to fill behind units with more than 18 inches of No. 57 stone to make stone continuous. Assume a unit weight of 100 pcf for No. 57 stone.

When noted in the plans, locate a 4 inch diameter continuous perforated PVC drain pipe in the No. 57 stone behind bottom row of PRW units. Separation geotextiles are required between No. 57 stone and backfill or natural ground and between stone and overlying fill or pavement section except when concrete pavement, full depth asphalt or cement treated base is placed directly on stone.

At the Contractor's option, use PRW cap or top units at top of walls unless there is a back slope or concrete barrier rail above precast gravity walls. For precast gravity walls with back slopes, use top PRW units only and extend top of walls at least 4 inches above where finished grade intersects PRW top units. When concrete barrier rail is required above precast gravity walls, use concrete barrier rail with moment slab as shown in the plans and do not use PRW cap units. When single faced precast concrete barrier is required in front of and against precast gravity walls, fill voids between barrier and wall faces with Class V select material.

Submit working drawings and design calculations for acceptance in accordance with Article 105-2. Submit working drawings showing plan views, wall profiles with required resistances, typical sections, No. 57 stone and geotextile locations and details of footings, PRW units, etc.

If necessary, include details on working drawings for slope protection, concrete barrier rail with moment slab and obstructions extending through walls or interfering with footings, barriers or moment slabs. Submit design calculations for each wall section with different surcharge loads, geometry or material parameters to the Engineer. When designing precast gravity walls with computer software, a hand calculation is required for the tallest wall section. Provide precast gravity wall designs sealed by an engineer licensed in the state of North Carolina.

(C) Preconstruction Meeting

Before starting precast gravity wall construction, hold a preconstruction meeting with the Engineer to discuss the construction and inspection of the precast gravity walls. If this meeting occurs before all precast gravity wall submittals have been accepted, additional preconstruction meetings may be required before beginning construction of precast gravity walls without accepted submittals. The Prime Contractor and Precast Gravity Wall Installer Superintendent will attend preconstruction meetings.

455-4 CONSTRUCTION METHODS

Control drainage during construction in the vicinity of precast gravity walls. Direct run off away from precast gravity walls, No. 57 stone and backfill. Contain and maintain stone and backfill and protect material from erosion.

Excavate as necessary for precast gravity walls in accordance with the accepted submittals. If applicable and at the Contractor's option, use temporary shoring for wall construction instead of temporary slopes to construct precast gravity walls. Define "temporary shoring for wall construction" as temporary shoring not shown in the plans or required by the Engineer including shoring for OSHA reasons or the Contractor's convenience.

Notify the Engineer when foundation excavation is complete. Do not place concrete for footings until excavation depth and foundation material are approved by the Engineer.

Construct CIP concrete footings at elevations and with dimensions shown in the accepted submittals and in accordance with Section 420. Cure footings at least 24 hours before placing PRW units.

Stack PRW units with no negative wall batter (wall face leaning forward) so the final wall position is as shown in the accepted submittals. Place PRW units with a maximum vertical joint width of 1/2 inch. Stagger PRW units to create a running bond by centering units over joints in the row below as shown in the accepted submittals. Construct precast gravity walls with the following tolerances:

A. PRW units are level from front to back and between units when checked with a 4 foot long level,
B. Wall face is within 2 inches of horizontal and vertical alignment shown in the accepted submittals when measured along a 10 foot straightedge unless otherwise approved, and
C. Wall batter is within 2 degrees of batter required by the PRW Unit Vendor.

Overlap adjacent separation geotextiles at least 18 inches at seams and hold geotextiles in place with wire staples or anchor pins as needed. If a drain is required, install wall drainage systems consisting of drains and outlet components as shown in the accepted submittals and in accordance with Section 815.

Place No. 57 stone between and behind PRW units in 8 inch to 10 inch thick lifts. Compact stone with hand operated compaction equipment to the satisfaction of the Engineer. Backfill for precast gravity walls behind No. 57 stone in accordance with Article 410-8. Set PRW cap units with a 1/2 inch to 1-1/2 inch overhang as shown in the plans.

Pave slopes above and behind precast gravity walls with slope protection as shown in the plans and accepted submittals and in accordance with Article 462-3. Construct slope protection joints at a maximum spacing of 10 feet. Make 1/2 inch thick expansion joints that meet Article 420-10 for every third joint and 1/2 inch deep grooved contraction joints that meet Subarticle 825-

10(B) for the remaining joints.

455-5 MEASUREMENT AND PAYMENT

Precast Gravity Retaining Walls will be measured and paid in square feet. Precast gravity walls will be measured as the square feet of wall face area with the pay height equal to the difference between top of wall and top of footing elevations. Define "top of wall" as top of PRW cap or top units.

The contract unit price for *Precast Gravity Retaining Walls* will be full compensation for providing design, submittals, labor, tools, equipment and precast gravity wall materials, excavating, hauling and removing excavated materials, placing and compacting backfill material and supplying footings, PRW units, select material, wall drainage systems, geotextiles, PRW cap and top units, slope protection and any incidentals necessary to construct precast gravity walls.

No separate payment will be made for temporary shoring for wall construction. Temporary shoring for wall construction will be incidental to the contract unit price for *Precast Gravity Retaining Walls*.

The contract unit price for *Precast Gravity Retaining Walls* does not include the cost for ditches, fences, handrails, guardrail or barriers associated with precast gravity walls as these items will be paid for elsewhere in the contract.

Where it is necessary to provide backfill material behind No. 57 stone from sources other than excavated areas or borrow sources used in connection with other work in the contract, payment for furnishing and hauling such backfill material will be paid as extra work in accordance with Article 104-7. Placing and compacting such backfill material is not considered extra work but is incidental to the work being performed.

Payment will be made under:

Pay Item	Pay Unit
Precast Gravity Retaining Walls	Square Foot

SECTION 458
WATERPROOFING AND DAMPPROOFING

458-1 DESCRIPTION

Waterproof or dampproof concrete surfaces in accordance with these specifications for the particular method of waterproofing or dampproofing called for in the plans. Furnish and apply all asphalt, tar, fabric, asphalt plank and any other materials.

458-2 MATERIALS

Refer to Division 10.

Item	Section
Asphalt Binder	1020-7(B)
Asphalt Primer	1020-7(A)
Tar	1020-7(C)
Woven Cotton Fabric	1020-7(D)

458-3 METHOD A WATERPROOFING

(A) General

Method A waterproofing consists of one coat of asphalt primer, and 3 mop coats of hot asphalt cement with 2 layers of cotton fabric alternating between the mop coats.

(B) Preparation of Surface

Ensure that concrete surfaces are dry, reasonably smooth and free from projections or holes which are capable of puncturing the membrane. Immediately before applying the waterproofing, thoroughly clean the surface of dust and loose materials.

Make sure that the concrete is at least 14 days old for Class A concrete, at least 10 days old for Class AA concrete, or at least 7 days old for high early strength concrete, before beginning waterproofing. Do not waterproof in wet weather nor when the temperature is below 35°F, without permission from the Engineer.

(C) Application

Give waterproofed surfaces a thorough coat of asphalt primer, and allow it to set thoroughly before applying the first mop coat. Heat the asphalt cement for the mop coat to a temperature of at least 300°F and frequently stir to avoid local overheating. Equip the heating kettles with thermometers.

Begin the waterproofing at the low point of the surface.

Use a half width first strip of fabric; and a full width second strip. Lap the full width of the first strip. Make the third and each succeeding strip full width and lap so there are 2 layers of fabric at all points with laps at least 2 inches wide. Make sure that the end laps are at least 12 inches.

Beginning at the low point of the surface, mop a section about 20 inches wide and the full length of the surface with hot asphalt cement. Immediately roll the first strip of fabric into the asphalt cement and press into place to eliminate all air bubbles and to provide a firm bond to the surface. Mop this strip and an adjacent section of the surface of a width equal to slightly more than half the width of the fabric with hot asphalt binder and roll a full width of the fabric into this cement, completely covering the first strip, and press into place. Mop this second strip and an adjacent section of the concrete surface with hot asphalt cement and place the third strip of fabric to lap the first strip at least 2 inches. Continue this process until the entire surface is covered, each strip of fabric lapping at least 2 inches over the second preceding strip. Give the entire surface a final mopping of hot asphalt cement.

Mop on concrete to completely cover the surface sufficiently heavy on cloth to completely conceal the weave. Use at least 12 gallons of asphalt on horizontal surfaces for each 100 square feet of finished work and at least 15 gallons on vertical surfaces. Perform the work so, at the close of a day's work, all laid cloth receives the final mopping of asphalt. Thoroughly seal down all laps.

(D) Special Requirements

At the edges of the membrane and at any points punctured by such appurtenances as drains or pipes, make suitable provisions to prevent water from getting between the waterproofing and the waterproofed surface.

Place all membrane flashing at curbs and against girders, spandrel walls, etc., with separate sheets of membrane lapping the main membrane at least 12 inches. Closely seal flashing with either a metal counter-flashing or by embedding the upper edges of the flashing in a groove poured full of joint filler.

Provide expansion joints, both horizontal and vertical, with water stops and premolded joint filler as called for in the plans. Seal expansion joints in the face adjacent to the membrane bituminous material. Carry the membrane continuously across all expansion joints.

At the ends of the structure carry the membrane well down on the abutments and make suitable provisions for all movement.

(E) Repairs

Repair any damage that occurs as directed by the Engineer. Repair by patching when permitted by the Engineer. Extend the first ply of the patch at least 12 inches beyond the outermost damaged portion of the membrane and extend the second ply at least 3 inches beyond the first.

(F) Backfilling

Do not backfill without permission and until the final mop coat thoroughly hardens. Place backfill so the waterproofing is not damaged.

458-4 METHOD B DAMP PROOFING

(A) General

Method B dampproofing consists of 2 coats of tar, Grade RT 6.

(B) Preparation of Surface

Make sure the surfaces are dry. Immediately before applying the first dampproofing coat, thoroughly clean the surfaces of dust and loose materials. Permit the concrete to cure for at least 14 days for Class A concrete, at least 10 days for Class AA concrete or 7 days for high early strength concrete before dampproofing.

(C) Application

Give the concrete surfaces 2 applications of tar, Grade RT 6. Apply the tar with suitable brushes to secure uniform and thorough applications. Do not apply the second coat of tar until the first coat thoroughly sets. Do not apply dampproofing during any time that the surface is exposed to any moisture. Make sure that the temperature of the tar is such that uniform and thorough application is obtained. Do not backfill until the second coat thoroughly sets.

458-5 MEASUREMENT AND PAYMENT

Method A Waterproofing will be measured and paid as the actual number of square yards of surface that is waterproofed. In measuring this quantity, measurement is made along the actual surface that is to be waterproofed before the waterproofing is applied.

Method B Dampproofing will be measured and paid as the actual number of square yards of surface that is dampproofed. In measuring this quantity, measurement is made along the actual surface that is to be dampproofed before the dampproofing is applied.

These prices and payments will be full compensation for all items required to waterproof and dampproof including, but not limited to, those items contained in Article 458-1.

Payment will be made under:

Pay Item	Pay Unit
Method A Waterproofing	Square Yard
Method B Dampproofing	Square Yard

SECTION 460
CONCRETE AND METAL RAILS

460-1 DESCRIPTION

Furnish and place metal, pipe or concrete barrier bridge rails, concrete curbs and concrete end posts in accordance with these specifications and as shown in the plans. Provide concrete barrier rails with moment slabs above retaining walls in accordance with the contract and accepted submittals. Furnish posts, rail bars, pipe fittings, hardware, paint, barrier delineators, concrete, reinforcing steel, admixtures, forms, falsework and all other materials; galvanize; paint; fabricate and erect rail; and place, finish and cure concrete.

460-2 MATERIALS

Refer to Division 10.

Item	Section
Aluminum Rail	1074-5
Barrier Delineators	1088-2
Curing Materials	1026
Epoxy Coated Reinforcing Steel	1070-7
Galvanized Steel Rail	1074-5
Paint	1080
Pipe Rail	1074-6
Portland Cement Concrete	1000
Reinforcing Steel	1070

Use Class AA concrete for concrete barrier rails, concrete curbs and end posts, and Class A concrete for moment slabs in accordance with Article 1000-3. Use epoxy coated reinforcing steel for concrete barrier rails in accordance with Article 1070-7.

460-3 CONSTRUCTION METHODS

Adhere to the construction load limitations of Article 420-20 while placing concrete for all bridge rails.

(A) Metal Rail

Use either aluminum or galvanized steel rail, but use the same material on all structures on the project on which metal rail is required.

Use shims if necessary to obtain correct post alignment.

Drive aluminum rivets cold. Thoroughly coat the base of aluminum rail post, closure plates, shims or any other aluminum surface in contact with concrete with an approved aluminum impregnated caulking compound.

(B) Pipe Rail

Give galvanized pipe rail one field coat of organic zinc repair paint, of minimum wet thickness of 1.5 mils, after erection in accordance with Section 442 unless otherwise required in the contract.

(C) Concrete Barrier

This subarticle applies to the construction of concrete barrier rail, vertical concrete barrier rail, concrete curbs, median barrier rail and concrete parapet, referred to collectively as concrete barrier rail.

Plans for the concrete barrier rail are detailed for slip-formed CIP concrete. Unless otherwise noted, construct concrete barrier rail detailed in the plans using conventional forms or by slip-forming using an approved self-propelled extrusion machine. Except as noted herein, construct in accordance with Section 420.

Construct joints in the barrier rails at the locations and of the type shown in the plans.

Construct concrete barrier rail to the shape, line, grade and dimensions shown in the plans except that when slip-forming rails, either radius or chamfer the corners. Check slip-formed rail concrete directly behind the extrusion machine using successive overlapping applications of the 10 foot straightedge. Correct high and low areas while the concrete is still workable. Limit horizontal and vertical deviation from plan line and grade to no more than 1/4 inches in 10 feet.

Provide sufficient internal vibrators to consolidate the concrete along the faces of forms and adjacent to joints. Consolidate the concrete by internal vibration in one pass of the

extrusion machine. Produce a dense and homogeneous barrier free of voids and honeycomb with minimum hand finishing. Coordinate concrete delivery and placement to provide uniform progress while minimizing stopping and starting of the extrusion machine.

When plans require horizontal deck drains through the barrier rails, use drain couplings with slip-formed rails.

Correct all exposed surfaces that are not satisfactory to the Engineer as to uniformity of color and texture or because of excessive patching as required. Give the roadway face of barrier rails constructed using conventional forms a Class 2 surface finish in accordance with Subarticle 420-17(F). Use a broom finish on the roadway face of slip-formed barrier rails.

Provide barrier rail delineators in accordance with Section 854.

(D) Concrete Barrier Rail with Moment Slab

Construct concrete barrier rails with moment slabs in accordance with the plans and accepted submittals. Construct concrete barrier in accordance with Subarticle 460-3(C) and moment slab in accordance with Section 420. Do not remove moment slab false work until concrete achieves a minimum compressive strength of 2,400 psi.

460-4 MEASUREMENT AND PAYMENT

____ *Bar Metal Rail* will be measured and paid as the actual number of linear feet of metal rail, measured along the top bar of the rail that is completed and accepted.

32" Alaska Rail and 42" *Oregon Metal Rail* will be measured and paid as the actual number of linear feet of bridge railing and concrete curb. Concrete end post payment shall be included in the cost to provide the concrete curb. The price and payment will be full compensation for all materials, labor, equipment, tools, and incidentals necessary to construct the bridge railing, the concrete curb and concrete end posts.

__" *Galvanized Steel Pipe Rail* will be measured and paid as the actual number of linear feet of pipe rail, measured along the top pipe of the installed pipe rail, that is completed and accepted.

Concrete Barrier Rail will be measured and paid as the number of linear feet of concrete barrier rail shown in the plans.

Concrete Barrier Rail with Moment Slab will be measured and paid for in linear feet. Concrete barrier rails with moment slabs will be measured as the length of concrete barrier rail above retaining walls. The contract unit price for *Concrete Barrier Rail with Moment Slab* will be full compensation for earthwork, materials, hauling and any incidental labor for providing concrete barrier rails with moment slabs in accordance with the contract.

Vertical Concrete Barrier Rail will be measured and paid as the number of linear feet of vertical concrete barrier rail shown in the plans.

Concrete Median Barrier will be measured and paid as the number of linear feet shown in the plans.

____ *x* ____ *Concrete Parapet* will be measured and paid as the number of linear feet of concrete parapet shown in the plans.

There will be no direct payment for bridge rail delineators as they are incidental to the work being performed.

These prices and payments will be full compensation for all items required to provide bridge railing including, but not limited to, those items contained in Article 460-1.

Payment will be made under:

Pay Item	Pay Unit
____ Bar Metal Rail	Linear Foot
32" Alaska Rail	Linear Foot
42" Oregon Rail	Linear Foot
__" Galvanized Steel Pipe Rail	Linear Foot
Concrete Barrier Rail	Linear Foot
Concrete Barrier Rail with Moment Slab	Linear Foot
Vertical Concrete Barrier Rail	Linear Foot
Concrete Median Barrier	Linear Foot
____ x ____ Concrete Parapet	Linear Foot

SECTION 462
SLOPE PROTECTION

462-1 DESCRIPTION

Construct slope protection under the ends of bridges or at other locations in accordance with details shown in the contract. Excavate and backfill, furnish and place concrete, reinforcement and other materials. Unless otherwise noted in the plans, use CIP reinforced concrete.

462-2 MATERIALS

Refer to Division 10.

Item	Section
Curing Materials	1026
Joint Fillers	1028-1
Low Modulus Silicone Sealant	1028-3
Portland Cement Concrete, Class B	1000
Wire Reinforcement	1070-3

462-3 CONSTRUCTION METHODS

Immediately before placing the concrete slope protection, properly shape and firmly compact the slope so it conforms to the required lines and grades.

Construct concrete slope protection in accordance with Section 420, except as otherwise provided herein. Furnish and place reinforcement as shown in the plans and in accordance with Section 425. After placing the concrete for one section, strike it off to plan grade and finish to a dense and uniform surface.

Provide a reasonably smooth and uniform surface for the finished slope protection that does not vary more than 1/2 inch in a distance of 10 feet.

Do not place backfill adjacent to concrete slope protection at any one end bent until each individual section of concrete slope protection at the end bent cures for 3 or more curing days in accordance with Subarticle 420-15(A). Place backfill no later than 5 calendar days after the last section of concrete slope protection placed at the end bent cures for 3 curing days. Compact all backfill to a degree comparable to the adjacent undisturbed material.

462-4 MEASUREMENT AND PAYMENT

__" *Slope Protection* will be measured and paid as the actual number of square yards of slope protection, measured along the top surface of the concrete slope protection, which is completed and accepted.

The price and payment will be full compensation for all items required to provide slope protection including, but not limited to, those items contained in Article 462-1.

Payment will be made under:

Pay Item	Pay Unit
__" Slope Protection	Square Yard

DIVISION 5
SUBGRADE, BASES AND SHOULDERS

SECTION 500
FINE GRADING SUBGRADE, SHOULDERS AND DITCHES

500-1 DESCRIPTION

Perform the work covered by this section on all portions of the project which will be paved under the contract including, but not limited to, preparing, grading, shaping, manipulating moisture content and compacting either an unstabilized or stabilized roadbed to a condition suitable for placement of base course, pavement and shoulders. Clean, shape and maintain roadway ditches; strip existing vegetation; and place and compact in accordance with Sections 235 and 560 all materials resulting from the shaping operation. Stockpile surplus material for the construction of shoulders and dispose of any necessary surplus stockpile material as waste.

On those portions of the project where there is no pavement to be placed under the contract, perform the work of Sections 225 or 230, depending upon the source of the material. This section will not be applicable to such work.

500-2 CONSTRUCTION METHODS

(A) General

Shape the roadway to conform to the lines, grades and typical sections shown on the plans. Strip all existing vegetation from the ground surface wherever shaping of the roadway is to be done. Use all suitable surplus material in the construction of the roadway or stockpile for use in shoulder construction. Dispose of surplus material in excess of that needed for roadway or shoulder construction as waste. Obtain additional material, if needed, from roadway excavation or borrow sources.

Remove all unsuitable material, boulders and all vegetative matter and replace with suitable material. Obtain suitable material, when not available from the shaping or fine grading operation, from roadway excavation or borrow sources.

Clean, reshape and maintain roadway ditches in a satisfactory condition until final acceptance of the project. Conduct operations so as to avoid damage to any previously constructed structures and facilities.

(B) Preparation of Subgrade

Shape the subgrade to the lines, grades and typical sections shown on the plans. Where the Engineer directs that areas of the subgrade are to be stabilized with aggregate, the subgrade surface in such areas may, subject to the approval of the Engineer, be left uniformly below grade to provide for the addition of the stabilizer material.

Store or stockpile material excavated in preparing the subgrade so as to not interfere with proper drainage or later operations of stabilization, placing base or placing pavement.

(C) Compaction of Subgrade

Compact all material to a depth of 8 inches below the finished surface of the subgrade to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T 99 as modified by the Department. Copies of these modified testing procedures as described in the *Conventional Density Operator's Manual* are available from the Materials and Tests Unit on the Department's website.

Compact the subgrade at a moisture content which is approximately that required to produce the maximum density indicated by the above test method. Dry or add moisture to the subgrade when required to provide a uniformly compacted and acceptable subgrade.

Where the subgrade is to be stabilized with lime, aggregate or cement, the above density requirements will not apply before the incorporation of the stabilizing material; however, perform compaction in accordance with Articles 501-10, 510-3 or 542-9, as appropriate.

500-3 TOLERANCES

A tolerance of ± 1/2 inch from the established grade will be permitted after the subgrade has been graded to a uniform surface. Subgrade tolerance of ± 1/4 inch from the established grade is required for subgrade under concrete pavement mainline lanes.

Perform the grading operation such that the maximum difference between the established grade and the graded subgrade within any 100 foot section is 1/2 inch for normal subgrade and 1/4 inch for subgrade for concrete pavement.

500-4 MAINTENANCE OF SUBGRADE

Provide and maintain ditches and drains to drain the subgrade satisfactorily. Where previously approved subgrade is damaged by natural causes, hauling equipment or other traffic, restore the subgrade to the required lines, grades, typical sections and density.

500-5 MEASUREMENT AND PAYMENT

Fine Grading will be paid at the contract lump sum price. Such lump sum price will be full payment for all material excavated to a depth of 0.4 feet below the existing graded surface.

Any material which has been excavated from the subgrade at the depth greater than 0.4 feet below the existing graded surface will be *Unclassified Excavation* and will be paid in accordance with Article 225-7.

As an exception to the above, on those areas in which the Contractor is responsible for constructing the embankment on which the subgrade is located, no payment will be made for that excavation that may be necessary to bring the grade to the established subgrade elevation and typical section. Incorporate such surplus material into the project at no additional cost to the Department.

When sufficient material is not available from the fine grading operation to complete the work of fine grading, additional material will be paid in accordance with Article 225-7 for *Unclassified Excavation* or Article 230-5 for *Borrow Excavation*, depending on the source of material.

Surplus material stockpiled for shoulder construction and incorporated into the work will be paid in accordance with Article 560-4 for *Shoulder Borrow*. No payment will be made for the removal and disposal of any surplus material remaining in the stockpile after the shoulders have been completed.

Maintenance, repair and restoration of the subgrade to the required lines, grades, typical sections and density as it applies to fine grading is incidental to the work of this section.

Payment will be made under:

Pay Item	**Pay Unit**
Fine Grading	Lump Sum

SECTION 501
LIME-TREATED SOIL

501-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, treating the subgrade, embankment, natural ground or existing pavement structure by adding water and lime in the form specified herein, mixing, shaping, compacting and finishing the mixture to the required density. Prepare the soil layer to be stabilized; haul, proportion, spread and mix the materials within the depth range as shown on plans; manipulate, compact and finish the lime-treated soil; correct, repair and maintain the lime-treated soil; and apply a sand seal in accordance with the requirements of Article 501-3. Construct the work in accordance with the typical sections, lines and grades shown on the plan.

501-2 MATERIALS

Refer to Division 10.

Item	Section
Lime	1052-1
Water	1024-4

Use soil material which consists of material upon which the pavement is to be placed, existing material upon which the embankment is to be placed, approved borrow material or a combination of these materials proportioned as directed by the Engineer. Remove all vegetation, roots or other objectionable matter from the soil, as well as all aggregate or stone larger than 2 inches for the full depth to be treated.

501-3 LIMITATIONS

Do not perform lime stabilization when the air temperature is below 45°F. Do not mix the lime with frozen soils or when the soils contain frost. Apply lime to such areas as can be initially mixed and sealed during the day of application. Do not apply lime when wind conditions are such that blowing lime becomes hazardous to traffic, workers or adjacent property owners or when excessive loss of lime may occur.

Do not construct lime-treated soil that will not be covered with a layer of pavement or base by December 1 of that same calendar year. The Engineer may suspend the lime stabilization operations in writing when he determines that the Contractor will not cover the completed stabilization by December 1 as specified above.

Failure of the Contractor to cover the lime-treated soil as required will result in the Engineer notifying the Contractor in writing to cover the lime-treated soil with a sand seal. Apply the sand seal in accordance with Section 660, except Articles 660-3 and 660-12 will not apply. If the Contractor fails to apply the sand seal within 72 hours after receipt of such notice, the Engineer may proceed to have such work performed by other forces and equipment. The application of the sand seal by the Contractor or other forces will in no way relieve the Contractor of the responsibility to maintain or repair the damaged stabilization, no matter what the cause of damage, at no cost to the Department.

501-4 EQUIPMENT

(A) General

Use any combination of machines and equipment to produce the required results that meet the approval of the Engineer. Correct any leakage of fluids or materials promptly or the Engineer may order such equipment removed and replaced with satisfactory equipment. Use equipment and methods for applying lime, water, curing seal and blotting sand that will not damage the base and in accordance with Article 107-21.

(B) Lime Spreaders

Spread lime at the required rate by methods and equipment which have been approved.

(C) Water Distribution Equipment

Add water to the soil with a pressure distributor or other suitable equipment capable of uniformly distributing the required amount.

(D) Mixers

Perform mixing with a self-propelled rotary mixer, except that disc harrows, motor graders and other equipment may be used only to supplement the mixing done by the rotary mixer.

Use mixing equipment capable of mixing to a compacted depth of at least 10 inches.

(E) Compaction Equipment

Use compaction equipment that is self-propelled. Perform finish rolling with a pneumatic tired roller, or as permitted, a smooth, steel-wheel roller or a combination of both types.

(F) Scarifying Equipment

Use a grader-scarifier for the initial scarification of the soil. Use equipment capable of scarifying to the full depth of the stabilized treatment. When required, use a weeder, spiketooth harrow or nail drag, followed by a broom drag to scarify during finishing operations.

501-5 PROTECTION AND SAFETY

Take necessary precautions to protect personnel from dust created by the lime application and mixing operation to include eye protection, dust masks and appropriate training.

501-6 PREPARATION OF ROADBED

Before the addition of any lime to the soil, grade and shape the area to be stabilized in accordance with the typical sections, lines and grades shown on the plans. Remove all materials such as aggregate larger than 2 inches, roots and turf.

501-7 SCARIFYING

When required by the method of application, scarify the soil to the required depth and width and then partially pulverize by making one pass through the area with a pulverizing rotary mixer. Delete the pulverizing portion of the scarifying operation in areas where the soil types or conditions make pulverizing with a rotary mixer impractical.

501-8 APPLICATION OF LIME

(A) General

When the Contractor has brought the soil layer to the elevation required by the plans, the Engineer will sample the soil and determine the quantity of lime to be incorporated. Allow 24 calendar days for the Engineer to perform the required sampling, testing and final design of the lime stabilization. The optimum moisture will be determined by the Engineer.

Spread lime or lime slurry only on an area of such size that all primary mixing operations can be completed in the same day during daylight hours, except where the work is to be done at night as required by the contract.

Incorporate the lime or lime slurry into the soil mixture at the rates determined by the Engineer. Distribute the lime at the uniform rate and minimize the scattering by the wind. Mix the lime into the soil within 2 hours after application.

No equipment, except that used in spreading, slaking and mixing, will be allowed to pass over the freshly spread lime until it is mixed with the soil.

(B) Slurry Method

Do not add lime slurry to the soil when the moisture content exceeds 2% above optimum moisture. Aerate soil or allow to dry naturally until the soil contains no more than 2% above optimum moisture.

Mix hydrated lime applied by this method with water in approved agitating equipment and apply to the soil to be treated as a thin water suspension or slurry. When quicklime is used to produce the slurry, use equipment specifically manufactured for the slaking of quicklime. Use distributing equipment that provides continuous agitation of the slurry from the slurry production site until the slurry is applied to the soil. Proportion the lime so that the dry solids content is at least 30% by weight.

Split the lime application into approximately 2 equal applications with the first being partially mixed into the soil to a minimum depth of 3 inches before applying the second application.

(C) Quicklime

Do not add dry quicklime to the soil when the moisture content exceeds 4% above optimum moisture. Aerate soil or allow to dry naturally until it contains no more than 4% above optimum moisture.

Where the "Bottom-Dump" method of application is used, omit the preliminary scarification of the soil surface. Apply the quicklime by slowly driving the tanker truck over the coverage area with the bottom discharge valves open creating a windrow of quicklime.

Repeat the process until the tanker is empty in order to provide at least 3, for a 24 foot roadway, reasonably uniform and equally spaced windrows over the area being stabilized. The number of windrows required will depend on the width of the section being stabilized and will be stipulated by the Engineer.

Carefully spread the windrows of quicklime with a motor grader into an equal depth layer over the entire area to be stabilized.

After the lime has been spread, follow with a sprinkling of water to slake the lime. After a complete slaking of the lime, thoroughly mix the lime with the soil. The Engineer may direct that the lime first be mixed into the soil followed by sprinkling and additional mixing to ensure complete slaking of the lime throughout the layer to be stabilized.

(D) Hydrated Lime

Use hydrated lime only with written permission and do not add to the soil when the moisture content exceeds 6% above optimum moisture.

501-9 MIXING

(A) Primary Mixing

Immediately after the lime has been spread and slaked, if required, mix the lime into the soil for the full depth of treatment. Mix the lime into the soil to provide a compacted depth of at least 8 inches. A minimum number of mixing passes will be required to ensure uniform incorporation of the lime. Add water as necessary and thoroughly mix with the soil lime mixture so that the mixture contains no less than optimum moisture. A tolerance of 3% above optimum will be allowed. Incorporate all of the lime thoroughly and uniformly into the soil layer to the full depth of treatment so that the result is a homogeneous, friable mixture of soil and lime, free of clods or lumps exceeding 2 inches in size.

After primary mixing operations and before curing, shape and lightly compact the lime-treated area to the approximate section to allow for proper drainage and to minimize evaporation loss.

(B) Preliminary Curing

Following primary mixing operations, cure the stabilized layer for 1 to 4 days. The actual duration of this curing period will be determined by the Engineer. During the curing period, keep the surface of the material moist to prevent drying and cracking and maintain in a properly sealed and crowned condition. Mix, compact, shape and finish the stabilized layer no later than 4 days after primary mixing.

(C) Final Mixing and Pulverizing

Immediately after the completion of the preliminary curing period, mix and pulverize completely the stabilized layer to the full depth of the stabilization. Continue the final mixing until all of the clods are broken down to pass a 1/2 inch sieve and at least 80% pass a No. 4 sieve, exclusive of rock. Add water, as required, during the final mixing to raise the moisture content before compaction.

501-10 COMPACTING, SHAPING AND FINISHING

Begin compaction of the mixture immediately after completion of the final mixing operations. Aerate or moisten the mixture as necessary during compaction operations to maintain the moisture between optimum and optimum plus 2%. Compact the full depth of the mixture to a density equal to at least 97% of that obtained by compacting a sample of the soil lime mixture in accordance with AASHTO T 99 as modified by the Department. Copies of these modified procedures are available upon request from Materials and Tests Unit. Accompany the compaction with sufficient blading to eliminate irregularities.

Perform the final rolling of the completed surface with a pneumatic-tired roller or if permitted a smooth, steel-wheel roller.

Complete shaping, final mixing, compacting and finishing on the same day upon completion of the preliminary curing. This work is to be completed no later than 4 days after primary mixing and done during daylight hours, unless otherwise provided in the contract. If the above work is not completed as specified, rip up the entire section and add additional lime, as directed by the Engineer, at no additional cost to the Department.

501-11 THICKNESS

The compacted thickness of the completed treated soil layer will be determined by measurements made in test holes located at random intervals not to exceed 500 feet. Do not deviate the measured thickness from that shown on the plans by more than plus 1 inch or minus 1/2 inch.

Where the lime-treated soil layer is deficient in thickness by more than 1/2 inch, remove and replace the area of deficient thickness with lime-treated soil having the required thickness at no cost to the Department.

As an exception to the above, if the deficiency is not considered sufficient to seriously impair the required strength of the lime-treated soil layer, the deficient area may, at the discretion of the Engineer, be left in place.

501-12 FINAL CURING

After the lime-treated soil has been finished in accordance with Article 501-10, protect it against drying for a 7 day curing period in accordance with Section 543.

501-13 TRAFFIC

Completed sections of the lime-treated soil may be opened when necessary to lightweight local traffic, provided it has hardened sufficiently to prevent marring or distorting of the surface and provided the curing is not impaired. Do not use construction equipment on the lime-treated soil, except as necessary to discharge material into the spreader during paving operations or except as may be otherwise permitted for embankment construction.

501-14 MAINTENANCE

Maintain the lime-treated soil in an acceptable condition until final acceptance of the project. Include immediate repair of any defects or damage in maintenance operations. Repeat as necessary to keep the lime-treated soil in an acceptable condition. Perform repairs to lime-treated soil by replacing the lime-treated soil for its full depth rather than by adding a thin layer of lime stabilized material to the existing layer. An alternate repair method may be used if approved in writing.

501-15 MEASUREMENT AND PAYMENT

Lime-Treated Soil will be measured and paid as the number of square yards of each layer of lime-treated soil that has been completed and accepted. In determining this quantity, the width of the lime-treated soil will be measured across the top surface of the treated layer. The length will be the actual length constructed, measured along the centerline of the surface of the treated layer.

Lime for Lime-Treated Soil where hydrated lime or quick lime is spread directly on the soil in solid form or when hydrated lime is used to produce a slurry, the quantity of lime to be paid will be the number of tons of lime that has been incorporated into the soil at the required rates. No measurement will be made of any lime added or replaced for corrective measures during construction or for repairing damaged areas. Measurement is to be made in bulk in the truck on certified platform scales or other certified weighting devices.

Where quicklime is slaked on the project and applied in slurry form, measurement will be calculated as indicated below for each truckload using the certified lime purity for that load.

A+B = Total hydrated lime produced (pay quantity)

Where:

A = Certified weight of quicklime delivered x % purity x 1.32
B = Certified weight of quicklime delivered x % inert material

Asphalt Curing Seal will be paid in accordance with Article 543-5.

Blotting Sand will be paid in accordance with Article 818-4.

If a layer of lime-treated soil is deficient in thickness but has been permitted to be left in place in accordance with Article 501-11, payment for that lime-treated soil and lime will be made at 50% of the contract unit prices for *Lime-Treated Soil* and *Lime for Lime-Treated Soil*.

Sand seal applied due to the failure of the Contractor to cover the lime-treated soil as required will be incidental to the work of this section. If the Contractor fails to provide sand seal as required and the Engineer has the work performed by other forces, the cost of such work will be deducted from monies due or to become due to the Contractor.

Maintenance, repair and restoration of the lime stabilization is incidental to the work of this section.

Payment will be made under:

Pay Item	Pay Unit
Lime-Treated Soil	Square Yard
Lime for Lime-Treated Soil	Ton

SECTION 505
AGGREGATE SUBGRADE

505-1 DESCRIPTION

Construct aggregate subgrades in accordance with the contract. Install geotextile for subgrade stabilization and place Class IV subgrade stabilization at locations shown in the plans and as directed by the Engineer.

Undercut natural soil materials if necessary to construct aggregate subgrades. Define "subsoil" as the portion of the roadbed below the Class IV subgrade stabilization. For Type 2 aggregate subgrades, undercut subsoil as needed. The types of aggregate subgrades with thickness and compaction requirements for each are as shown below.

Type 1 – A 6 to 24 inch thick aggregate subgrade with Class IV subgrade stabilization compacted to 92% of AASHTO T 180 as modified by the Department or to the highest density that can be reasonably obtained.

Type 2 – An 8 inch thick aggregate subgrade on a proof rolled subsoil with Class IV subgrade stabilization compacted to 97% of AASHTO T 180 as modified by the Department.

505-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextile for Subgrade Stabilization, Type 5a	1056
Select Material, Class IV	1016

Use Class IV select material for Class IV subgrade stabilization.

505-3 CONSTRUCTION METHODS

When shallow undercut is required to construct aggregate subgrades, undercut 6 inches to 24 inches as shown on the plans or as directed by the Engineer. For Type 2 aggregate subgrades, proof roll subsoil in accordance with Section 260 before installing geotextile for subgrade stabilization. Perform undercut excavation in accordance with Section 225.

Do not leave geotextiles exposed for more than 7 days before covering geotextiles with Class IV subgrade stabilization (standard size no. ABC). Install geotextile for subgrade stabilization on subsoil with the long dimension, i.e., machine direction (MD), of the roll parallel to the roadway centerline and completely cover subsoil with geotextiles. For fill sections, the minimum roll width is required under roadway edges and shoulders adjacent to fill slopes as shown in the plans. Overlap adjacent geotextiles at least 18 inches in the direction that ABC will be placed to prevent lifting the edge of the top geotextile. Pull geotextiles taut so they are in tension and free of kinks, folds, wrinkles or creases. Hold geotextiles in place as needed with wire staples or anchor pins.

Do not operate heavy equipment on geotextiles until geotextiles are covered with Class IV subgrade stabilization (standard size no. ABC). Replace any damaged geotextiles to the satisfaction of the Engineer.

Place Class IV subgrade stabilization (standard size no. ABC) by end dumping ABC on geotextiles. Compact ABC as required for the type of aggregate subgrade constructed.

Maintain Class IV subgrade stabilization in an acceptable condition and minimize the use of heavy equipment on ABC in order to avoid damaging aggregate subgrades. Provide and maintain drainage ditches and drains as required to prevent entrapping water in aggregate subgrades.

505-4 MEASUREMENT AND PAYMENT

Shallow Undercut of natural soil materials from subsoil for Type 1 aggregate subgrades will be measured and paid in cubic yards, measured in the original position and computed by the average end area method that is acceptably excavated in accordance with the contract. The contract unit price for *Shallow Undercut* will be full compensation for excavating, hauling and disposing of materials to construct aggregate subgrades.

Undercut Excavation of natural soil materials from subsoil for Type 2 aggregate subgrades will be measured and paid in accordance with Article 225-7 or 226-3. No measurement will be made for any undercut excavation of fill materials from subsoil.

Class IV Subgrade Stabilization will be measured and paid in tons. Class IV subgrade stabilization will be measured by weighing material in trucks in accordance with Article 106-7. The contract unit price for *Class IV Subgrade Stabilization* will be full compensation for furnishing, hauling, handling, placing, compacting and maintaining ABC.

Geotextile for Subgrade Stabilization will be measured and paid in square yards. Geotextiles will be measured along the ground surface as the square yards of exposed geotextiles before placing ABC. No measurement will be made for overlapping geotextiles. The contract unit price for *Geotextile for Subgrade Stabilization* will be full compensation for providing, transporting and installing geotextiles, wire staples and anchor pins.

Payment will be made under:

Pay Item	Pay Unit
Shallow Undercut	Cubic Yard
Class IV Subgrade Stabilization	Ton
Geotextile for Subgrade Stabilization	Square Yard

SECTION 510
AGGREGATE STABILIZATION

510-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, furnishing all aggregate and water; hauling, spreading and mixing the required amount of aggregate with the subgrade materials; shaping and compacting the stabilized subgrade to the required grade and typical section; and maintaining the aggregate.

510-2 MATERIALS

Refer to Division 10.

Item	Section
Stabilizer Aggregate	1008-1

510-3 CONSTRUCTION METHODS

(A) Mixing

Remove sufficient subgrade material, if necessary, to compensate for the addition of the stabilizer aggregate. Spread the quantity of aggregate required by the contract uniformly over the subgrade by means of a mechanical spreader. Spread the aggregate on the subgrade in advance of the mixing operations only to the extent that processing can be completed within one week. Mix the aggregate with the top 3 inches of the subgrade soil. Continue mixing until the aggregate is uniformly mixed with the soil to the width and depth to be treated.

The aggregate shall be sampled, tested and approved before placing layers of base material or pavement thereon.

(B) Shaping and Compaction

Shape the stabilized subgrade to the lines, grades and typical sections shown on the plans.

Compact the entire depth and width of the stabilized subgrade to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T 99 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit. Compact the stabilized subgrade at a moisture content which is approximately that required to produce the maximum density indicated by the above test method. Dry or add moisture to the material as required to provide a uniformly compacted and acceptable subgrade.

510-4 TOLERANCE

A tolerance of ± 1/2 inch from the established grade will be permitted after the stabilized subgrade has been graded to a uniform surface.

Perform grading of the subgrade such that the maximum differential between the established grade and the stabilized subgrade within any 100 foot distance is 1/2 inch.

510-5 PROTECTION

Protect the aggregate stabilized subgrade in accordance with Article 500-4.

510-6 MEASUREMENT AND PAYMENT

Stabilizer Aggregate will be measured and paid as the actual number of tons of aggregate, exclusive of any corrective material, which has been mixed with the completed and accepted subgrade. This quantity will be measured as provided for in Article 520-11.

Payment will be made under:

Pay Item	Pay Unit
Stabilizer Aggregate	Ton

SECTION 520
AGGREGATE BASE COURSE

520-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, constructing a base composed of an approved aggregate material hauled to the road, placed on the road, mixed, compacted and shaped in accordance with the lines, grades, depths and typical sections shown in the plans; applying a sand seal in accordance with Article 520-5; and maintaining the base.

520-2 MATERIALS

Refer to Division 10.

Item	Section
Aggregate Base Course	1005, 1006 and 1010

520-3 METHODS OF PRODUCTION

Furnish aggregate upon which no restrictions are placed on the production or stockpiling, except as provided in Sections 1005, 1006 and 1010. Place aggregates on the roadway which have been sampled, tested and approved in accordance with Article 520-6.

520-4 SUBGRADE PREPARATION

Prepare the subgrade in accordance with Section 500 before placement of the base material.

520-5 HAULING AND PLACING AGGREGATE BASE MATERIAL

Place the aggregate material on the subgrade with a mechanical spreader box capable of placing the material to a uniform loose depth and without segregation; except, for areas inaccessible to a mechanical spreader box, the aggregate material may be placed by other methods approved by the Engineer. In addition, as approved by the Engineer, place by end dumping aggregate on approved sandy subgrade soils to provide a working platform and reduce wheel rutting of the subgrade. When allowed, end dumping will be limited to a uniformly spread thickness of 2 to 3 inches prior to placing the remaining aggregate thickness with a mechanical spreader box.

Where the Contractor elects to use more than one source of aggregate as described in Section 1005, place the various types of aggregate used in an approved manner which will permit the sampling and testing required by Section 1006 and 1010.

Where the required compacted thickness of base is 10 inches or less, the base material may be spread and compacted in one layer. Where the required compacted thickness is more than 10 inches spread the base material and compact in 2 or more approximately equal layers. Compact the base material to a minimum thickness of approximately 4 inches for any one layer.

Have each layer of material sampled, tested, compacted and approved before placing succeeding layers of base material or pavement.

Do not place base material on frozen subgrade or base.

Base course that is in place on November 15 shall immediately be covered with a subsequent layer of pavement structure or with a sand seal. Base course that has been placed between November 16 and March 15 inclusive shall be covered within 7 calendar days with a subsequent layer of pavement structure or with a sand seal. Apply sand seal in accordance with Section 660, except Articles 660-3 and 660-12 will not apply.

Failure by the Contractor to cover the base course as required above will result in the Engineer notifying the Contractor in writing to cover the base course with a sand seal and to suspend the operations of placing aggregate base course until such cover has been placed. If the Contractor fails to apply the sand seal within 72 hours after receipt of such notice, the Engineer may proceed to have such work performed with other forces and equipment. The application of the sand seal by the Contractor or by others will in no way relieve the Contractor of the responsibility to maintain or repair the damaged base or subgrade, no matter what the cause of damage.

Do not allow traffic on the completed base course other than necessary local traffic and that developing from the operation of essential construction equipment as may be authorized by the Engineer. Repair any defects that develop in the completed base or any damage caused by local or construction traffic acceptably. Hauling equipment may be operated with the approval of the Engineer, over a lower layer of base, however, acceptably repair any rutting, weaving or soft areas that develop.

Do not exceed 35 mph with hauling equipment traveling over any part of the base.

Use methods of handling, hauling and placing which will minimize segregation and contamination. If segregation occurs, the Engineer may require that changes to the Contractor's methods and may require mixing on the road to correct segregation. Remove and replace all aggregate which is contaminated with foreign materials to the extent that the base course will not adequately serve its intended use. The above requirements will be applicable regardless of the type of aggregate placed and regardless of prior acceptance.

520-6 SAMPLING, TESTING AND ACCEPTANCE

Perform sampling for the determination of gradation, LL and PI for the various types of aggregate, as defined in Section 1010.

Where visual observation indicates the need to do so, the Engineer may require the Contractor to road mix areas of nonuniform gradation. The Engineer reserves the right to take samples in addition to the lot acceptance samples from within the lot in areas exhibiting nonuniform gradation. When the test results from such an additional sample is outside the gradation limits in Section 1010 and the nonuniformity cannot be corrected by road mixing, the aggregate base course represented by the sample will be rejected and replaced by the Contractor.

520-7 SHAPING AND COMPACTION

Machine and compact the layer of base within 48 hours after beginning the placing of a layer of the base. Maintain each layer to the required cross section during compaction and compact each layer to the required density before placing the next layer.

Compact the base material at a moisture content which is approximately that required to produce a maximum density. Dry or add moisture to the material when required to provide a uniformly compacted and acceptable base. If it is necessary to add water after the material is placed, scarify the material and add water uniformly throughout the full depth of the layer of the base course material. Density determination will be based on Article 520-9.

Shape the final layer of base material in accordance with the lines, grades and typical section as shown on the plans. Construct the base course so that it is smooth, hard, dense, unyielding and well bonded upon completion. A broom drag may be used in connection with the final finishing and conditioning of the surface of the base course.

520-8 TOLERANCES

After final shaping and compacting of the base, the Engineer will check the surface of the base for conformance to the grade and typical section and determine the base thickness.

Construct the base so that the thickness of the base is within a tolerance of ± 1/2 inch of the base thickness required by the plans. When the base course will be used under concrete pavement, the tolerance will be ± 1/4 inch.

Construct the base so that the maximum differential between the established grade and the base within any 100 feet section is 1/2 inch or 1/4 inch when used as a base course under concrete pavement.

520-9 DENSITY DETERMINATION

The Engineer may use nuclear or conventional means as described below to determine the density of selected base course materials required by Sections 520 and 540. The target density will be from the material's most recent AASHTO T 180 test results, which may be obtained from the Materials and Tests Unit.

A new target density is to be obtained when there is a change in the source of material, when a significant change occurs in the composition of the materials from the same source or when determined necessary.

(A) Conventional Method

When electing to use conventional density test number 3 (ring test) to determine density, compact each layer of the base to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHTO T 180 as modified by the Department. Information on these modified testing procedures are available in the *NCDOT Conventional Density Operator's Manual* on line in the Materials and Tests Unit's website.

(B) Nuclear Method

When electing to use a nuclear density gauge to determine density, compact each layer of the base to a density meeting requirements in the *NCDOT Nuclear Density Testing*

Manual – Base Course, FDR and Select Materials. Copies of this manual are available upon request from the Materials and Tests Unit.

520-10 MAINTENANCE

Where the base material is placed in a trench section, provide adequate drainage through the shoulders to protect the subgrade and base until such time as the shoulders are completed.

Maintain the surface of the base by watering, machining, rolling or dragging when necessary to prevent damage to the base by weather or traffic.

Where the base or subgrade is damaged, repair the damaged area; reshape the base to required lines, grades and typical sections; and recompact the base to the required density at no cost to the Department.

520-11 MEASUREMENT AND PAYMENT

Aggregate Base Course will be measured and paid at the contract unit price per ton for the actual number of tons of aggregate which has been incorporated into the completed and accepted work. Sampling and acceptance will be determined in accordance with Section 1010.

The aggregate will be measured by being weighed in trucks on certified platform scales or other certified weighing devices. If permitted by the contract, the weight of base course material shipped by barge may be determined from water displacement measurements.

No deductions will be made for any moisture contained in the aggregate at the time of weighing.

Sand seal applied due to the failure of the Contractor to cover the base course as required will be incidental to the work of this section. If the Contractor fails to provide sand seal as required and the Engineer has the work performed by other forces, the cost of such work will be deducted from monies due or to become due to the Contractor.

Maintenance, repair and restoration of the base course and subgrade is incidental to the work of this section. If segregation during handling, hauling or placing occurs and the Engineer requires a change in methods or mixing on the road to correct this segregation, this work will be incidental to the work of this section. Removal and replacement of aggregate which is contaminated with foreign materials or outside the gradation limits will be incidental to the work of this section.

Payment will be made under:

Pay Item	Pay Unit
Aggregate Base Course	Ton

SECTION 535
CONDITIONING EXISTING BASE

535-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, scarifying, shaping, furnishing water, compacting and maintaining the base. Included in the work is:

(A) Conditioning of an existing base to prepare it for the placement of a pavement directly upon the base. Included in the conditioning is scarifying, shaping and compacting the base to conform to the required lines, grades, depths and typical sections established by the plans.

(B) Conditioning of an existing base in preparation for the placement of additional layers of base material. Included in the conditioning is scarifying, shaping and compacting the base to conform to the approximate lines, grades, depths and typical sections established by the plans.

535-2 CONSTRUCTION METHODS

Compact the base to a degree satisfactory to the Engineer. Dry or add moisture to the material when required to provide a uniformly compacted and acceptable base.

Do not condition the existing base when it contains excess moisture or is frozen.

Maintain the base in accordance with Article 520-10.

535-3 MEASUREMENT AND PAYMENT

Conditioning Existing Base will be measured and paid at the contract unit price per 1,000 square yards for the actual number of units of 1,000 square yards of base over which the work of conditioning existing base has been acceptably performed. The length will be measured along the centerline of the surface of the base. The width will be the width required by the plans or established by the Engineer measured across the top surface of the base.

Payment will be made under:

Pay Item	Pay Unit
Conditioning Existing Base	1,000 Square Yards

SECTION 540
CEMENT-TREATED BASE COURSE

540-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, construction and curing a cement-treated base composed of aggregate, furnishing of water and aggregate; the mixing, proportioning, hauling and spreading of the materials; furnishing Portland cement at the point where it is incorporated into the mix; manipulating, compacting and finishing the base; maintaining the base; making repairs or corrections to the base; and applying sand seal in accordance with Article 540-3. Compact, shape and cure the base to conform to the lines, grades, depths and typical sections shown on the plans.

When cement-treated base course is called for on the plans, the Contractor has the option of providing a plant mixed cement-treated base course or a road mixed cement-treated base course as specified below.

540-2 MATERIALS

Refer to Division 10.

Item	Section
Aggregate	1010
Portland Cement, Type I	1024-1
Water	1024-4

540-3 LIMITATIONS

Do not construct cement-treated base when the air temperature is less than 40°F nor when conditions indicate that the temperature may fall below 40°F within 24 hours. Do not incorporate frozen materials into the mixture nor place material on frozen subgrade. Protect the base from freezing for 7 days after completion.

Do not place cement-treated base that will not be covered with pavement by December 1 of the same year. Failure of the Contractor to cover the cement-treated base as required above will result in the Engineer notifying the Contractor in writing to cover the cement-treated base with a sand seal. Apply the sand seal in accordance with Section 660, except Articles 660-3 and 660-12 will not apply. If the Contractor fails to apply the sand seal within 72 hours after receipt of such notice, the Engineer may proceed to have the work performed with other forces and equipment. The application of the sand seal by the Contractor or other forces will

in no way relieve the Contractor of the responsibility to maintain or repair the damaged base, no matter what the cause of damage.

540-4 PREPARATION OF SUBGRADE

Prepare the subgrade in accordance with Section 500. Prepare the subgrade so that it is firm and able to support without displacement the construction equipment and the compaction operations hereinafter specified. Soft or yielding subgrade shall be corrected and made stable before construction proceeds. Moisten the subgrade as needed before spreading the base material.

540-5 CONSTRUCTION METHODS

(A) Composition of Mixture

When the Contractor proposes to use a source of aggregate that is not documented by a currently approved job mix formula, submit to the Department's Materials and Tests Unit, samples of all aggregates proposed for use at least 3 weeks before beginning production. Take the aggregate samples in the presence of the Engineer. Submit in writing the proposed gradation for the cement-treated base material. The Department will then prepare a mix design based upon the samples submitted and the Contractor's stated proposed gradation.

A job mix formula will be established for the cement-treated base material within the design limits in Section 1010. Use the job mix formula unless modified in writing by the Engineer.

Prepare all cement-treated base material mixtures so that they conform to the job mix formula within the tolerance ranges specified in Table 540-1. If the Contractor is unable to maintain the production within the tolerance ranges specified in Table 540-1 for two consecutive lots, production will stop until such time as a new mix design and job mix formula has been established and approved by the Engineer.

TABLE 540-1
TOLERANCES FOR JOB MIX FORMULA
PORTLAND CEMENT-TREATED BASE

Sieve Size	Tolerance for Percent Passing
1 1/2"	0
1"	± 5
1/2"	± 8
No. 4	± 7
No. 10	± 7
No. 40	± 4
No. 200	± 2
Material Passing No. 10 Sieve (Soil Mortar)	
No. 40	± 8
No. 200	± 5

(B) Plant Mixed Cement-Treated Base Course

(1) Mixing

(a) General

Add to the aggregate the quantity of cement specified by the Engineer.

Thoroughly mix the cement, aggregates and water in an approved central mixing plant. Use a batch or continuous-flow type stationary mixer and equip it with feeding and metering devices that will add aggregate, cement and water into the mixer in the specified quantity. Use batch weights or rates of feed of cement that are within 0.3% of the quantity designated by the Engineer. Use batch

weights or rates of flow of water that are within a range of optimum to optimum plus 1.5% moisture. Use batch weights or rates of feed of aggregate that are within 5% of the amounts designated by the Engineer.

Mix materials at least 20 seconds to assure a proper blend of materials.

(b) Batch Type Plant

Equip the mixer with a sufficient number of paddles of a type and arrangement to produce a uniformly mixed batch.

Add water during the mixing operation as required to provide the quantity of moisture specified; however, do not add water to the mixture before the aggregate and cement have been mixed sufficiently to prevent the formation of cement balls.

Equip the mixer with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period.

(c) Continuous Flow Type Plant

Calibrate and mark cement storage silos so that the amount of cement in the silo can be readily determined at any time. Design feeders and/or meters for introducing the cement into the mixer such that the amount of cement can be accurately determined before it is introduced into the mixer. Use a variable speed motor on the cement feeder which is regulated by a control mechanism indicating the speed of the motor in rpm or equivalent measure. Design the indicator so that it can be read in daylight from a point 4 feet from the indicator. Equip the cement holding tank which is used in feeding cement with an air pressure gauge and air pressure regulating control such that air pressure can be regulated to a uniform flow.

Measure the water by a meter which determines flow in gallons per minute and control it with 2 valves. Use a variable flow valve for controlling the rate of flow of the water only on one valve and use an on-off valve connected to the plant controls such that the water is turned on and/or off when the plant is started and stopped for the other valve.

After the material has been processed by the pug mill, store it in a holding bin with the minimum capacity of 3 tons before discharging into trucks. Hold the material in the holding bin for loading purposes only and do not store for loading subsequent trucks. Loading trucks directly from a belt or auger box will not be permitted.

Have available a satisfactory platform for obtaining samples from trucks. Make provisions for calibrating the plant daily and at other times as deemed necessary by the Engineer. On plants that are electronically controlled, manual calibration will be required to verify the electronic calibration and shall be performed at the beginning of a project. If the plant operation is interrupted by more than 4 calendar days during an active project, perform the manual calibration process again. Perform random manual calibrations at the direction of the Engineer.

(2) Hauling and Placing

Haul the mixed base material to the roadway in trucks with protective covers to avoid moisture loss. Do not exceed one hour between the loading of the haul trucks and the beginning of compaction.

Place stringlines for alignment control for placing a layer of base.

Place the base in a uniform layer on the moistened, prepared subgrade to produce the depth required by the plans. To ensure homogenous distribution of the base material

in each layer, place the material using approved spreaders. Perform the spreading operations to eliminate pockets of material of non-uniform gradation resulting from segregation in the hauling or discharging operations. Spread each layer so that compaction can be started without further shaping.

A single spreader may be used provided it is capable of placing a uniform, full-depth layer of material across the full width of the base in one pass. Otherwise, 2 or more spreaders will be required and operate the spreaders so that the spreading progresses along the full width of the base in a uniform manner.

Base placed on areas inaccessible to mechanical spreading equipment may be spread in one layer by approved methods. After spreading, compact the material thoroughly to the required lines, grades and typical sections by means of pneumatic tampers or with other compaction equipment which will constantly obtain the degree of compaction required.

(C) Road Mixed Cement-Treated Base Course

(1) Equipment

Use any combination of machines or equipment that will produce the required results meeting the approval of the Engineer. Use a cement spreader which has an adjustable rate of flow and the capability of spreading the required amount of cement in one pass. Mix cement, aggregate and water with a self-propelled rotary mixer capable of mixing to a depth of 10 inches. Correct any leakage of fluids and/or materials promptly or the Engineer may order such equipment removed and replaced with satisfactory equipment. Use equipment and methods for applying cement, water, curing seal and blotting sand that does not damage the base and in accordance with Article 107-21.

(2) Spreading and Mixing

Place the required quantity of aggregate on the prepared subgrade in a uniform layer. Spread aggregate on the subgrade in advance of the mixing operations only to the extent that processing can be completed within one week. Apply the required quantity of cement in a uniform spread on the aggregate in place and immediately blend the aggregate until the cement is uniformly distributed throughout the aggregate. Maintain the moisture content at or below the optimum moisture at the time of application of the cement. Do not apply cement on excessively windy days and apply only to such an area that all operations shall be completed on the same day during daylight hours.

The Engineer will establish the actual cement content during construction.

Immediately after the aggregate and cement have been thoroughly blended, apply water as needed and incorporate into the mixture. Control the application of the water so that there is no excessive concentration on or near the surface of the mixture. After the necessary water has been applied, continue mixing until a thorough and uniform mixture is obtained.

Maintain the moisture content at the time of final mixing and during compaction within a range of optimum to optimum plus 1.5% as determined. Make sure that the moisture content in the mix does not exceed the quantity that will cause the base course to become unstable during compaction or finishing operations.

540-6 COMPACTION

Begin compaction immediately after the plant mixed base has been placed on the prepared subgrade or immediately after cement and water has been incorporated into the previously placed aggregate. Compact any one layer of base so the thickness is between 4 inches and 8 inches.

After spreading, maintain the moisture content of the material within a range of optimum to optimum plus 1.5% moisture during compaction.

Accomplish compaction by the use of approved self-propelled rollers, except do not use a sheep-foot roller for more than 2 passes. Compact the base by the use of approved self-propelled rollers to a density equal to at least 97% of the maximum density obtained by compacting a sample of the material in accordance with AASHTO T 180 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit. The Engineer may, at his option, utilize nuclear methods as described in the *NCDOT Nuclear Density Testing Manual – Base Course, FDR and Select Materials* to determine the density of the base instead of the methods required above. Copies of this manual are available upon request from the Materials and Tests Unit.

Complete final compaction, including that necessary due to correction of high or low areas, within 3 hours after water has been added to the mixture. Do not leave any cement-aggregate mixture undisturbed for more than 30 minutes if it has not been compacted and finished. When rain causes excessive moisture, reconstruct the entire section. When such reconstruction is necessary, perform the work of reconstruction and provide the cement required at no cost to the Department.

540-7 CONSTRUCTION JOINTS

Build the base for large, wide areas in a series of parallel lines of convenient length and width meeting the approval of the Engineer. Form straight longitudinal joints at the edge of each day's construction by cutting back into the completed work to form a vertical face free of loose or shattered materials. Where traffic considerations require that a longitudinal joint be exposed for an excessive length of time, the Engineer may require that it be covered with a curing seal in accordance with Section 543.

540-8 TOLERANCES

After final shaping and compacting of the base, the Engineer will check the surface of the base for conformance to the grade and typical section and determine the base thickness.

Construct the thickness of the base so that it is within a tolerance of ± 1/2 inch of the base thickness required by the plans. When the base course will be used under concrete pavement the tolerance will be ± 1/4 inch.

Construct the base so that the maximum differential between the established grade and the base within any 100 foot section is 1/2 inch or 1/4 inch when used as a base course under concrete pavement.

540-9 CURING

After the cement-treated base has been finished as specified herein, cure it in accordance with Section 543.

540-10 AGGREGATE FOR CEMENT-TREATED BASE

Use aggregate for cement-treated base course from an approved source participating in the Department’s Aggregate Quality Control/Quality Assurance Program (Aggregate QC/QA Program) which has been sampled, tested and approved in accordance with Section 1006.

540-11 TRAFFIC

Completed sections of the base may be opened when necessary to lightweight local traffic, provided the base has hardened sufficiently to prevent marring or distorting of the surface and provided the curing is not impaired. Do not operate construction equipment on the base, except as necessary to discharge into the spreader during paving operations.

540-12 MAINTENANCE

Maintain the base in an acceptable condition until final acceptance of the project. Include immediate repair of any defects or damage that may occur in any maintenance operation. Perform this maintenance at no cost to the Department and repeat as often as may be necessary to keep the base in an acceptable condition. Perform repairs to the base by replacing the base for its full depth rather than by adding a thin layer of cement-stabilized material to the existing layer of base.

540-13 MEASUREMENT AND PAYMENT

Aggregate for Cement-Treated Base Course will be measured and paid at the contract unit price per ton that has been incorporated into the completed and accepted work. The quantity will be measured by weighing in trucks on certified platform scales or other certified weighing devices. No deduction will be made for any moisture contained in the aggregate at the time of weighing. Measurement will not be made of any base mixture added or replaced for corrective measures during construction or for repairing damaged areas.

Portland Cement for Cement-Treated Base Course will be measured and paid at the contract unit price per ton that has been incorporated into the mix. When bulk cement is used, the quantity will be measured by weighing in trucks on certified platform scales or other certified weighing devices. When cement-treated base is produced at a commercial source for more than one project, the Engineer may elect to measure the cement based upon the cement content shown in the approved job mix formula. Measurement will not be made of any cement added or replaced for corrective measures during construction or for repairing damaged areas.

Asphalt Curing Seal will be paid in accordance with Article 543-5.

Blotting Sand will be paid in accordance with Article 818-4.

The above prices and payments will be full compensation for all work covered by this section including, but not limited to, the furnishing of water and aggregate; the mixing, proportioning, hauling and spreading of the materials; furnishing Portland cement at the point where it is incorporated into the mix; manipulating, compacting and finishing the base; maintaining the base; making repairs or corrections to the base; and applying sand seal in accordance with Article 542-3.

If the Contractor fails to provide sand seal as required and the Engineer has the work performed by other forces, the cost of such work will be deducted from monies due or to become due to the Contractor.

Payment will be made under

Pay Item	Pay Unit
Aggregate for Cement-Treated Base Course	Ton
Portland Cement for Cement-Treated Base Course	Ton

SECTION 542
SOIL-CEMENT BASE

542-1 DESCRIPTION

The work covered by this section consists of constructing and curing a soil-cement base by treating the subgrade, existing subbase or existing base, or any combination of these materials, by pulverizing, adding Portland cement, adding aggregate when required, mixing, wetting and compacting the mixture to the required density. Proportion, spread and mix the materials on the roadway; manipulate, compact and finish in accordance with the *Standard Specifications* and the lines, grades, depths and typical sections shown on the plans or established by the Engineer.

542-2 MATERIALS

Refer to Division 10.

Item	Section
Aggregate, ABC	Table 1005-1
Portland Cement, Type I	1024-1
Water	1024-4

Use soil material that consists of material existing in the area to be paved, approved borrow material or a combination of these materials proportioned as directed by the Engineer that is free from vegetation, roots or other objectionable matter; and does not contain aggregate or stone larger than 2 inches.

542-3 LIMITATIONS

Do not construct the soil-cement base when the air temperature is below 40°F nor when conditions indicate that the temperature may fall below 40°F within 24 hours. Do not place or mix materials with frozen subgrade. Protect the base from freezing for 7 days after completion. Perform the work only during daylight hours except as otherwise provided in the contract.

Do not construct soil-cement base that will not be covered with a layer of base or pavement by December 1st of the same year. Failure of the Contractor to cover the soil-cement base as required above will result in the Engineer notifying the Contractor in writing to cover the soil-cement base with a sand seal. Apply the sand seal in accordance with Section 660 except Articles 660-3 and 660-12 will not apply. If the Contractor fails to apply the sand seal within 72 hours after a receipt of such notice, the Engineer may proceed to have the work performed with other forces and equipment. The application of the sand seal by the Contractor or other forces will in no way relieve the Contractor of the responsibility to maintain or repair the damaged base, no matter what the cause of damage.

542-4 EQUIPMENT

(A) General

Use any combination of machines or equipment that will produce the required results meeting the approval of the Engineer. Correct any leakage of fluids and/or materials promptly or the Engineer may order such equipment removed and replaced with satisfactory equipment. Use equipment and methods for applying cement, water, curing seal and blotting sand that will not damage the base and in accordance with Article 107-21.

(B) Cement Spreaders

Use mechanical spreaders that have an adjustable rate of flow and the capability of spreading the required amount of cement in one pass.

(C) Water Distribution Equipment

Add water to the soil with a pressure distributor or other suitable equipment capable of uniformly distributing the required amount.

(D) Mixers

Perform all mixing with a self-propelled rotary mixer. Disc harrows, motor graders and other equipment may be used only to supplement the mixing done by the rotary mixer.

Use mixing equipment that is capable of mixing to a compacted depth of at least 10 inches.

(E) Compaction Equipment

Use self-propelled compaction equipment. Accomplish finish rolling with a pneumatic-tire roller or if permitted by the Engineer, a smooth steel-wheel roller.

(F) Scarifying Equipment

Use a grader-scarifier for the initial scarification of the soil. Use equipment capable of scarifying the soil to the full depth of the stabilized treatment. When required by the Engineer, use a weeder, spiketooth harrow or nail drag, followed by a broom drag when scarifying during finishing operations.

542-5 PREPARATION OF ROADBED

Before the addition of any cement to the soil, grade and shape the area to be stabilized in accordance with the typical sections, lines and grades shown on the plans. Perform drying or addition of moisture where necessary before the application of cement. Create the subgrade so it is firm and able to support the construction equipment and compaction operations specified. Correct and make stable, soft or yielding subgrade before construction proceeds.

542-6 SCARIFYING

Scarify the soil in the area to be stabilized to the required depth and width before application of cement. Pulverizing with a rotary mixer will follow scarifying, except it may be deleted in areas where, if determined, the soil types or conditions make pulverizing with a rotary mixer impractical.

542-7 APPLICATION OF CEMENT

When the Contractor has brought the subgrade to the elevation required by the plans, the Engineer will sample the soil to be stabilized in order to determine the quantity of cement to be incorporated. Incorporate 24 calendar days into the schedule to allow the Engineer sufficient time to perform the required sampling, testing and final design of the cement stabilization.

Before spreading cement, aggregate shall be spread at the rate shown in the plans.

Incorporate cement into the mix at the rate directed by the Engineer. Uniformly spread the quantity of cement required for the full depth of treatment over the surface in one pass. Do not apply cement on excessively wet grade or on windy days.

Apply cement to the soil when the percentage of moisture in the soil material is the correct amount that assures a uniform mixture of soil material and cement during the mixing operation. Do not exceed the optimum moisture content established by the Engineer for the soil cement moisture except by permission.

The optimum moisture content and density will be determined in the field by a moisture-density test on representative samples of soil-cement mixture; however, preliminary moisture-density values may be determined by laboratory tests using soils from the project. Moisture content will be determined by the Engineer in accordance with standard test procedures used by the Department.

Apply cement only to such an area that all operations shall be completed in the same day during daylight hours. Complete finishing the soil-cement mix within 4 hours of adding water to the soil-cement mixture. No equipment, except that used in spreading and mixing, will be allowed to pass over the freshly spread cement until it is mixed with the soil. Replace all spread cement that has been displaced before mixing is started.

542-8 MIXING

Immediately after the cement has been spread, mix it with the loosened soil material for the full depth of the treatment until a homogenous and uniform mixture is produced. Mixing will

be sufficient when 100% of the mixture passes a 1/2 inch sieve and at least 80% passes a No. 4 sieve, exclusive of any aggregate.

Immediately after mixing the soil and cement, add any additional water that is necessary to bring the moisture content between optimum and optimum plus 2% as determined by the Engineer. If moisture content exceeds the specified range, the soil-cement mixture may, if approved by the Engineer, be manipulated by remixing or blading to reduce the moisture content to within the specified range. Avoid excessive concentrations of water as well as wet spots or streaks on or near the surface. After all mixing water has been applied, continue mixing until a uniform mixture is obtained at the required moisture content. Perform the operations of cement spreading, water application and mixing so that they result in a uniform soil, cement and water mixture for the full depth and width of the area being treated. Remix any soil and cement mixture that has not been compacted and finished within 30 minutes.

542-9 COMPACTION

Begin compaction of the mixture immediately after the mixing operation is completed. At the start of compaction, make sure that the moisture in the mixture is no more than 2% above or below the optimum moisture content and is less than the quantity which will cause the soil-cement mixture to become unstable during compaction and finishing. Compact the mixture to at least 97% of that obtained by a moisture-density test using AASHTO T 134 as modified by the Department. Copies of these modified testing procedures are available upon request from the Materials and Tests Unit.

Before compaction, prepare the mixture in a loose condition for its full depth. Compact the loose mixture uniformly to the specified density. During the compaction operations, initial shaping may be required to obtain uniform compaction and required grade and cross section.

542-10 FINISHING

When initial compaction is nearing completion, shape the surface of the soil-cement to the required lines, grades and cross section. Maintain the moisture content of the surface material at optimum or higher during finishing operations.

If necessary, lightly scarify the surface to remove any tire imprints or smooth surfaces left by equipment. Continue compaction until a uniform and adequate density is obtained.

Perform the compaction and finishing to produce a dense surface free of compaction planes, cracks, ridges or loose material.

When rain causes excessive moisture, reconstruct the entire section. Where such reconstruction is necessary, furnish all work and cement required.

542-11 THICKNESS

The compacted thickness of the completed soil-cement base will be determined by measurements made in test holes located at random intervals not to exceed 500 feet. Construct the soil-cement base so that the measured thickness does not deviate from that shown on the plans by more than + 1 inch or - 1/2 inch.

Where the base is deficient in thickness by more than 1/2 inch, remove and replace the area of deficient base with base of the required thickness.

As an exception to the above, if the deficiency is not considered sufficient to seriously impair the required strength of the soil-cement base, the deficient area may, at the discretion of the Engineer, be left in place.

542-12 CURING

After the cement-treated base has been finished as specified herein, cure it in accordance with Section 543.

542-13 CONSTRUCTION JOINTS

Build soil-cement for large wide areas in a series of parallel lanes of convenient length and width meeting the approval of the Engineer. Form straight longitudinal joints at the edge of each day's construction by cutting back into completed work to form a true vertical face free of loose or shattered material.

Construct joints to provide a vertical joint having adequately mixed properly compacted material immediately adjacent to the joint. A longitudinal joint adjacent to partially hardened soil-cement built the preceding day may be formed by cutting back into the previously constructed area during mixing operations. Set guide stakes for cement spreading and mixing if deemed necessary.

542-14 TRAFFIC

Completed sections of the base may be opened when necessary to light-weight local traffic, provided the base has hardened sufficiently to prevent marring or distorting of the surface and provided the curing is not impaired. Do not use construction equipment on the base for hauling except as necessary to discharge into the spreader during paving operations.

542-15 MAINTENANCE

Maintain the soil cement base in an acceptable condition until final acceptance of the project. Include, in maintenance operations, immediate repair of any defects or damage that may occur. Repeat as often as may be necessary to keep the base in an acceptable condition. Perform repairs to the base by replacing the base for its full depth rather than by adding a thin layer of soil-cement mixture to the existing layer of base.

542-16 MEASUREMENT AND PAYMENT

Soil Cement Base will be measured and paid at the contract unit price per square yard that has been completed and accepted. In measuring this quantity, the width of the base will be measured across the top surface of the base. The length will be the actual length constructed, measured along the centerline of the surface of the base. Measurement will not be made of any base added or replaced for corrective measures during construction or for repairing damaged areas.

Aggregate for Soil Cement Base will be measured and paid in tons at the contract unit price per ton. The aggregate will be measured by weighing in trucks or certified platform scales or other certified weighing devices. No deductions will be made for any moisture contained in the aggregate at the time of weighing.

Portland Cement for Soil Cement Base will be paid at the contract unit price per ton that has been incorporated into the mix. When bulk cement is used, the quantity will be measured by weighing in trucks on certified platform scales or other certified weighing devices. Measurement will not be made of any cement added or replaced for corrective measures during construction or for repairing damaged areas.

Asphalt curing seal will be paid as provided in Article 543-5.

Blotting Sand will be paid as provided in Article 818-4.

If a layer of *Soil Cement Base* is deficient in thickness but has been permitted to be left in place in accordance with Article 542-11, payment for that *Soil Cement Base* will be made at 50% of the contract unit prices for *Soil Cement Base*.

Sand seal applied due to the failure of the Contractor to cover the *Soil Cement Base* as required will be incidental to the work of this section. If the Contractor fails to provide sand seal as required and the Engineer has the work performed by other forces, the cost of such work will be deducted from monies due or to become due to the Contractor.

Payment will be made under:

Pay Item	Pay Unit
Soil Cement Base	Square Yard
Portland Cement for Soil Cement Base	Ton
Aggregate for Soil Cement Base	Ton

SECTION 543
ASPHALT CURING SEAL

543-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, keeping the stabilized layer moist; furnishing and applying the asphalt curing seal; correcting, maintaining and repairing the asphalt curing seal; and blotting sand where directed by the Engineer, to either a chemically stabilized soil layer or to a cement-stabilized base course.

543-2 MATERIALS

Refer to Division 10.

Item	Section
Asphalt, Grade CRS-1	1020-3
Asphalt, Grade CRS-1H	1020-3
Asphalt, Grade CRS-2	1020-3
Asphalt, Grade RS-1	1020-3
Asphalt, Grade RS-1H	1020-3

543-3 EQUIPMENT

Use equipment to apply the asphalt material in accordance with Article 600-5.

Use equipment to apply water, curing seal and blotting sand that is of such type and weight that it will not damage the completed stabilized layer.

543-4 CONSTRUCTION METHODS

Continuously moisten the finished stabilized layer or base course until the asphalt curing seal is placed. Place the curing seal as soon as possible, but no later than 24 hours after completing finishing operations except where delayed by wet weather. If wet weather delays application of the curing seal, apply the curing seal as soon as the surface becomes sufficiently dry.

At the time the asphalt curing seal is applied, prepare the surface of the stabilized layer or base so that it is free of all loose or extraneous material and contains sufficient moisture to prevent excessive penetration of the asphalt material. If deemed necessary, sweep the base surface clean of loose material before applying the curing seal. Apply the curing seal in accordance with Section 600.

Apply the asphalt material to the surface of the completed stabilized layer or base at a target rate of 0.14 +/- 0.04 gal/sy with approved equipment. Apply the asphalt material at the exact rate and temperature of application as established by the Engineer.

Cure the underlying materials for 7 curing days. Curing time will be counted in at least 1/2 day units and only when the air temperature measured at the location of the operation is at least 50°F. Complete the curing before placement of subsequent layers of pavement.

Maintain the curing material during the curing period so that all of the stabilized layer or base will be covered effectively during the period. Provide sufficient protection from freezing to the stabilized layer or base during the entire curing period and until it has hardened. Replace excessive loss of curing seal caused by heavy rains within 8 hours of placement.

If the Engineer determines that it is necessary to allow local traffic to use parts of the stabilized layer or base before the asphalt material has cured sufficiently, protect those areas by applying blotting sand in accordance with Section 818.

543-5 MEASUREMENT AND PAYMENT

Asphalt Curing Seal will be measured and paid at the contract unit price per gallon that has been placed on the stabilized layer or base. Seal material placed on the stabilized layer or base in excess of the authorized rate plus 0.02 gal/sy will not be measured for payment. Measurement will not be made of any curing seal used to replace curing seal lost by heavy rains which occur after placing the curing seal.

Blotting Sand will be paid as provided for in Article 818-4.

Payment will be made under:

Pay Item	Pay Unit
Asphalt Curing Seal	Gallon

SECTION 545
INCIDENTAL STONE BASE

545-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, furnishing, hauling, placing and shaping a graded stone material for use in driveways, temporary maintenance of traffic, adjacent to mailboxes, beneath traffic island, median covers and at any other locations, other than use as a part of any base course on which pavement is to be placed; shaping; tamping when required; maintaining the base; and disposing of any surplus stockpiled material.

545-2 MATERIALS

Use stone, gravel or recycled concrete for the graded stone material which is well graded from the 1-1/2 inches through the No. 200 sieve sizes in accordance with Section 1006. The liquid limit of the recycled concrete is raised 5 points to no more than 35.

545-3 GRADATION SAMPLING, TESTING AND ACCEPTANCE

Acceptance of the graded stone material will be made by visual inspection and approval by the Engineer as being satisfactory for the purpose intended before its use. No sampling or testing of the graded stone material will be performed.

545-4 PLACING AND SHAPING STONE

Spread the stone material uniformly over the area required and then shape and dress to the satisfaction of the Engineer.

Uniformly spread, grade to the required depth and firmly tamp the stone material beneath traffic island and median covers. If the Contractor desires, the surface of the stone material may be covered with a sufficient amount of fine material to facilitate grading and shaping.

545-5 MAINTENANCE

Maintain the stone material until final acceptance of the project by reshaping and by the addition of incidental stone base material when directed by the Engineer.

Maintain all stone material beneath traffic islands and median covers in satisfactory condition until the covers are placed.

545-6 MEASUREMENT AND PAYMENT

Incidental Stone Base will be measured and paid at the contract unit price per ton that has been stockpiled or incorporated into the completed and accepted work. This quantity will be

measured as provided for in Article 520-11. Incidental stone base which has been stockpiled will not be measured more than one time.

Payment will be made under:

Pay Item	Pay Unit
Incidental Stone Base	Ton

SECTION 560
SHOULDER CONSTRUCTION

560-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, furnishing the source of the borrow; building; maintaining and obliterating haul roads; clearing and grubbing the borrow source; removal, hauling and disposition of overburden and other unsuitable material; excavation; hauling; formation of roadway shoulders include the reshaping and finishing of slopes adjacent to the shoulders and roadway ditches; restoration of the source and haul roads to an acceptable condition; disposal of surplus stockpiled material; and seeding and mulching.

560-2 MATERIALS

Refer to Division 10.

Item	Section
Shoulder Borrow	1019-2
Aggregate Shoulder Borrow	1019-3

560-3 CONSTRUCTION METHODS

Construct the top 6 inches of shoulders with soils capable of supporting vegetation in accordance with Article 1019-1.

Construct the shoulders in proper sequence with the type of base and pavement being constructed. Perform the work so as to provide proper drainage at all times. Shape and roll the shoulder material during placement to provide for bonding of layers and compaction to the satisfaction of the Engineer.

Before placing any earth material on existing graded shoulders, remove all existing vegetation and scarify the existing shoulders to ensure a proper bond.

Perform the final shaping of the shoulders, adjacent slopes and ditches in accordance with the typical section shown on the plans.

Provide adequate equipment to perform the work. Do not damage base, surface, pavement or drainage features during the construction of the shoulders. Should damage occur because of the Contractor's operations, repair the damaged portions or remove and replace them as directed by the Engineer at no cost to the Department.

560-4 MEASUREMENT AND PAYMENT

(A) General

Shoulder borrow will be measured in its original position or in the haul truck, as directed by the Engineer.

No measurement will be made of material transported directly from unclassified excavation or fine grading and deposited directly in place on the shoulder.

The quantity of shoulder borrow will be paid at the contract unit price per cubic yard for *Shoulder Borrow*, except as otherwise provided below.

(B) Measured in Original Position

The quantity of shoulder borrow to be paid will be the actual number of cubic yards of approved material, measured in its original position in the borrow source or stockpile by cross sectioning and computed by the average end area method, which has been incorporated into the completed and accepted work. No measurement will be made of any overburden or unsuitable material removed from the borrow source, nor of any material excavated before cross sections being taken.

(C) Truck Measurement

The quantity of shoulder borrow to be paid will be the actual number of cubic yards of approved material, measured in trucks, which has been incorporated into the completed and accepted work. Each truck will be measured by the Engineer and shall bear a legible identification mark indicating its capacity. Load each truck to its measured capacity at the time it arrives at the point of delivery. The recorded capacity will be adjusted by making a 25% deduction to allow for shrinkage, and the adjusted capacity will be the quantity to be paid.

When shoulder material is obtained as a result of fine grading operations, trenching out existing subgrade or shaping slopes and ditches, no direct payment will be made for the work of shoulder construction as such work will be incidental to the work of constructing the base or pavement.

No payment will be made for the removal and disposal of any surplus material remaining in the stockpile after the shoulders have been completed.

Where the borrow source has been furnished by the Department, payment for clearing and grubbing the source will be made as provided in Article 200-8 and payment for draining the source will be made as provided in Article 240-4. Where the source has been furnished by the Contractor, no separate payment will be made for clearing and grubbing or draining the source as such work will be incidental to the work covered by this section.

Payment for seeding and mulching all borrow sources will be made at the contract unit prices for the items established in the contract as payment for the work of seeding and mulching.

Payment will be made under:

Pay Item	Pay Unit
Shoulder Borrow	Cubic Yard

DIVISION 6
ASPHALT PAVEMENTS

SECTION 600
PRIME COAT

600-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, treating an existing non-asphalt base course with asphalt material by furnishing and applying the prime, furnishing and placing granular material to protect the prime and maintaining the prime coat in accordance with these specifications.

Treat all non-asphalt bases beneath an asphalt surface treatment with a prime coat.

600-2 MATERIALS

Refer to Division 10.

Item	Section
Prime Coat Materials	1020-5

Use materials for prime coat application that are on the APL for prime coats available on the Department's website.

Where the grade of prime coat material is not established by the contract, the Contractor may select the grade to be used from the APL. All prime coat materials shall be delivered to the project ready for use.

600-3 WEATHER LIMITATIONS

Apply prime coat only when the surface to be treated is free of standing water, at proper moisture content and the atmospheric temperature measured at the location of the operation away from artificial heat is 40°F or above for plant mix and 50°F or above for asphalt surface treatment.

Do not apply prime coat on a frozen surface or when the weather is foggy or rainy.

600-4 BASE PREPARATION

Clean the base of objectionable debris, excessive dust and any other deleterious matter before placing the prime coat.

When directed by the Engineer, dampen the surface of the base before application of the prime coat.

600-5 APPLICATION EQUIPMENT

Provide, maintain and operate a pressure distributor that is designed and equipped such that the asphalt material remains at a constant temperature and is applied uniformly on variable widths of surface at predetermined and controlled rates. Use a distributor equipped with a tachometer or synchronizer, pressure gauges, accurate volume measuring devices or a calibrated tank and a mounted thermometer for measuring temperature.

Use a distributor equipped with a power driven pump of sufficient capacity to distribute the required quantity of asphalt material at constant flow and uniform pressure. Provide a full circulation spray bar adjustable laterally and vertically and adjustable in length to conform to the required width of application without overlapping. Provide and maintain nozzles designed to provide equal and uniform application at all times. Provide a hand spray hose and nozzle

to cover areas inaccessible to the spray bars. Equip the distributor with a positive shut-off control for the spray bar and hand hose.

600-6 APPLICATION RATES AND TEMPERATURES

Apply the prime coat at a rate from 0.20 to 0.50 gal/sy. The exact rate for each application will be established by the Engineer before application.

The required rate of application of asphalt materials will be based on the volume of material measured at the application temperature. Apply the prime coat material at a temperature that is in accordance with the manufacturer's recommendations or as approved by the Engineer.

600-7 APPLICATION OF PRIME COAT

Apply the prime coat only when the base to be treated has been approved by the Engineer.

Cover bridge floors, curbs and handrails of structures and all other appurtenances to protect them from tracking or splattering of prime coat.

After the prime coat has penetrated sufficiently and when directed by the Engineer, roll the primed surface until all loose base material is thoroughly bonded.

600-8 MAINTENANCE AND PROTECTION

When directed by the Engineer, apply blotting sand in accordance with Section 818.

Maintain the prime coat in an acceptable condition until such time as the pavement is placed. Replace any damaged prime coat.

600-9 MEASUREMENT AND PAYMENT

Ensure the volume of the distributor tank is calibrated by a commercial laboratory or the manufacturer before use. Provide a calibration chart with an accurately calibrated measuring stick graduated in increments of not more than 25 gal on the distributor at all times for use by the Engineer.

Prime Coat will be paid at the contract unit price per gallon of prime coat material satisfactorily placed on the roadway. Each distributor load of prime coat material delivered and used on the project will be measured. Repair damaged prime coat at no cost to the Department.

Blotting Sand will be paid in accordance with Article 818-4.

Payment will be made under:

Pay Item	Pay Unit
Prime Coat	Gallon

SECTION 605
ASPHALT TACK COAT

605-1 DESCRIPTION

Apply tack coat material to existing asphalt or concrete surfaces in accordance with these specifications.

Apply tack coat beneath each layer of asphalt plant mix to be placed. Where a prime coat or a newly placed asphalt surface treatment mat coat has been applied, apply tack coat as directed by the Engineer.

605-2 MATERIALS

Refer to Division 10.

Item	Section
Asphalt Binder, Grade PG 58-28	1020-2
Asphalt Binder, Grade PG 64-22	1020-2
Emulsified Asphalt, Grade CRS-1	1020-3
Emulsified Asphalt, Grade CRS-1H	1020-3
Emulsified Asphalt, Grade CRS-2	1020-3
Emulsified Asphalt, Grade HFMS-1	1020-3
Emulsified Asphalt, Grade RS-1H	1020-3

Do not dilute or mix the tack coat material with water, solvents or other materials before application.

Unless otherwise specified in the contract, use any of the grades of tack coat material specified in this article.

For tack coat beneath an open-graded asphalt friction course, the asphalt grade and rate of application to be used on the project will be specified in accordance with Section 650-5.

605-3 WEATHER LIMITATIONS

Apply tack coat only when the surface to be treated is dry and when the atmospheric temperature measured at the location of the paving operation away from artificial heat is 35°F or above.

Do not apply tack coat when the weather is foggy or rainy.

605-4 SURFACE PREPARATION

Ensure that the existing asphalt or concrete surface is free of all dust and foreign material before applying the tack coat.

Remove grass, dirt and other materials from the edge of the existing pavement before the placement of tack coat. Properly dispose of these materials as directed by the Engineer.

605-5 ACCEPTANCE OF ASPHALT MATERIALS

The acceptance of asphalt materials will be in accordance with Article 1020-1.

605-6 APPLICATION EQUIPMENT

Provide equipment for heating and uniformly applying the asphalt material in accordance with Article 600-5.

605-7 APPLICATION RATES AND TEMPERATURES

Apply tack coat uniformly across the existing surface at target application rates shown in Table 605-1.

TABLE 605-1
APPLICATION RATES FOR TACK COAT

Existing Surface	Target Rate (gal/sy)
	Emulsified Asphalt
New Asphalt	0.04 ± 0.01
Oxidized or Milled Asphalt	0.06 ± 0.01
Concrete	0.08 ± 0.01

Apply tack coat at a temperature within the ranges shown in Table 605-2. Tack coat shall not be overheated during storage, transport or at application.

TABLE 605-2 APPLICATION TEMPERATURE FOR TACK COAT	
Asphalt Material	**Temperature Range**
Asphalt Binder, Grade PG 58-28 or PG 64-22	350 - 400°F
Emulsified Asphalt, Grade RS-1H	130 - 160°F
Emulsified Asphalt, Grade CRS-1	130 - 160°F
Emulsified Asphalt, Grade CRS-1H	130 - 160°F
Emulsified Asphalt, Grade HFMS-1	130 - 160°F
Emulsified Asphalt, Grade CRS-2	130 - 160°F

605-8 APPLICATION OF TACK COAT

Apply only as much tack coat material as can be covered with base, intermediate or surface course material during the next day's operation except where public traffic is being maintained.

If public traffic is being maintained, cover the tack coat in the same day's operation. Provide safe traffic conditions. If needed, apply suitable granular material so it bonds to the tack coat. In addition, the Engineer may limit the application of tack coat in advance of the paving operation depending on traffic conditions, project location, proximity to business or residential areas or other reasons.

Take necessary precautions to limit the tracking or accumulation of tack coat on either existing or newly constructed pavements. Excessive accumulation of tack coat requires corrective measures.

Apply tack coat with a distributor spray bar that can be adjusted to uniformly coat the entire surface at the rate directed by the Engineer. Use a hand hose attachment only on irregular areas and areas inaccessible to the spray bar. Cover these areas uniformly and completely.

Apply tack coat as directed by and in the presence of the Engineer. Do not place any asphalt mixture until the tack coat has sufficiently cured.

Apply tack coat to all exposed transverse and longitudinal edges of each course before mixture is placed adjacent to such surfaces. Apply tack coat to contact surfaces of headers, curbs, gutters, manholes and vertical faces of old pavements.

Cover bridge floors, curbs and handrails of structures and all other appurtenances to protect them from tracking or splattering tack coat material.

605-9 PROTECTION OF TACK COAT

After the tack coat has been applied, protect it until it has cured for a sufficient length of time to prevent it from being picked up by traffic.

605-10 MEASUREMENT AND PAYMENT

There will be no direct payment for the work covered by this section.

Payment at the contract unit prices for the various mix items covered by Sections 610, 650 and 654 will be full compensation for all work covered by this section.

SECTION 607
MILLING ASPHALT PAVEMENT

607-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, milling and re-milling the pavement at locations, depths, widths and typical sections indicated in the contract; cleaning the milled surface; loading, hauling and stockpiling the milled material for use in recycled asphalt mixtures; and disposal of any excess milled material.

Except where the milled material is used in the work or where otherwise directed by the Engineer, provide areas outside the right of way to dispose of milled material, which shall be property of the Contractor.

607-2 EQUIPMENT

Use a self-propelled unit capable of removing the existing asphalt pavement to the depths, widths and typical sections shown in the contract. Use milling machines designed and built exclusively for pavement milling operations and with sufficient power, traction and stability to accurately maintain depth of cut and slope. Use milling machines equipped with an electronic control system that will automatically control the longitudinal profile and cross slope of the milled pavement surface. Accomplish this through the use of a mobile grade reference, an erected string line, joint matching shoe, slope control systems or a combination of approved methods. Use an erected fixed stringline when required by the contract. Otherwise, use a mobile grade reference system capable of averaging the existing grade or pavement profile over at least 30 feet. Use either a non-contacting laser or sonar type ski systems with at least 3 referencing stations mounted on the milling machine at a length of at least 24 feet. Coordinate the position of the grade control system such that the grade sensor is at the approximate midpoint of the mobile reference system. Use a machine capable of leaving a uniform surface suitable for handling traffic without damage to the underlying pavement structure. Use a milling machine and other loading equipment capable of loading milled material to be used in other parts of the work without segregation.

Provide additional equipment necessary to satisfactorily remove the pavement in the area of manholes, water valves, curb, gutter and other obstructions.

Equip the milling equipment with a means of effectively limiting the amount of dust escaping from the removal operation in accordance with Federal, State and local air pollution control laws and regulations.

607-3 CONSTRUCTION METHODS

Mill the existing pavement to restore the pavement surface to a uniform longitudinal profile and cross section in accordance with typical sections shown in the plans. Where indicated in the contract, remove pavement to a specified depth and produce a specified cross slope. Mill intersections and other irregular areas unless otherwise directed by the Engineer.

The Contractor may elect to make multiple cuts to achieve the required depth of cut or cross slope required by the plans.

Establish the longitudinal profile of the milled surface by a mobile string line on the side of the cut nearest the centerline of the road. Establish the cross slope of the milled surface by an automatic cross slope control mechanism or by a second skid sensing device located on the opposite edge of the cut. The Engineer may waive the requirement for automatic grade and cross slope controls where conditions warrant.

Operate the milling equipment so as to prevent damage to the underlying pavement structure, utilities, drainage facilities, curb and gutter, paved surfaces outside the milled area and any other appurtenances. Produce milled pavement surfaces that are reasonably smooth and free of excessive scarification marks, gouges, ridges, continuous grooves or other damage. Repair any leveling or patching required as a result of negligence by the Contractor with hot asphalt plant mix in a manner acceptable to the Engineer. Coordinate the adjustment of manholes, meter boxes and valve boxes with the milling operation in accordance with Article 858-3 including a temporary asphalt ramp. Variable depth milling is intended to improve the cross-sectional slope of the pavement.

When necessary, the contractor may remove the top section of a utility and use a bridge steel plate placed to cover the entire width of the structure, ensuring no debris is dropped inside the structure. Backfill with compacted material and hot mix asphalt as a temporary riding surface as well as any further necessary requirements of the utility owner. This steel plate must be capable of carrying any traffic load carried by the facility. Where necessary, double-reference the location of each structure that has been removed and maintain a map of their location. Construct a temporary ramp of asphalt plant mix to extend a minimum of 3 feet around raised structures before opening to traffic.

The Engineer may require re-milling of any area exhibiting pavement laminations, scabbing or other defects. "Scabbing" is defined as a thin layer of existing pavement that remains after milling and has the potential to delaminate. Thoroughly clean the milled pavement surface of all loose aggregate particles, dust and other objectionable material. Disposing or wasting of oversize pieces of pavement or loose aggregate material will not be permitted within the right of way.

Conduct pavement removal operations so as to effectively minimize the amount of dust being emitted. Plan and conduct the operation so it is safe for persons and property adjacent to the work including the traveling public.

607-4 TOLERANCE

Remove the existing pavement to the depth required by the contract. The Engineer may vary the depth of milling by not more than one inch. In the event the directed depth of milling cut is altered by the Engineer more than one inch, either the Department or the Contractor may request an adjustment in unit price in accordance with Article 104-3. In administering Article 104-3, the Department will give no consideration to value given to RAP due to the deletion or reduction in quantity of milling. Article 104-3 will not apply to the item of *Incidental Milling*.

607-5 MEASUREMENT AND PAYMENT

(A) Milled Asphalt Pavement

Milled Asphalt Pavement, __" Depth will be measured and paid as the actual number of square yards of pavement surface milled in accordance with this specification. In measuring this quantity, the length will be the actual length milled, measured along the pavement surface. The width will be the width required by the plans or directed by the Engineer, measured along the pavement surface. Areas to be paid under this item include mainline travel lanes, full width turn lanes greater than 500 feet in length, collector lanes, shoulders, and any additional equipment necessary to remove pavement in the area of manholes, water valves, curb, gutter and other obstructions.

(B) Variable Depth Milled Asphalt Pavement

Milling Asphalt Pavement, __" *to* __" will be measured and paid as the actual number of square yards of pavement surface milled in accordance with this specification. In measuring this quantity, the length will be the actual length milled, measured along the pavement surface. The width will be the width required by the plans or directed by the Engineer, measured along the pavement surface. Areas to be paid under this item include mainline travel lanes, full width turn lanes greater than 500 feet in length, collector lanes, shoulders, and any additional equipment necessary to remove pavement in the area of manholes, water valves, curb, gutter and other obstructions.

For each square yard that the Engineer directs to be milled, including, but not limited to, the mainline, turn lanes, bus loading and unloading areas, widening for bus or truck U-turns, shoulders, intersections and crossovers requiring any additional equipment necessary to remove pavement in the area of manholes, water valves, curb, gutter and other obstructions, compensation will be made at the contract unit price per square yard for *Milling Asphalt Pavement, __" Depth* or *Milling Asphalt Pavement*, __" *to* __".

(C) Incidental Milling

Incidental Milling to be paid will be the actual number of square yards of surface milled where the Contractor is required to mill butt joints, irregular areas, full width turn lanes 500 feet or less, intersections and re-mill areas that are not due to the Contractor's negligence. In measuring this quantity, the length will be the actual length milled, measured along the pavement surface. The width will be the width required by the plans or directed by the Engineer, measured along the pavement surface. Where the Contractor elects to make multiple cuts to achieve the final depth, no additional measurement will be made. Compensation will be made at the contract unit price per square yard for *Incidental Milling*.

(D) Milling of Defects

If defects are determined to be the result of the Contractor's negligence, then measurement for the re-milling or repairs will not be made. If the Engineer directs re-milling of an area and is not due to the Contractor's negligence, the re-milled area will be measured as provided in Subarticle 607-5(C) and paid at the contract unit price per square yard for *Incidental Milling*.

Payment will be made under:

Pay Item	Pay Unit
Milling Asphalt Pavement, __" to __"	Square Yard
Milling Asphalt Pavement, __" Depth	Square Yard
Incidental Milling	Square Yard

SECTION 609
QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS

609-1 DESCRIPTION

Produce and construct asphalt mixtures and pavements in accordance with a quality management system as described herein. Apply these *Standard Specifications* to all materials and work performed in accordance with Division 6. Perform all quality control (QC) activities in accordance with the Department's *Asphalt Quality Management System (QMS) Manual* in effect on the date of contract advertisement.

(A) Quality Control (QC)

Define a "quality control (QC) program" as all activities, including mix design, process control, plant and equipment calibration, sampling and testing and necessary adjustments in the process that are related to production of a pavement that meet the *Standard Specifications*. Provide and conduct a QC program in accordance with this section.

(B) Quality Assurance (QA)

Define a "quality assurance (QA) program" as all activities, including inspection, sampling and testing related to determining that the quality of the completed pavement conforms to specification requirements. The Department will conduct a QA program in accordance with Article 609-9.

609-2 MIX DESIGN/JOB MIX FORMULA REQUIREMENTS

Apply all requirements of Article 610-3.

609-3 FIELD VERIFICATION OF MIXTURE AND JOB MIX FORMULA ADJUSTMENTS

Conduct field verification of the mix at each plant within 45 calendar days before initial production of each mix design, when required by the *Allowable Mix Adjustment Policy* as

defined in Section 7.4 of the *Asphalt QMS Manual* and when directed by the Engineer as deemed necessary.

Field verification testing consists of performing a minimum of one full test series on mix sampled and tested in accordance with Subarticle 609-6(B). Mix obtained from Department or non-Department work may be used for this purpose provided it is sampled, tested and the test data handled in accordance with the *Asphalt QMS Manual* and this article.

Obtain the mix verification sample and split in accordance with procedures in the *Asphalt QMS Manual.* Do not begin normal plant production until all field verification test results have been completed and the mix has been satisfactorily verified by the Contractor's Level II technician.

In addition to the required sampling and testing for field verification, perform all preliminary inspections and plant calibrations as outlined in the *Asphalt QMS Manual*. Retain records of these calibrations and mix verification tests at the QC laboratory. Furnish copies to the Engineer for review and approval within one working day after beginning production of the mix.

Failure by the Contractor to fully comply with the above mix verification requirements will result in immediate production stoppage by the Engineer. Do not resume normal production until all mix verification sampling, testing, calibrations and plant inspections have been performed and approved by the Engineer.

609-4 CONTRACTOR'S QUALITY CONTROL PERSONNEL REQUIREMENTS

Obtain all certifications in accordance with the Department's QMS Asphalt Technician Certification Program as outlined in the *Asphalt QMS Manual*. Perform all sampling, testing, data analysis and data posting by or under the direct supervision of a certified QMS asphalt plant technician.

Provide a certified asphalt plant technician Level I to perform QC operations and activities at each plant site at all times during production of material for the project. A plant operator who is a certified asphalt plant technician Level I may be used to meet this requirement when daily production for each mix design is less than 100 tons provided the randomly scheduled increment sample as defined in Section 7.3 of the *Asphalt QMS Manual* is not within that tonnage. When performing in this capacity, the plant operator will be responsible for all QC activities that are necessary and required. Absences of the Level I technician, other than those for normal breaks and emergencies shall be pre-approved by the appropriate Engineer or his designated representative. Any extended absence of the technician that has not been approved will result in immediate suspension of production by the Engineer. All mix produced during this absence will be accepted in accordance with Article 105-3.

Provide and have readily available a certified asphalt plant technician Level II to supervise, coordinate and make any necessary adjustments in the mix QC process in a timely manner. The Level II technician may serve in a dual capacity and fulfill the Level I technician requirements specified above.

Provide a certified QMS roadway technician with each paving operation at all times during placement of asphalt. This person is responsible for monitoring all roadway paving operations and all QC processes and activities, to include stopping production or implementing corrective measures when warranted. Provide a certified density gauge operator when density control is being used.

Post in the QC laboratory an organizational chart, including names, telephone numbers and current certification numbers of all personnel responsible for the QC program while asphalt paving work is in progress.

609-5 CONTRACTOR'S QUALITY CONTROL FIELD LABORATORY REQUIREMENTS

For a contract with 5,000 or more total tons of asphalt mix, furnish and maintain a Department certified laboratory at the plant site meeting the minimum requirements outlined in Section 7.2 of the *Asphalt QMS Manual*.

For a contract with less than 5,000 total tons of asphalt mix, the QC testing may be conducted in a Department certified off-site laboratory meeting the requirements.

Provide testing equipment as required in Section 7.2 of the *Asphalt QMS Manual*. Provide equipment that is properly calibrated and maintained. Allow all measuring and testing devices to be inspected to confirm both calibration and condition. If at any time the Engineer determines that the equipment is not operating properly or is not within the limits of dimensions or calibration described in the applicable test method, the Engineer may stop production until corrective action is taken. Maintain and have available a record of all calibration results at the laboratory.

609-6 PLANT MIX QUALITY CONTROL

(A) General

Include in the QC process the preliminary inspections, plant calibrations and field verification of the mix and JMF in accordance with the *Asphalt QMS Manual*. Obtain all scheduled samples at randomly selected locations in accordance with the *Asphalt QMS Manual*. Log all samples taken on forms provided by the Department. Split and retain all samples taken in accordance with the *Asphalt QMS Manual*. Provide documentation as required in Article 609-8. Identify any additional QC samples taken and tested on the appropriate forms. Process control test results shall not be plotted on control charts nor reported to the QA Laboratory.

Retain and store all samples in accordance with the requirements of Section 7.5 of the *Asphalt QMS Manual*.

(B) Required Sampling and Testing Frequencies

Maintain minimum test frequencies as established in the schedule below. Complete all tests within 24 hours of the time the sample is taken, unless specified otherwise within these provisions. If the specified tests will not be completed within the required time frame, cease production at that point until such time the tests are completed.

If the Contractor’s testing frequency fails to meet the minimum frequency requirements as specified, all mix without the specified test representation will be unsatisfactory. The Engineer will evaluate if the mix may remain in place in accordance with Article 105-3.

Sample and test the completed mixture from each JMF at the following minimum frequency during mix production:

Accumulative Production Increment	Number of Samples per Increment
750 tons	1

If production is discontinued or interrupted before the accumulative production increment tonnage is completed, continue the increment on the next production day(s) until the increment tonnage is completed. Obtain a random sample within the specified increment at the location determined in accordance with the *Asphalt QMS Manual*. Conduct QC testing on each random sample in accordance with Section 7.3 of the *Asphalt QMS Manual*. When daily production of each mix design exceeds 100 tons and a regularly scheduled full test series on a sample from a random sample location for that JMF does not occur during that day’s production, perform at least one partial test series in accordance with Section 7.3 of the *Asphalt QMS Manual*. These partial test series and

associated tests do not substitute for the regularly scheduled random sample for that increment.

(C) Control Charts

Maintain standardized control charts furnished by the Department at the field laboratory. For mix incorporated into the project, record full test series data from all regularly scheduled random samples or samples directed by the Engineer that replace regularly scheduled random samples, on control charts the same day the test results are obtained.

Record QC sample data on the standardized control charts in accordance with Section 7.4 of the *Asphalt QMS Manual*.

Maintain a continuous moving average with the following exceptions.

Re-establish a new moving average only when:

(1) A change in the binder percentage, aggregate blend or G_{mm} is made on the JMF, or

(2) When the Contractor elects to stop or is required to stop production after one or two moving average values, respectively, fall outside the moving average limits as outlined in Table 609-1, or

(3) Failure to stop production after 2 consecutive moving averages exceed the moving average limits occurs, but production does stop at a subsequent time, re-establish a new moving average beginning at the actual production stop point.

In these cases, re-establish the moving averages for all mix properties. Moving averages will not be re-established when production stoppage occurs due to an individual test result exceeding the individual test limits or the *Standard Specifications*.

All individual test results for regularly scheduled random samples or samples directed by the Engineer that replace regularly scheduled samples are part of the plant QC record and shall be included in moving average calculations with the following exception. When the Contractor's testing data has been proven incorrect, use the correct data as determined by the Engineer instead of the Contractor's data to determine the appropriate pay factor in accordance with Section 7.20.1 of the *Asphalt QMS Manual*. In this case, replace the data in question and any related data proven incorrect.

(D) Control Limits

Establish control limits for mix production in accordance with Table 609-1. Control limits for the moving average limits are based on a moving average of the last 4 data points. Apply all control limits to the applicable target source.

TABLE 609-1
CONTROL LIMITS

Mix Control Criteria	Target Source	Moving Average Limit	Individual Limit
2.36 mm Sieve	JMF	± 4.0%	± 8.0%
1.18mm Sieve (S4.75A only)	JMF	± 4.0%	± 8.0%
0.075 mm Sieve	JMF	± 1.5%	± 2.5%
Binder Content	JMF	± 0.3%	± 0.7%
VTM @ N_{des}	JMF	± 1.0%	± 2.0%
VMA @ N_{des}	Min. Spec. Limit	Min. Spec. Limit	- 1.0%
$P_{0.075}$/ P_{be} Ratio	1.0	± 0.4 %	± 0.8%
% G_{mm} @ N_{ini}	Max. Spec. Limit	-	+ 2.0%
TSR	Min. Spec. Limit	-	- 15%

(E) Corrective Actions

All required corrective actions are based upon initial test results and shall be taken immediately upon obtaining those results. If more than one corrective action or adjustment applies, give precedence to the more severe of these actions. Stopping production when required takes precedence over all other corrective actions. Document all corrective actions.

If the process adjustment improves the property in question such that the moving average after 4 additional tests is on or within the moving average limits, the Contractor may continue production.

When any of the following occur, production of a mix shall cease immediately:

(1) An individual test result for a mix control criteria (including results for required partial test series on mix) exceeds both the individual test control limits and the applicable specification design criteria, or

(2) Two consecutive field TSR values fail to meet the minimum specification requirement, or

(3) Two consecutive binder content test results exceed the individual limits, or

(4) Two consecutive moving average values for any one of the mix control criteria fall outside the moving average limits.

Do not resume normal plant production until one of the following has occurred.

Option 1: Approval has been granted by the appropriate QA supervisor.

Option 2: The mix in question has been satisfactorily verified in accordance with Section 7.4 of the *Asphalt QMS Manual*. Normal production may resume based on the approval of the contractor's Level II technician, provided notification and the verification test results have been furnished to the QA Laboratory.

Failure to fully comply with any of the above corrective actions will result in immediate production stoppage by the Engineer. Normal production shall not resume until a complete verification process has been performed and approved by the Engineer.

Failure to stop production when required will make all mix unacceptable from the stop point tonnage to the point when Option 1 or Option 2 occurs or to the tonnage point when production is actually stopped, whichever occurs first.

In any case, remove and replace this mix with materials that comply with the *Standard Specifications*, unless otherwise approved by the Engineer. The Engineer will evaluate acceptance of the mix in question based on Articles 105-3 and 609-11.

Immediately notify the Engineer when any moving average value exceeds the moving average limit. If two consecutive moving average values for any one of the mix control criteria fall outside the moving average limits, immediately cease production of that mix and make adjustments. The Contractor may elect to stop production after only one moving average value falls outside the moving average limits. In either case, do not determine a new moving average until the fourth test after the elective or mandatory stop in production.

(F) Allowable Resampling and Retesting for Mix Deficiencies

The Contractor shall resample and retest for plant mix deficiencies when warranted as outlined in Section 7.19 of the *Asphalt QMS Manual*. Perform the retesting within 10 days after initial test results are determined. Retests for any mix deficiency other than as listed below will not be allowed, unless otherwise permitted.

The Department reserves the right to require the Contractor to resample and retest at any time or location as directed by the Engineer.

TABLE 609-2
RETEST LIMITS FOR MIX DEFICIENCIES

Property	Limit
VTM	by more than ± 2.5%
VMA	by more than ± 2.0%
% Binder Content	by more than ± 1.0%
0.075 mm sieve	by more than ± 3.0%
2.36 mm sieve	exceeds both the Specification mix design limits and one or more of the above tolerances
TSR	by more than - 15% from Specification limit

609-7 FIELD COMPACTION QUALITY CONTROL

(A) General

Perform QC of the compaction process in accordance with these provisions and applicable requirements of Article 610-10. The Contractor may elect to use either pavement core samples or density gauge readings as the method of density control. Provide to the Department at the pre-construction conference the method of density QC that will be used on the project.

Establish acceptable control strips when required at locations approved by the Engineer and in accordance with the *Asphalt QMS Manual*. In addition, place control strips anytime deemed necessary by the Engineer.

Perform density sampling and testing on all pavements as outlined in Sections 10.4 and 10.6 of the *Asphalt QMS Manual* unless otherwise approved by the Engineer.

Perform the sampling and testing at the minimum test frequencies as specified. If the density testing frequency fails to meet the minimum frequency as specified, all mix without the required density test representation will be unsatisfactory. The Engineer will evaluate if the mix may remain in place in accordance with Article 105-3.

(B) Limited Production Procedures

Define “resurfacing” as the first new uniform layer placed on an existing pavement. Proceed on limited production when, for the same mix type and on the same contract, one of the following conditions occur (except as noted below).

(1) Two consecutive failing lots, except on resurfacing,

(2) Three consecutive failing lots on resurfacing, or

(3) Two consecutive failing density gauge control strips.

As exceptions to the above, pavement within each construction category (New and Other), as defined in Section 10.3.3 of the *Asphalt QMS Manual*, and pavement placed simultaneously by multiple paving crews will be evaluated independently for limited production purposes.

Limited production is defined as the production, placement and compaction of a sufficient quantity of mix to construct a 300 feet control strip plus 100 feet of pavement adjacent to each end of the control strip.

Remain on limited production until such time as satisfactory density results are attained or until two control strips have been attempted without achieving acceptable density test results. If the Contractor fails to achieve satisfactory density after two control strips have been attempted, cease production of that mix type until such time as the cause of the failing density test results can be determined. As an exception, the Engineer may grant

approval to produce a different mix design of the same mix type if Quality Control and Quality Assurance plant mix test indicate the failing densities are attributed to the mix problem(s) rather than compaction related problems and limited production startup would not be required. The determination of whether a mix problem exists at this time will be made by QA personnel.

If the Contractor does not operate by the limited production procedures when conditions as specified in Section 10.9 of the *Asphalt QMS Manual*, all mix produced thereafter will be unacceptable. Remove this material and replace with material that complies with the *Standard Specifications,* at no additional cost to the Department.

609-8 CONTRACTOR QUALITY CONTROL DOCUMENTATION (RECORDS)

Document all QC activities, records of inspection, samples taken, adjustments to the mix and test results on a daily basis. Note the results of observations and records of inspection as they occur in a permanent field record. Record adjustment to mix production and test results on forms provided. Process control sample test results are for the Contractor's informational purposes only.

Make all such records available to the Engineer, upon request, at any time during project construction. Complete and maintain all QC records and forms and distribute in accordance with the *Asphalt QMS Manual*. Submit data electronically using the Department's software. Failure to maintain QC records and forms as required, or to provide these records and forms to the Engineer upon request, may result in production stoppage, placement stoppage, technician certification revocation and removal from the NCDOT Certified Asphalt Plant List until the problem is resolved.

Falsification of test results, documentation of observations, records of inspection, adjustments to the process, discarding of samples and/or test results or any other deliberate misrepresentation of the facts will result in the revocation of the applicable person's QMS certification. The Engineer will determine acceptability of the mix and/or pavement represented by the falsified results or documentation. If the mix and/or pavement in question is determined to be acceptable, the Engineer may allow the mix to remain in place at no pay for the mix, asphalt binder and other mix components. If the mix or pavement represented by the falsified results is determined not to be acceptable, remove and replace with mix that complies with the *Standard Specifications*.

609-9 QUALITY ASSURANCE

The Department's QA program will be conducted by a certified QMS technician(s) and will be accomplished based on the requirements of Section 7.6 for mix and Sections 10.5 and 10.7 for density in the *Asphalt QMS Manual*.

Differences between the Contractor's and the Department's split sample test results will be acceptable if within the limits of precision in Table 609-3.

TABLE 609-3 LIMITS OF PRECISION FOR TEST RESULTS	
Mix Property	**Limits of Precision**
25.0 mm sieve (Base Mix)	± 10.0%
19.0 mm sieve (Base Mix)	± 10.0%
12.5 mm sieve (Intermediate & Type P-57)	± 6.0%
9.5 mm sieve (Surface Mix)	± 5.0%
4.75 mm sieve (Surface Mix)	± 5.0%
2.36 mm sieve (All Mixes, except S4.75A)	± 5.0%
1.18 mm sieve (S4.75A)	± 5.0%
0.075 mm sieve (All Mixes)	± 2.0%
Asphalt Binder Content	± 0.5%
Maximum Specific Gravity (G_{mm})	± 0.020
Bulk Specific Gravity (G_{mb})	± 0.030
TSR	± 15.0%
QA retest of prepared QC Gyratory Compacted Volumetric Specimens	± 0.015
Retest of QC Core Sample	± 1.2% (% Compaction)
Comparison QA Core Sample	± 2.0% (% Compaction)
QA Verification Core Sample	± 2.0% (% Compaction)
Density Gauge Comparison of QC Test	± 2.0% (% Compaction)
QA Density Gauge Verification Test	± 2.0% (% Compaction)

The Engineer will immediately investigate the reason for differences if any of the following occur: QA test results of QC split sample does not meet above limits of precision, QA test results of QC split sample does not meet the individual test control limits or the specification requirements or QA verification sample test results exceed the allowable retesting tolerances.

If the potential for a pavement failure exist, the Engineer may suspend production, wholly or in part, in accordance with Article 108-7 while the investigation is in progress. The Engineer's investigation may include, but not be limited to: review and observation of the QC technician's sampling and testing procedures, evaluation and calibration of QC and QA testing equipment, comparison testing of other retained quality control samples, and/or comparison testing of additional density core samples.

The Engineer will periodically witness the sampling and testing being performed by the Contractor. If the Engineer observes that the sampling and QC tests are not being performed in accordance with the applicable test procedures, the Engineer may stop production until corrective action is taken. The Engineer will promptly notify the Contractor of observed deficiencies, both verbally and in writing. The Engineer will document all witnessed samples and tests.

609-10 ACCEPTANCE

Final acceptance of the asphalt pavement will be made by the Department in accordance with the following:

(A) Mix Acceptance

The Engineer will base final acceptance of the mix on the results of random testing made on split samples during the assurance process, verification samples, retests (if applicable) and validation of the Contractor’s quality control process conducted in accordance with specifications.

(B) Density Acceptance

The Department will evaluate the asphalt pavement for density compliance after the asphalt mix has been placed and compacted using the Contractor's quality control test

results, the Department's quality assurance test results (including verification samples) and by observation of the Contractor's total density quality control process conducted in accordance with specifications.

609-11 MEASUREMENT AND PAYMENT

Any mix produced that is not verified may be assessed a price reduction at the Engineer's discretion in addition to any reduction in pay due to mix or density deficiencies.

Produce and construct all asphalt mixtures and pavements in accordance with these *Standard Specifications*. There will be no direct payment for work covered by this Specification. Payment at the contract unit prices for the various asphalt items will be full compensation for all work covered by these specifications.

If the mix or pavement represented by the falsified results is removed and replaced, payment will be made for the actual quantities of materials required to replace the falsified quantities, not to exceed the original amounts.

SECTION 610
ASPHALT CONCRETE PLANT MIX PAVEMENTS

610-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, the construction of one or more courses of asphalt mixture placed on a prepared surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness and typical sections shown on the plans. This work includes producing, weighing, transporting, placing and compacting the plant mix; furnishing aggregate, asphalt binder, anti-strip additive and all other materials for the plant mix; furnishing and applying tack coat as specified; furnishing scales; maintaining the course until final acceptance of the project; making any repairs or corrections to the course that may become necessary; providing and conducting QC as specified in Section 609; and surface testing of the completed pavement. The design requirements for the various mix types are given in Section 610 for dense-graded mix types, Section 650 for OGFC, Section 652 for PADC and Section 661 for UBWC.

Perform all activities in accordance with the Department's *Asphalt Quality Management System (QMS) Manual* in effect on the date of contract advertisement

Provide and conduct the QC and required testing for acceptance of the asphalt mixture in accordance with Section 609.

Define "warm mix asphalt (WMA)" as additives or processes that allow a reduction in the temperature at which asphalt mixtures are produced and placed. Use only NCDOT approved WMA additives listed on the NCDOT APL maintained by the Materials and Tests Unit.

610-2 MATERIALS

Refer to Division 10.

Item	Section
Anti-Strip Additives	1020-8
Asphalt Binder, Performance Grade	1020-2
Coarse Aggregate	1012-1(B)
Fine Aggregate	1012-1(C)
Mineral Filler	1012-1(D)
Reclaimed Asphalt Pavement (RAP)	1012-1(F)
Reclaimed Asphalt Shingles (RAS)	1012-1(E)
Silicone	1020-9

610-3 COMPOSITION OF MIXTURES (MIX DESIGN AND JOB MIX FORMULA)

(A) Mix Design-General

Prepare the asphalt mix design using a mixture of coarse and fine aggregate, asphalt binder, mineral filler and other additives when required. Size, uniformly grade and combine the several aggregate fractions in such proportions that the resulting mixture meets the grading and physical requirements of the *Standard Specifications* for the specified mix type. Materials that will not produce a mixture within the design criteria required by the specifications will be rejected, unless otherwise approved by the Engineer.

At least 10 days excluding official state holidays before start of asphalt mix production, submit the mix design and proposed JMF targets for each required mix type and combination of aggregates to the Engineer for review and approval. Prepare the mix design using a Department certified mix design technician in an approved mix design laboratory and in accordance with the procedures outlined in Section 4.5 of the *Asphalt QMS Manual.*

For the final surface layer of the specified mix type, use a mix design with an aggregate blend gradation above the maximum density line on the 2.36 mm and larger sieves.

The Contractor has the option to use a recycled plant mix in lieu of virgin plant mix. However, all provisions of the specifications for virgin mixes apply to recycled mixes. This means that the same design criteria tests, test frequencies, and quality control requirements will apply.

Reclaimed Asphalt Pavement (RAP) or Reclaimed Asphalt Shingles (RAS) may be incorporated into asphalt plant mixes in accordance with Article 1012-1 and the following applicable requirements. However, use of RAP materials is not allowed in Open-Graded Friction Course (OGFC) mixes or Ultra-Thin Bonded Wearing Course (UBWC) mixes. Use of RAS materials is not allowed in Ultra-Thin Bonded Wearing Course (UBWC) mixes.

RAS material may constitute up to 6% by weight of total mixture, except for Open Graded Friction Course (OGFC) mixes, which are limited to 5% RAS by weight of total mixture. Also, when the percentage of RAP is greater than 30% by weight of total mixture, use Fractionated RAP (FRAP) meeting the requirements of Subarticle 1012-1(F)(c).

When RAP, RAS, or a combination of both is used in asphalt mixtures, the recycled binder replacement percentage (RBR%) shall not exceed the amounts specified in Table 610-4 for the mix type. For recycled mixtures, the virgin binder Performance Grade (PG) grade to be used is specified in Table 610-5 for the mix type based on the recycled binder replacement percentage (RBR%).

If the Contractor wishes to submit mix designs containing recycled material amounts exceeding the specified maximums, additional testing will be required to verify the Performance Grade (PG) of the reclaimed binder. Also, the Contractor has the option to have additional testing performed to determine if the mix can be approved using a virgin binder grade different than specified in Table 610-5. The Engineer will determine if the binder grade is acceptable for use based on the test data submitted with the mix design. If the mix design is acceptable, the Engineer will establish and approve the grade and percentage of virgin asphalt binder to be used.

If a change in the source of RAP or RAS be made, a new mix design and JMF may be required in accordance with Article 1012-1. Samples of the completed recycled mixture may be taken by the Department on a random basis and the recovered asphalt binder will be tested in accordance with Article 1020-2. If the grading is determined to be a value other than required for the specified mix type, the Engineer may require the Contractor to

adjust any combination of the grade, the percentage of additional asphalt binder or the blend of reclaimed material to bring the grade to the specified value.

(B) Mix Design Criteria

Design and produce asphalt concrete mixtures that conform to the gradation requirements and design criteria in Table 610-2 and Table 610-3 for the mix type specified. The mix type designates the nominal maximum aggregate size and the design traffic level.

Surface mix designs will be tested by the Department for rutting susceptibility. Rut depth requirements for each surface mix type and traffic level are specified in Table 610-3. Mix designs that fail to meet these requirements will be unacceptable and shall be redesigned by the Contractor such that rut depths are acceptable.

Table 610-2 provides gradation control points to be adhered to in the development of the design aggregate structure for each mix type. Aggregate gradations shall be equal to or pass between the control points. Table 610-3 provides the mix design criteria for the various mix types.

Use an anti-strip additive in all asphalt mixes. It may be hydrated lime or a chemical additive or a combination of both as needed to meet the retained strength requirements as specified in Table 610-3. When a chemical additive is used, add at a rate of not less than 0.25% by weight of binder in the mix, or as approved by the Engineer. When hydrated lime is used, add at a rate of not less than 1.0% by weight of the total dry aggregate.

(C) Job Mix Formula (JMF)

Establish the JMF gradation target values within the design criteria specified for the particular type of asphalt mixture to be produced. Establish the JMF asphalt binder content at the percentage that will produce voids in total mix (VTM) at the midpoint of the specification design range for VTM, unless otherwise approved by the Engineer. The formula for each mixture will establish the following: blend percentage of each aggregate fraction, the percentage of reclaimed aggregate, if applicable, a single percentage of combined aggregate passing each required sieve size, the total percentage and grade of asphalt binder required for the mixture (by weight of total mixture), the percentage and grade of asphalt binder to be added to the mixture (for recycled mixtures), the percentage of chemical anti-strip additive to be added to the asphalt binder or percentage of hydrated lime to be added to the aggregate, the temperature at that the mixture is to be discharged from the plant, the required field density and other volumetric properties.

When WMA is used, document the additive or process used and recommended rate on the JMF submittal. Verify the JMF based on plant produced mixture from the trial batch.

The mixing temperature at the asphalt plant will be established on the JMF. The JMF mix temperature shall be within the ranges shown in Table 610-1 unless otherwise approved by the Engineer.

TABLE 610-1
MIXING TEMPERATURE AT THE ASPHALT PLANT

Binder Grade	JMF Temperature
PG 58-28; PG 64-22	250 - 290°F
PG 76-22	300 - 325°F

When RAS is used, the JMF mix temperature shall be established at 275°F or higher.

Have on hand at the asphalt plant the approved mix design and JMF issued by the Department, before beginning the work.

The JMF for each mixture will remain in effect until modified in writing, provided the results of QMS tests performed in accordance with Section 609 on material currently

being produced conform with specification requirements. When a change in sources of aggregate materials is to be made, a new mix design and JMF will be required before the new mixture is produced. When a change in sources of RAP or RAS material is to be made, a new JMF is required and a new mix design may be required. When unsatisfactory results or other conditions make it necessary, the Engineer may revoke the existing JMF or establish a new JMF.

TABLE 610-2
AGGREGATE GRADATION CRITERIA
(Percent Passing Control Points)

Standard Sieves (mm)	Mix Type (Nominal Max. Aggregate Size)							
	4.75 mm		9.5 mm[A]		19.0 mm		25.0 mm	
	Min	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
50.0	-	-	-	-	-	-	-	-
37.5	-	-	-	-	-	-	100	-
25.0	-	-	-	-	100	-	90.0	100
19.0	-	-	-	-	90.0	100	-	90.0
12.5	100	-	100	-	-	90.0	-	-
9.50	95.0	100	90.0	100	-	-	-	-
4.75	90.0	100	-	90.0	-	-	-	-
2.36	-	-	32.0[B]	67.0[B]	23.0	49.0	19.0	45.0
1.18	30.0	60.0	-	-	-	-	-	-
0.075	6.0	12.0	4.0	8.0	3.0	8.0	3.0	7.0

A. For the final surface layer of the specified mix type, use a mix design with an aggregate blend gradation above the maximum density line on the 2.36 mm and larger sieves.

B. For Type S9.5B, the percent passing the 2.36 mm sieve shall be a minimum of 60% and a maximum of 70%.

TABLE 610-3
MIX DESIGN CRITERIA

Mix Type	Design ESALs millions[A]	Binder PG Grade	Compaction Levels G_{mm} @		Max. Rut Depth (mm)	Volumetric Properties[B]			
			N_{ini}	N_{des}		VMA % Min.	VTM %	VFA Min.-Max.	$\%G_{mm}$ @ N_{ini}
S4.75A	< 1	64 - 22	6	50	11.5	16.0	4.0 - 6.0	65 - 80	≤ 91.5
S9.5B	0 - 3	64 - 22	6	50	9.5	16.0	3.0 - 5.0	70 - 80	≤ 91.5
S9.5C	3 - 30	64 - 22	7	65	6.5	15.5	3.0 - 5.0	65 - 78	≤ 90.5
S9.5D	> 30	76 - 22	8	100	4.5	15.5	3.0 - 5.0	65 - 78	≤ 90.0
I19.0C	ALL	64 - 22	7	65	-	13.5	3.0 - 5.0	65 - 78	≤ 90.5
B25.0C	ALL	64 - 22	7	65	-	12.5	3.0 - 5.0	65 - 78	≤ 90.5
	Design Parameter					**Design Criteria**			
All Mix Types	Dust to Binder Ratio ($P_{0.075}$ / P_{be})					0.6 - 1.4[C]			
	Tensile Strength Ratio (TSR)[D]					85% Min[E]			

A. Based on 20 year design traffic.

B. Volumetric Properties based on specimens compacted to N_{des} as modified by the Department.

C. Dust to Binder Ratio ($P_{0.075}$ / P_{be}) for Type S4.75A is 1.0 - 2.0.

D. NCDOT-T-283 (No Freeze-Thaw cycle required).

E. TSR for Type S4.75A & B25.0C mixes is 80% minimum.

TABLE 610-4 MAXIMUM RECYCLED BINDER REPLACEMENT PERCENTAGE (RBR%)			
Recycled Material	**Intermediate & Base Mixes**	**Surface Mixes**	**Mixes Using PG 76-22**
RAS	23%	20%	18%
RAP or RAP/RAS Combination	45%	40%	18%

TABLE 610-5 BINDER GRADE REQUIREMENTS (BASED ON RBR%)			
Mix Type	**%RBR ≤ 20%**	**21% ≤ %RBR ≤ 30%**	**%RBR > 30%**
S4.75A, S9.5B, S9.5C, I19.0C, B25.0C	PG 64-22	PG 64-22[A]	PG 58-28
S9.5D, OGFC	PG 76-22[B]	n/a	n/a

A. If the mix contains any amount of RAS, the virgin binder shall be PG 58-28.

B. Maximum Recycled Binder Replacement (%RBR) is 18% for mixes using PG 76-22 binder.

610-4 WEATHER, TEMPERATURE AND SEASONAL LIMITATIONS FOR PRODUCING AND PLACING ASPHALT MIXTURES

Do not produce or place asphalt mixtures during rainy weather, when the subgrade or base course is frozen or when the moisture on the surface to be paved would prevent proper bond. Do not place asphalt material when the air or surface temperatures, measured at the location of the paving operation away from artificial heat, do not meet Table 610-6.

Do not place surface course material that is to be the final layer of pavement between December 15 and March 16 of the next year if it is 1 inch or greater in thickness, or between November 15 and April 1 of the next year if it is less than 1 inch in thickness, unless otherwise approved by the Engineer.

As an exception to the above, when in any day's operations the placement of a layer of asphalt base course material or intermediate material 2 inches or greater in thickness has started, it may continue until the temperature drops to 32°F.

Do not place plant mix base course that will not be covered with surface or intermediate course during the same calendar year or within 15 days of placement if the plant mix is placed in January or February. Failure by the Contractor to cover the plant mix as required above will result in the Engineer notifying the Contractor in writing to cover the plant mix with a sand seal. Apply the sand seal in accordance with Section 660, except that Articles 660-3 and 660-12 will not apply. In the event the Contractor fails to apply the sand seal within 72 hours of receipt of such notice, the Engineer may proceed to have such work performed with Department forces and equipment.

TABLE 610-6 PLACEMENT TEMPERATURES FOR ASPHALT	
Asphalt Concrete Mix Type	**Minimum Surface and Air Temperature**
B25.0C	35°F
I19.0C	35°F
S4.75A, S9.5B, S9.5C	40°F[A]
S9.5D	50°F

A. For the final layer of surface mixes containing recycled asphalt shingles (RAS), the minimum surface and air temperature shall be 50°F.

610-5 ASPHALT MIXTURE PRODUCTION

Use plants that are either of the batch mixing, continuous mixing or drum mixing type, and so designed, equipped and operated that the weighing, proportioning and mixing of the materials will result in a uniform and satisfactory asphalt mixture meeting these specifications. All plants shall conform to requirements of Sections 5 and 6 of the *Asphalt QMS Manual*.

Before production of the mix, stockpile aggregates for a sufficient period of time to facilitate the drainage of free moisture. Keep the different aggregate sizes separated until they have been delivered to the cold feeders. Keep the separate stockpiles readily accessible for sampling. When mineral filler is required in the mix, feed or weigh-in separately from the other aggregates.

Introduce the asphalt binder and other additives, when required, into the mixture at the amounts and percentages specified by the JMF. No working tolerance will be allowed. Introduce the hot and dry aggregates, mineral filler, and recycled materials, in amounts and at temperatures such that the mixture produced is within the production control limits of Subarticle 609-6(D). Provide a positive means of controlling mixing time to obtain complete and uniform coating of the aggregate particles and thorough distribution of the asphalt binder throughout the aggregate. Produce the mixture at the asphalt plant within ±25 °F of the JMF mix temperature. The temperature of the mixture, when discharged from the mixer, shall not exceed 350°F.

All asphalt plants shall be certified by the Department. Certification is effective from the date of issuance and is non-expiring subject to continued compliance. The Department will check the plant on an annual basis or as deemed necessary by the Engineer. Any plant that is relocated, modified or changes ownership shall be recertified before use.

Any completely automatically controlled asphalt plant that, due to the basic design of the plant, does not meet all these specifications for conventional batch mixing, continuous mixing or drum mixing may be used on a project by project basis provided a uniformly consistent mix meeting all mix requirements can be produced and the plant has been approved in writing by the Department.

Any asphalt plant that cannot consistently produce a high quality mix meeting these specifications will be in non-compliance with these specifications and may have its certification revoked.

Upon a malfunction of required automatic equipment on a batch mixing plant, the plant may continue to operate manually for the following 2 consecutive working days, provided acceptable mixture is being produced.

When a malfunction of required automatic equipment on a drum mixer or continuous plant occurs, manual operation of the plant will not be allowed except that if, in the opinion of the Engineer, an emergency traffic condition exists, the plant may be allowed to operate manually until the unsafe traffic condition is corrected. All mix produced by manual operation will be subject to Section 609.

610-6 HOT MIX STORAGE SYSTEMS

When a storage system is used, provide a system capable of conveying the mix from the plant to the storage bin and storing the mix without a loss in temperature, segregation or oxidation of the mix. Limit storage time to the ability of the storage system to maintain the mix within the specification requirements. Material may be stored in storage bins without an approved heating system for no more than 24 hours.

Provide a continuous type or skip bucket type conveyor system. Enclose continuous type conveyors so that the mix temperature is maintained within specification requirements. Provide a system designed in such manner as to prevent segregation of the mix during discharge from the conveyor into the bins and equipped with discharge gates that will not cause segregation of the mix while loading the mix into trucks.

610-7 HAULING OF ASPHALT MIXTURE

Transport the mixture from the mixing plant to the point of use in vehicles that have tight, clean, smooth beds approved by the Department, that have been sprayed with an approved release agent material to prevent the mixture from adhering to the beds. Remove excess release agent before loading. Cover each load of mixture with a solid, waterproof tarp constructed of canvas, vinyl, or other suitable material. Provide a 3/8 inch to 5/8 inch diameter hole on each side of the vehicle body near the center of the body and above the bed of the vehicle for the purpose of inserting a thermometer.

Assure temperature of the mixture immediately before discharge from the hauling vehicle is within a tolerance of ±25°F of the specified JMF mix temperature.

610-8 SPREADING AND FINISHING

Apply tack coat in accordance with Section 605.

Mixtures produced simultaneously from different plant sources cannot be intermingled by hauling to the same paver on the roadway unless the mixtures are being produced from the same material sources and same JMF.

As referenced in Section 9.6.3 of the *Asphalt QMS Manual*, use the automatic screed controls on the paver to control the longitudinal profile. Where approved by the Engineer, the Contractor has the option to use either a fixed or mobile string line.

Perform this work in accordance with and using equipment meeting Section 9 of the *Asphalt QMS Manual.*

Use a material transfer vehicle (MTV) when placing all asphalt concrete plant mix pavements which require the use of asphalt binder grade PG 76-22 and for all types of OGFC, unless otherwise approved by the Engineer. Use a MTV for all surface mix regardless of binder grade on Interstates, US Routes, NC Routes (primary routes) that have 4 or more lanes and are median divided. Where required above, use the MTV when placing all full width travel lanes and collector lanes. Use MTV for all ramps, loops, and Y-lines that have 4 or more lanes and are median divided, and all full width acceleration lanes, full width deceleration lanes, and full width turn lanes that are greater than 1,000 feet in length. Use a MTV meeting Section 9.5(E) of the *Asphalt QMS Manual.*

Place asphalt concrete base course material in trench sections with asphalt pavement spreaders made for the purpose or with other equipment approved by the Engineer.

Request the Engineer to waive the requirement for use of pavers for spreading and finishing where irregularities or obstacles make their use impractical. Spread, rake and lute the mixture by hand methods or other approved methods in these areas.

Operate the paver as continuously as possible. Pave intersections, auxiliary lanes and other irregular areas after the main line roadway has been paved, unless otherwise approved by the

Engineer. Place a wedge course at locations ahead of the paving operation as required by the Engineer.

Repair any damage caused by hauling equipment across structures at no additional cost to the Department.

610-9 COMPACTION

Immediately after the asphalt mixture has been spread, struck off and surface and edge irregularities adjusted, thoroughly and uniformly compact the pavement. Compact the mix to the required degree of compaction for the type of mixture being placed.

Provide sufficient number and weight of rollers, except as noted, to compact the mixture to the required density while it is still in a workable condition. Obtain approval of equipment used in compaction from the Engineer before use. Where uniform density is not being obtained throughout the depth of the layer of material being tested, change the type and/or weight of the compaction equipment as necessary to achieve uniform density even though such equipment has been previously approved.

Compact all final wearing surfaces, except OGFC, using a minimum of two steel-wheel tandem rollers, unless otherwise approved by the Engineer. Pneumatic-tire rollers with two tandem axles and smooth tread tires may be used for intermediate rolling.

Limit rolling for OGFC to one coverage with a tandem steel-wheel roller weighing a maximum of 10 tons, with additional rolling limited to one coverage with the roller where necessary to improve the riding surface.

Steel-wheel tandem vibratory rollers specifically designed for the compaction of asphalt pavements may be used on all layers 1 inch or greater in thickness during the breakdown and intermediate rolling phase. Do not operate vibratory rollers in the vibratory mode during the finish rolling phase on any mix type or pavement course, OGFC or on PADC.

When vibratory rollers are used, use rollers that have variable amplitude and frequency capabilities and that are designed specifically for asphalt pavement compaction. Provide rollers equipped with controls that automatically disengage the vibration mechanism before the roller stops when being used in the vibratory mode.

The Engineer may prohibit or restrict the use of vibratory rollers where damage to the pavement being placed, the underlying pavement structure, bridges, drainage structures, utilities or other facilities is likely to occur or is evident.

Do not use rolling equipment that results in excessive crushing of the aggregate or excessive displacement of the mixture.

In areas inaccessible to standard rolling equipment, thoroughly compact the mixture by the use of hand tampers, hand operated mechanical tampers, small rollers or other methods approved by the Engineer.

Use rollers that are in good condition and capable of being reversed without backlash to compact the mixture. Operate rollers with the drive wheels nearest the paver and at uniform speeds slow enough to avoid displacement of the mixture. Equip steel-wheel rollers with wetting devices that will prevent the mixture from sticking to the roller wheels.

Begin compaction of the material immediately after the material is spread and shaped to the required width and depth. Carry out compaction in such a manner as to obtain uniform density over the entire section. Perform compaction rolling at the maximum temperature at which the mix will support the rollers without moving horizontally. Complete the compaction (including both intermediate rolling) before the mixture cooling below a workable temperature. Perform finish rolling to remove roller marks resulting from the compaction rolling operations.

610-10 DENSITY REQUIREMENTS

TABLE 610-7
DENSITY REQUIREMENTS

Mix Type	Minimum % G_{mm} (Maximum Specific Gravity)
S4.75A	85.0[A]
S9.5B	90.0
S9.5C, S9.5D, I19.0C, B25.0C	92.0

A. Compaction to the above specified density shall be required when the S4.75A mix is applied at a rate of 100 lbs/sy or higher.

Compact the asphalt plant mix to at least the minimum percentage of the maximum specific gravity listed in Table 610-7, except as noted in Section 10.3.4 of the *Asphalt QMS Manual.*

Compaction with equipment other than conventional steel drum rollers may be necessary to achieve adequate compaction. Occasional density sampling and testing to evaluate the compaction process may be required. The Contractor shall maintain minimum test frequencies as established. Should the Contractor's density testing frequency fail to meet the minimum frequency as, all mix without required density test representation shall be considered unsatisfactory and if allowed to remain in place, will be evaluated for acceptance in accordance with Article 105-3.

610-11 JOINTS

(A) Transverse Joints

When the placing of the mixture is to be suspended long enough to permit the mixture to become chilled, construct a transverse joint.

If traffic will not pass over the end of the paving, a butt joint will be permitted, provided proper compaction is achieved. If traffic will pass over the joint, construct a sloped wedge ahead of the end of the full depth pavement to provide for proper compaction and protection of the full depth pavement. Construct the joint square to the lane alignment and discard all excess material. Place a paper parting strip beneath this wedge to facilitate joint construction unless waived by the Engineer.

Before paving operations are resumed, remove the sloped wedge and cut back into the previously constructed pavement to the point of full pavement depth. Coat the exposed edge of the previously constructed pavement with tack coat.

When laying of the mixture is resumed at the joint, complete and then test the construction of the joint in accordance with Article 610-12 while the mixture is still in a workable condition.

(B) Longitudinal Joints

Tack the exposed edge of all longitudinal joints before placing the adjoining pavement.

Form longitudinal joints by allowing the paver to deposit the mixture adjacent to the joint to such depth that maximum compaction can be obtained along the joint. Pinch the joint by rolling immediately behind the paver.

When multi-lane multi-layer construction is required, offset the longitudinal joints in each layer from that in the layer immediately below by approximately 6 inches. Construct the joints in the final layer, where possible, between designated travel lanes of the final traffic pattern.

610-12 SURFACE REQUIREMENTS AND ACCEPTANCE

Construct pavements using quality-paving practices as detailed herein. Construct the pavement surface smooth and true to the plan grade and cross slope. Immediately correct any defective areas with satisfactory material compacted to conform with the surrounding area.

Pavement imperfections resulting from unsatisfactory workmanship such as segregation, improper longitudinal joint placement or alignment, non-uniform edge alignment or excessive pavement repairs will be unsatisfactory. Pavement imperfections will be evaluated for acceptance in accordance with Article 105-3.

When directed by the Engineer due to unsatisfactory laydown or workmanship, operate under the limited production procedures. Limited production for unsatisfactory laydown is defined as being restricted to the production, placement, compaction and final surface testing (if applicable) of a sufficient quantity of mix necessary to construct only 2,500 feet of pavement at the laydown width.

Remain on limited production until such time as satisfactory laydown results are obtained or until three consecutive 2,500 feet sections have been attempted without achieving satisfactory laydown results. If the Contractor fails to achieve satisfactory laydown results after three consecutive 2,500 feet sections have been attempted, cease production of that mix type until such time as the cause of the unsatisfactory laydown results can be determined. As an exception, the Engineer may grant approval to produce a different mix design of the same mix type if the cause is related to mix problems rather than laydown procedures.

Mix placed under the limited production procedures for unsatisfactory laydown or workmanship will be evaluated for acceptance in accordance with Article 105-3.

Each pavement layer will be tested by the Contractor and the Engineer using a 10 foot stationary straightedge furnished by the Contractor. Any location on the pavement selected by the Department shall be tested as well as all transverse joints. Apply the straightedge parallel to the centerline of the surface. Do not exceed 1/8 inch variation of the surface being tested from the edge of the straightedge between any two contact points. Correct areas found to exceed this tolerance by removal of the defective work and replacement with new material, unless other corrective measures are permitted. Provide the work and materials required in the correction of defective work.

610-13 FINAL SURFACE TESTING AND ACCEPTANCE

On portions of this project where the typical section requires two or more layers of new pavement, perform smoothness acceptance testing of the longitudinal profile of the finished pavement surface using either an Inertial Profiler or a North Carolina Hearne Straightedge (Model No. 1). Final surface testing is not required on ramps, loops and turn lanes.

Use an Inertial Profiler (Option 1) to perform smoothness acceptance testing of the longitudinal profile of the finished pavement surface. Furnish an inertial profiler(s) necessary to perform this work. Maintain responsibility for all costs related to the procurement, handling, and maintenance of these devices.

Furnish and operate the Hearne straightedge (Option 2) to determine and record the longitudinal profile of the pavement on a continuous graph.

Before beginning any paving operations, the Contractor shall select one of the above options and submit documentation to the Engineer on the selected option for smoothness acceptance.

(A) Option 1 - Inertial Profiler

Use an Inertial Profiler to measure the longitudinal pavement profile for construction quality control and smoothness acceptance. Use a profiler with line laser technology as single-point laser technology will not be allowed. Produce International Roughness Index (IRI) and Mean Roughness Index (MRI) values for measuring smoothness.

Use testing and recording software to produce electronic inertial road profiles in a format compatible with the latest version of FHWA's ProVAL (Profile Viewing and Analysis) software.

The Inertial Profiler shall be calibrated and verified in accordance with the most current version of AASHTO M 328. Provide certification documentation that the profiler meets AASHTO M 328 to the Engineer before the first day the Inertial Profiler is used on the project.

Configure the profiler to record the actual elevation of the pavement surface. Do not use the profiler's internal IRI calculation mode. The profile data shall be filtered with a 300 feet Butterworth high-pass filter. The interval at which relative profile elevations are reported shall be 1 inch.

Provide IRI data in accordance with most current version of ASTM E1926. Use personnel trained to record and evaluate IRI data.

Provide an Inertial Profiler Operator that has been certified by the Department's Profiler and Operator Certification Program as administered by the Materials and Tests Unit. Provide the user selected Inertial Profiler settings to the Engineer for the project records.

In the presence of the Engineer, at the beginning of each day's data collection, perform a block test to verify the Inertial Profiler's ability to accurately collect elevation data is met and perform bounce test to verify that the Inertial Profiler's accelerometers are performing correctly.

Remove all objects and foreign material on the pavement surface prior to longitudinal pavement profile testing.

In the presence of the Engineer, operate the profiler at any speed as per the manufacturer's recommendations to collect valid data. Operate the Inertial Profiler in the direction of the final traffic pattern. Collect IRI data from both wheel paths during the same run. Define a "wheel path" as the 3 feet from the edge of the travel lane. MRI values are the average of the IRI values from both wheel paths. When using an inertial profiler that collects a single trace per pass, take care to ensure that the measurements from each trace in a travel lane start and stop at the same longitudinal locations. Unless otherwise specified, multiple runs are not necessary for data collection.

Operate the automatic triggering method at all times unless impractical. Areas excluded from testing by the profiler may be tested using a 10-foot straightedge in accordance with Article 610-12. The profiler shall reach the intended operating speed before entering the test section. The runup and runout distances should be sufficient to obtain the intended operating speed and to slow down after testing is completed.

Divide the pavement surface for the project into sections which represent a continuous placement (i.e. the start of the project to bridge, intersection to intersection). Terminate a section 50 feet before a bridge approach, railroad track, or similar interruption. (Separate into 0.10-mile sections).

The evaluation of the profiles will be performed on a section basis. A section is 0.10 mile of a single pavement lane. For any section, which is less than 0.10 mile in length, the applicable pay adjustment incentive will be prorated on the basis of the actual length.

Mark the limits of structures and other special areas to be excluded from testing using the profiler's event identifier such that the exact locations can be extracted from the profile data file during processing.

Unless otherwise authorized by the Engineer, perform all smoothness testing in the presence of the Engineer. Perform smoothness tests on the finished surface of the completed project or at the completion of a major stage of construction as approved by

the Engineer. Coordinate with and receive authorization from the Engineer before starting smoothness testing. Perform smoothness tests within 7 days after receiving authorization. Any testing performed without the Engineer's presence, unless otherwise authorized, may be ordered retested at the Contractor's expense.

After testing, transfer the profile data from the profiler portable computer's hard drive to a write once storage media (Flash drive, USB, DVD-R or CD-R) or electronic media approved by the Engineer. Label the disk or electronic media with the Project number, Route, file number, date, and termini of the profile data. Submit the electronic data on the approved media to the Engineer immediately after testing and this media will not be returned to the Contractor.

Submit a report with the documentation and electronic data of the evaluation for each section to the Engineer within 10 days after completion of the smoothness testing. The report shall be in the tabular format for each 0.10 segment or apportion thereof with a summary of the MRI values and the localized roughness areas including corresponding project station numbers or acceptable reference points. Calculate the pay adjustments for all segments in accordance with the formulas in Sections (1) and (2) shown below. The Engineer shall review and approve all pay adjustments unless corrective action is required. Submit the electronic files compatible with ProVAL and the evaluation in tabular form with each 0.10 mile segment occupying a row. Include each row with the beginning and ending station for the section, the length of the section, the original IRI values from each wheel path, and the MRI value for the section. Each continuous run for a section will occupy a separate table and each table will have a header that includes the following: the project contract number, county, the roadway number or designation, a lane designation, the JMF used for the final lift, the dates of the smoothness runs, and the beginning and ending station of the continuous run. Summarize each table at the bottom.

Traffic control and all associated activities included in the pavement smoothness testing of the pavement surface will be the responsibility of the Contractor.

(1) Acceptance for New Construction

IRI and MRI numbers recorded in inches per mile will be established for each 0.10 mile section for each travel lane of the surface course designated by the contract. Areas excluded from testing by the profiler will be tested using a 10 foot straightedge in accordance with Article 610-12.

Table 610-8 provides the acceptance quality rating scale of pavement based on the final rideability determination.

TABLE 610-8
MRI PRICE ADJUSTMENT PER 0.10-MILE SECTION

MRI after Completion (Inches Per Mile)	Price Adjustment Per Lane (0.10-Mile Section)
45.0 and Under	$200.00
45.1-55.0	PA = 600 – (10 * MRI)
55.1-70.0	Acceptable (No Pay Adjustment)
70.1-90.0	PA = 650 – (10 * MRI)
Over 90.1	Corrective Action Required

This price adjustment will apply to each 0.10-mile section or prorated for a portion thereof, based on the Mean Roughness Index (MRI), the average IRI values from both wheel paths.

When corrections to the pavement surface are required, the Engineer shall approve the Contractor's method of correction. Methods of correction shall be milling and inlay, remove and replace or other methods approved by the Engineer. To produce a uniform cross section, the Engineer may require correction to the adjoining traffic

lanes or shoulders. Corrections to the pavement surface, the adjoining traffic lanes and shoulders will be at no cost to the Department.

Where corrections are made after the initial smoothness testing, the pavement will be retested by the Contractor to verify that corrections have produced the acceptable ride surface. No incentives will be provided for sections on which corrective actions have been required. The Contractor will have one opportunity to perform corrective action(s).

(2) Localized Roughness

Areas of localized roughness shall be identified through the "Smoothness Assurance Module (SAM)" provided in the ProVAL software. Use the SAM report to optimize repair strategies by analyzing the measurements from profiles collected using inertial profilers. The ride quality threshold for localized roughness shall be 165 inches per mile for any sections that are 15 feet to 100 feet in length at the continuous short interval of 25 feet. Submit a continuous roughness report to identify each section with project station numbers or reference points outside the threshold and identify all localized roughness, with the signature of the Operator included with the submitted IRI trace and electronic files.

The Department will require that corrective action be taken regardless of final IRI. Re-profile the corrected area to ensure that the corrective action was successful. If the corrective action is not successful, the Department will assess a penalty or require additional corrective action.

$$\mathbf{PA} = (165 - \text{LR\#})\ 5$$

Where:

PA = Pay Adjustment (dollars)

LR# = The Localized Roughness number determined from SAM report for the ride quality threshold

Corrective work for localized roughness shall be approved by the Engineer before performing the work and shall consist of either replacing the area by milling and inlaying or other methods approved by the Engineer. Any corrective action performed shall not reduce the integrity or durability of the pavement that is to remain in place. Milling and inlay or any corrective actions shall meet the specifications requirements for ride quality over the entire length of the correction. Notify the Engineer five days before commencement of the corrective action.

Localized roughness correction work shall be for the entire traffic lane width. Pavement cross slope shall be maintained through corrective areas.

(B) Option 2 - North Carolina Hearne Straightedge

Push the straightedge manually over the pavement at a speed not exceeding 2 miles per hour. For all lanes, take profiles in the right wheel path approximately 3 feet from the right edge of pavement in the same direction as the paving operation, unless otherwise approved by the Engineer due to traffic control or safety considerations. As an exception, lanes adjacent to curb and gutter, expressway gutter, or shoulder berm gutter may be tested in the left wheel path. Make one pass of the straightedge in each full width travel lane. The full lane width should be comparable in ride quality to the area evaluated with the Hearne Straightedge. If deviations exist at other locations across the lane width, use a 10 foot non-mobile straightedge or the Hearne Straightedge to evaluate which areas may require corrective action. Take profiles as soon as practical after the pavement has been rolled and compacted, but no later than 24 hours following placement of the pavement, unless otherwise authorized by the Engineer. Take profiles over the entire length of the final surface travel lane pavement exclusive of structures, approach slabs, paved shoulders, tapers, or other irregular shaped areas of pavement, unless otherwise approved

by the Engineer. Test in accordance with this provision all mainline travel lanes, full width acceleration or deceleration lanes, and collector lanes.

At the beginning and end of each day's testing operations, and at such other times as determined by the Engineer, operate the straightedge over a calibration strip so that the Engineer can verify correct operation of the straightedge. The calibration strip shall be a 100 foot section of pavement that is reasonably level and smooth. Submit each day's calibration graphs with that day's test section graphs to the Engineer. Calibrate the straightedge in accordance with the Section 11.1.4 of the *Asphalt QMS Manual*.

Plot the straightedge graph at a horizontal scale of approximately 25 feet per inch with the vertical scale plotted at a true scale. Record station numbers and references (bridges, approach slabs, culverts, etc.) on the graphs. Distances between references/stations shall not exceed 100 feet. Have the operator record the Date, Project No., Lane Location, Wheel Path Location, Type Mix and Operator's Name on the graph.

Upon completion of each day's testing, evaluate the graph, calculate the Cumulative Straightedge Index (CSI) and determine which lots, if any, require corrective action. Document the evaluation of each lot on a *QA/QC-7 form*. Submit the graphs along with the completed *QA/QC-7 forms* to the Engineer, within 24 hours after profiles are completed, for verification of the results. The Engineer will furnish results of their acceptance evaluation to the Contractor within 48 hours of receiving the graphs. In the event of discrepancies, the Engineer's evaluation of the graphs will prevail for acceptance purposes. The Engineer will retain all graphs and forms.

Use blanking bands of 0.2 inch, 0.3 inch and 0.4 inch to evaluate the graph for acceptance. The 0.2 inch and 0.3 inch blanking bands are used to determine the Straightedge Index (SEI), which is a number that indicates the deviations that exceed each of the 0.2 inch and 0.3 inch bands within a 100 foot test section. The Cumulative Straightedge Index (CSI) is a number representing the total of the SEIs for one lot, which consist of not more than 25 consecutive test sections. In addition, the 0.4 inch blanking band is used to further evaluate deviations on an individual basis. The CSI will be determined by the Engineer in accordance with Section 11.1.5 of the *Asphalt QMS Manual.*

The pavement will be accepted for surface smoothness on a lot by lot basis. A test section represents pavement one travel lane wide not more than 100 feet in length. A lot will consist of 25 consecutive test sections, except that separate lots will be established for each travel lane, unless otherwise approved by the Engineer. In addition, full width acceleration or deceleration lanes, ramps, turn lanes and collector lanes will be evaluated as separate lots. For any lot that is less than 2,500 feet in length, the applicable pay adjustment incentive will be prorated on the basis of the actual lot length. For any lot which is less than 2,500 feet in length, the applicable pay adjustment disincentive will be the full amount for a lot, regardless of the lot length.

If during the evaluation of the graphs, five lots require corrective action, then proceed on limited production for unsatisfactory laydown in accordance with Article 610-12. Proceeding on limited production is based upon the Contractor's initial evaluation of the straightedge test results and shall begin immediately upon obtaining those results. Additionally, the Engineer may direct the Contractor to proceed on limited production in accordance with Article 610-12 due to unsatisfactory laydown or workmanship.

Limited production for unsatisfactory laydown is defined as being restricted to the production, placement, compaction and final surface testing of a sufficient quantity of mix necessary to construct only 2,500 feet of pavement at the laydown width. Once this lot is complete, the final surface testing graphs will be evaluated jointly by the Contractor and the Engineer. Remain on limited production until such time as acceptable laydown results are obtained or until three consecutive 2,500 foot sections have been attempted without achieving acceptable laydown results. The Engineer will determine if normal

production may resume based upon the CSI for the limited production lot and any adjustments to the equipment, placement methods, and/or personnel performing the work. Once on limited production, the Engineer may require the Contractor to evaluate the smoothness of the previous asphalt layer and take appropriate action to reduce and/or eliminate corrective measures on the final surface course. Additionally, the Contractor may be required to demonstrate acceptable laydown techniques off the project limits before proceeding on the project.

If the Contractor fails to achieve satisfactory laydown results after three consecutive 2,500 foot sections have been attempted, cease production of that mix type until such time as the cause of the unsatisfactory laydown results can be determined.

As an exception, the Engineer may grant approval to produce a different mix design of the same mix type if the cause is related to mix problem(s) rather than laydown procedures. If production of a new mix design is allowed, proceed under the limited production procedures detailed above.

After initially proceeding under limited production, the Contractor shall immediately notify the Engineer if any additional lot on the project requires corrective action. The Engineer will determine if limited production procedures are warranted for continued production.

If the Contractor does not operate by the limited production procedures as specified above, the 5 lots, which require corrective action, will be considered unacceptable and may be subject to removal and replacement. Mix placed under the limited production procedures for unsatisfactory laydown will be evaluated for acceptance in accordance with Article l05-3.

The pay adjustment schedule for the Cumulative Straightedge Index (CSI) test results per lot is in Table 610-9.

TABLE 610-9
PAY ADJUSTMENT SCHEDULE FOR CUMULATIVE STRAIGHTEDGE INDEX
(Obtained by adding SE Index of up to 25 consecutive 100 ft test sections)

CSI[A]	Acceptance Category	Corrective Action	Pay Adjustment Before Corrective	Pay Adjustment After Corrective Action
0-0	Acceptable	None	$300 Incentive	None
1-0 or 2-0	Acceptable	None	$100 Incentive	None
3-0 or 4-0	Acceptable	None	No Adjustment	No Adjustment
1-1, 2-1, 5-0 or 6-0	Acceptable	Allowed	$300 Disincentive	$300 Disincentive
3-1, 4-1, 5-1 or 6-1	Acceptable	Allowed	$600 Disincentive	$600 Disincentive
Any other Number	Unacceptable	Required	Per CSI after Correction(s) (not to exceed 100% Pay)	

A. Either Before or After Corrective Actions

Correct any deviation that exceeds a 0.4 inch blanking band such that the deviation is reduced to 0.3 inch or less.

Corrective actions shall be performed at the Contractor's expense and shall be presented for evaluation and approval by the Engineer prior to proceeding. Any corrective action performed shall not reduce the integrity or durability of the pavement that is to remain in place. Corrective action for deviation repair may consist of overlaying, removing and replacing, indirect heating and rerolling. Scraping of the pavement with any blade type device will not be allowed as a corrective action. Provide overlays of the same type mix,

full roadway width, and to the length and depth established by the Engineer. Tapering of the longitudinal edges of the overlay will not be allowed.

Corrective actions will not be allowed for lots having a CSI of 4-0 or better. If the CSI indicates Allowed corrective action, the Contractor may elect to take necessary measures to reduce the CSI instead of accepting the disincentive. Take corrective actions as specified if the CSI indicates required corrective action. The CSI after corrective action shall meet or exceed Acceptable requirements.

Where corrective action is allowed or required, the test section(s) requiring corrective action will be retested, unless the Engineer directs the retesting of the of the entire lot. No disincentive will apply after corrective action if the CSI is 4-0 or better. If the retested lot after corrective action has a CSI indicating a disincentive, the appropriate disincentive will be applied.

Test sections and/or lots that are initially tested by the Contractor that indicate excessive deviations such that either a disincentive or corrective action is necessary, may be re-rolled with asphalt rollers while the mix is still warm and in a workable condition, to possibly correct the problem. In this instance, reevaluation of the test section(s) shall be completed within 24 hours of pavement placement and these test results will serve as the initial test results.

Incentive pay adjustments will be based only on the initially measured CSI, as determined by the Engineer, before any corrective work. Where corrective actions have been taken, payment will be based on the CSI determined after correction, not to exceed 100% payment.

Areas excluded from testing by the N.C. Hearne Straightedge will be tested by using a non-mobile 10-feet straightedge. Assure that the variation of the surface from the testing edge of the straightedge between any 2 contact points with the surface is not more than 1/8 inch. Correct deviations exceeding the allowable tolerance in accordance with the corrective actions specified above, unless the Engineer permits other corrective actions.

Furnish the North Carolina Hearne Straightedge(s) necessary to perform this work. Maintain responsibility for all costs relating to the procurement, handling, and maintenance of these devices. The Department has entered into a license agreement with a manufacturer to fabricate, sell and distribute the N.C. Hearne Straightedge. The Department's Pavement Construction Section may be contacted for the name of the current manufacturer and the approximate price of the straightedge.

610-14 DENSITY ACCEPTANCE

The Department will evaluate the asphalt pavement for density acceptance after the asphalt mix has been placed and compacted using the Contractor's QC test results, the Department's QA test results (including verification samples) and by observation of the Contractor's density QC process. Minimum density requirements for all mixes will be as specified in Table 610-7. Density acceptance will be as provided in Section 10 of the *Asphalt QMS Manual*.

A failing lot for density acceptance purposes is defined as a lot for which the average of all test sections, and portions thereof, fails to meet the minimum specification requirement. If additional density sampling and testing, beyond the minimum requirement, is performed and additional test sections are thereby created, then all test results shall be included in the lot average. In addition, any lot or portion of a lot that is obviously unacceptable will be rejected for use in the work.

If the Engineer determines that a given lot of mix that falls in the New category does not meet the minimum specification requirements but the work is reasonably acceptable, the lot will be accepted at a reduced pay factor in accordance with the following formula. The reduced pay factor will apply only to the mix unit price.

$$\textbf{Reduced Pay Factor} = 100 + \left[\left(\frac{Actual\ \ Density - Specified\ \ Density}{2}\right) x30\right]$$

Where:

Actual Density = the lot average density, not to exceed 2.0% of the specified density

Specified Density = the density in Table 610-7 or as specified in the contract

All failing lots in the Other category will be evaluated for acceptance in accordance with Article 105-3.

Any density lot not meeting minimum density requirements detailed in Table 610-7 will be evaluated for acceptance in accordance with Article 105-3. If the lot is determined not to be acceptable, the mix will be removed and replaced with mix meeting and compacted to the requirement of these specifications.

610-15 MAINTENANCE

Maintain the plant mix pavement in an acceptable condition until final acceptance of the project. Immediately repair any defects or damage that may occur. Perform maintenance to damaged or defective pavement and repeat as often as may be necessary to keep the base or pavement in an acceptable condition.

610-16 MEASUREMENT AND PAYMENT

Hot Mix Asphalt Pavement will be paid at the contract unit price per ton that will be the actual number of tons of each type of hot mix asphalt pavement incorporated into the completed and accepted work in accordance with Article 106-7.

No direct payment will be made for providing and using the materials transfer vehicle or any associated equipment, as the cost of providing same will be included in the contract unit bid price per ton for the mix type to be placed.

Any reduction in pay due to failing density will be in addition to any reduction in pay due to failing mix property test results on the same mix.

A high frequency of asphalt plant mix or density deficiencies may result in future deficient asphalt being excluded from acceptance at an adjusted contract unit price in accordance with Article 105-3. This acceptance process will apply to all asphalt produced or placed and will continue until the Engineer determines a history of quality asphalt production and placement is reestablished.

Furnishing asphalt binder will be paid as provided in Article 620-4 for *Asphalt Binder for Plant Mix* for each grade required.

Provide the work and materials required in the correction of defective work or sand seal base course as required at no cost to the Department. If the Engineer has such work performed with Department forces and equipment, the cost of such work performed by Department forces will be deducted from monies due or to become due to the Contractor.

No direct payment will be made for final surface testing covered by this section. Payment at the contract unit prices for the various items covered by those sections of the specifications directly applicable to the work constructed will be full compensation for all work covered by Article 610-13 including, but not limited to, performing testing in accordance with this specification, any corrective work required as a result of this testing and any additional traffic control as may be necessary.

Payment will be made under:

Pay Item	Pay Unit
Asphalt Concrete Base Course, Type B25.0C	Ton
Asphalt Concrete Intermediate Course, Type I19.0C	Ton
Asphalt Concrete Surface Course, Type S4.75A	Ton
Asphalt Concrete Surface Course, Type S9.5B	Ton
Asphalt Concrete Surface Course, Type S9.5C	Ton
Asphalt Concrete Surface Course, Type S9.5D	Ton

SECTION 620
ASPHALT BINDER FOR PLANT MIX

620-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, furnishing of asphalt binder, with anti-strip additive when required, at an asphalt plant and incorporating the asphalt binder and anti-strip additive into the asphalt plant mix.

620-2 MATERIALS

Refer to Division 10.

Item	Section
Anti-strip Additives	1020-8
Asphalt Binder, All Grades	1020-2
Silicone	1020-9

The asphalt binder for the mixture will be accepted at the source subject to Article 1020-1.

Use additives from the NCDOT APL. Submit a sample and manufacturer's data to the Engineer for approval before use, if proposing to use a brand not on the NCDOT APL.

620-3 GENERAL REQUIREMENTS

The requirements of Section 610 that pertain to handling of asphalt binder will be applicable to the work covered by this section.

Add silicone to all asphalt binder used in surface courses and open-graded asphalt friction course, unless otherwise directed by the Engineer. The amount of silicone added will range from one ounce per 2,000 gal of asphalt binder to one ounce per 2,500 gal. Add silicone to the asphalt binder at the plant site unless added at the source and it is so noted on the delivery ticket.

Do not heat the asphalt binder to a temperature in excess of the supplier’s recommendation while stored or when being used in production of mix at the asphalt plant.

Introduce the actual quantity of asphalt binder at the established percentage shown on the applicable JMF into the mix by the plant weighing or metering system. No working tolerance for asphalt binder percentage will be allowed during production.

When required, incorporate an anti-strip additive. It may be either chemical additive mixed with the asphalt binder or hydrated lime added to the aggregate or a combination of both. Furnish the brand name of the type (lime or chemical), supplier and shipping point of anti-strip additive. Note on the asphalt binder delivery ticket the rate (or quantity), brand of chemical additive when added at the supplier’s terminal. Introduce and mix chemical anti-strip additive into the asphalt binder at either the supplier's terminal or at the asphalt plant site at the dosage required by the JMF. Use in-line blending equipment at either location. When added at the asphalt plant, use equipment that meets Sections 5 and 6 of the *Asphalt QMS Manual*. When added at the supplier's terminal, use equipment that in-line blends with a constant flow of the additive for a minimum of 80% of the asphalt binder loading time. When

hydrated lime is used, use equipment to introduce the lime that meets Sections 5 and 6 of the *Asphalt QMS Manual*. Thoroughly mix chemical anti-strip additive and asphalt binder together before incorporating into the asphalt plant mix.

620-4 MEASUREMENT AND PAYMENT

Asphalt Binder for Plant Mix and *Polymer Modified Asphalt Binder for Plant Mix* will be measured and paid as the theoretical number of tons required by the applicable JMF based on the actual number of tons of plant mix completed and accepted on the job.

Such price and payment will be full compensation for all work covered by this section.

There will be no direct payment for anti-strip additive. Payment at the contract unit prices for the various asphalt plant mix items will be full compensation for the work.

Adjustments will be made to the payments due the Contractor for each grade of asphalt binder when it has been determined that the monthly average terminal F.O.B. Selling Price of asphalt binder, Grade PG 64-22, has fluctuated from the Base Price Index for Asphalt Binder included in the contract. The methods for calculating a base price index, for calculating the monthly average terminal F.O.B. selling price and for determining the terminals used are in accordance with procedures on file with the Construction Unit.

When it is determined that the monthly selling price of asphalt binder on the first business day of the calendar month during which the last day of the partial payment period occurs varies either upward or downward from the base price index, the contract unit price for asphalt binder for plant mix will be adjusted. The adjusted contract unit price will be determined by adding the difference between the selling price and the base price index to the contract unit bid price for asphalt binder.

The adjusted contract unit price will then be applied to the theoretical quantity of asphalt binder authorized for use in the plant mix placed during the partial payment period involved, except that where recycled plant mix is used, the adjusted unit price will be applied only to the theoretical number of tons of additional asphalt binder materials required by the JMF.

Adjusted contract unit prices for all grades of asphalt binder, including additional asphalt binder materials in recycled mixtures, will be based on the average selling price and base price index for asphalt binder, Grade PG 64-22, regardless of the actual grade required by the JMF.

In determining the adjusted contract unit price for any material specified in this section the following formula will be used:

$$\mathbf{A} = \mathbf{B} + (\mathbf{D} - \mathbf{C})$$

Where:

A = Adjusted Contract Unit Price
B = Contract Unit Price
C = Base Price Index
D = Monthly Average Terminal F.O.B. Selling Price

In the event the Department is unable to secure an F.O.B. selling price from at least 4 terminals in a given month, payment will be at the contract unit price for each ton of asphalt binder used in the work during that month.

Payment will be made under:

Pay Item	**Pay Unit**
Asphalt Binder for Plant Mix	Ton
Polymer Modified Asphalt Binder for Plant Mix	Ton

SECTION 650
OPEN-GRADED ASPHALT FRICTION COURSE

650-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, construction of a plant mixed open-graded asphalt friction course (OGFC) properly laid upon a prepared surface in accordance with these specifications and in conformity with the lines, grades, thickness and typical sections shown on the plans; producing, weighing, transporting, placing and rolling the plant mix as specified in Section 610; furnishing the asphalt binder, anti-strip additive, fiber stabilizing additive, warm mix asphalt (WMA) additive and all other materials for the plant mix; furnishing and applying tack coat as specified; providing QC as specified in Section 609 as modified for OGFC; surface testing of the completed pavement; furnishing scales; making any repairs or corrections to the friction course that may become necessary and maintaining the friction course until final acceptance of the project.

650-2 MATERIALS

Refer to Division 10.

Item	Section
Anti-strip Additives	1020-8
Asphalt Binder, Performance Grade	1020-2
Coarse Aggregate	1012-1(B)
Fiber Stabilizing Additives	1020-10
Fine Aggregate	1012-1(C)
Mineral Filler	1012-1(D)
Reclaimed Asphalt Shingles (RAS)	1012-1(E)

650-3 COMPOSITION OF MIXTURE (MIX DESIGN AND JOB MIX FORMULA)

(A) General

Design the open-graded asphalt friction course using a mixture of coarse and fine aggregate, asphalt binder, mineral filler, fiber stabilizing additive and other additives as required to produce a mix meeting Table 650-1.

At least 20 days before start of asphalt mix production, submit the mix design and proposed JMF targets for each required mix type and combination of aggregates to the Engineer for review and approval. The mix design shall be prepared by a mix design technician approved by the Department in an approved mix design laboratory. Prepare the mix design in accordance with Article 610-3 and the Department's mix design procedures as found in Section 4 of the *Asphalt QMS Manual*.

The mix design and JMF target values will be established within the mix design criteria specified in Table 650-1 for the particular type of mixture to be produced.

(B) Mix Design Criteria

Design open-graded asphalt friction course (OGFC) mixtures conforming to the gradation requirements and other mix design criteria in Table 650-1 for the mix type specified.

Use the asphalt binder grade shown in Table 650-1 for the mix type specified. Reclaimed Asphalt Shingles (RAS) may be used in accordance with Subarticle 610-3(A).

Use an anti-strip additive in all OGFC mixes. It may be hydrated lime or a chemical additive or both. Add chemical anti-strip additive at a rate of 0.5% by weight of asphalt binder. Add hydrated lime at a rate of 1.0% by weight of dry aggregate. Use an approved source and grade. Add the anti-strip additive to the asphalt binder in accordance with Article 620-3.

If needed to prevent asphalt draindown, incorporate a stabilizing additive into all OGFC mixes. Stabilizing additives may be fibers meeting Article 1020-10, RAS, or an approved WMA additive. Add fiber or RAS at a dosage rate by weight of total mixture as approved by the Engineer. Add WMA additive at a dosage rate by weight of binder in the mix. If a WMA additive is used to prevent draindown, produce OGFC at a lower mix temperature as shown on the approved JMF.

In addition to the required mix design submittal, the Contractor shall prepare and deliver gyratory compactor specimens to the Department's Central Asphalt Laboratory for Cantabro durability testing. The Contractor shall prepare these specimens using lab produced mix in accordance with NCDOT procedures. Provide the samples at least 20 days before the anticipated beginning placement of OGFC mixture.

TABLE 650-1
OGFC DESIGN CRITERIA

Grading Requirements	**Total Percent Passing**
Sieve Size (mm)	*Type FC-1 Modified*
19.0	-
12.5	100
9.50	75 - 100
4.75	25 - 45
2.36	5 - 15
0.075	1.0 - 3.0
Asphalt Binder Grade	PG 76-22
Binder Content, %	5.5 - 8.0
Mixing Temperature at the Asphalt Plant[A]	300 – 325°F
Air Voids, % minimum	18.0
Cantabro Loss, % maximum	20.0
Draindown, % maximum	0.3

A. The JMF mix temperature shall be within the ranges shown unless otherwise approved by the Engineer.

650-4 PLANT EQUIPMENT

Use plant equipment in accordance with Article 610-5 and the requirements herein.

When fiber stabilizing additives are used as an ingredient of the mixture, use a separate feed system capable of accurately proportioning the required quantity into the mixture and in such a manner that uniform distribution will be obtained. Interlock the proportioning device with the aggregate feed or weigh system so as to maintain the correct proportions for all rates of production and batch sizes. Accurately control the proportion of fibers to within ± 10% of the amount required. Provide flow indicators or sensing devices for the fiber system that are interlocked with plant controls such that mixture production will be interrupted if introduction of the fiber fails.

When a batch type plant is used, add the fiber to the aggregate in the weigh hopper or as approved by the Engineer. Increase the batch dry mixing time by 8 to 12 seconds, or as directed by the Engineer, to assure the fibers are uniformly distributed before the injection of asphalt binder into the mixer.

When a continuous mix or dryer-drum type plant is used, add the fiber to the aggregate and uniformly disperse at the point of injection of asphalt binder. Add the fiber in such a manner that it will not become entrained in the exhaust system of the drier or plant.

650-5 CONSTRUCTION METHODS

Produce, transport to the site and place the OGFC in accordance with Section 610, except as otherwise provided below.

Do not place OGFC between October 31 and April 1 of the next year, unless otherwise approved by the Engineer. The minimum air and road surface temperature for placing Type FC-1 Modified mix will be 60°F.

Before starting production of the mix, stockpile all aggregates for a sufficient period of time to facilitate the drainage of free moisture.

Clean the existing surface in an acceptable manner before placement of any asphalt material.

Remove all existing raised pavement markers as directed by the Engineer and repair any damaged areas caused by the removal. Use an approved dense graded mixture of similar type material for the repair.

Apply tack coat in accordance with Section 605 and the following:

(A) Use Asphalt Binder Grade PG 58-28, Grade PG 64-22 tack coat material or an approved non-tracking hot applied (NTHA) asphalt tack coat material.

(B) Uniformly apply the asphalt binder tack coat material at an applied rate of0.06 to 0.08 gal/sy, or as directed by the Engineer.

Spread and finish the friction course as specified in Article 610-8. Roll the friction course as specified in Article 610-9.

Perform this work in accordance with and using equipment meeting Section 9.5 of the *Asphalt QMS Manual.*

Use a Material Transfer Vehicle (MTV) when placing all types of OGFC. Use a MTV meeting Section 9.5.1(E) of the *Asphalt QMS Manual.*

Remove and replace any part of the finished friction course that shows non-uniform distribution of asphalt binder, aggregate or fiber at no additional cost to the Department.

Coordinate plant production, transportation and paving operations such that uniform continuity of operation is maintained. If spreading operations are interrupted, the Engineer may require that a transverse joint be constructed any time the mixture immediately behind the paver screed cools to less than 250 ºF.

For end of project joints, provide a transition area consisting of one load of mixture per lane, or as directed by the Engineer. Taper the mixture in thickness from 3/8 inch at the end of the project to the typical thickness (approximately 3/4 inch) within the maximum distance of spread for one load of mixture. For ramps and gore areas, taper the mixture in thickness from that at the edge of the mainline, approximately 3/4 inch to 3/8 inch at the point of the ramp transverse joint. Construct the ramp transverse joint at a point specified by the plans or as directed by the Engineer.

650-6 QUALITY MANAGEMENT SYSTEM

Produce the OGFC in accordance with Section 609, with the following exceptions.

Sample and test the completed mixture from each mix design per plant per year at the following minimum frequency during mix production:

Accumulative Production Increment	Number of Samples per Increment
500 tons	1

Record the following data on the standardized control charts and in accordance with the requirements of Section 7.4 of the *Asphalt QMS Manual*:

(a) Aggregate Gradation Test Results:

1. 2.36 mm
2. 0.075 mm Sieves

(b) Binder Content, %, P_b

650-7 MEASUREMENT AND PAYMENT

Open-Graded Asphalt Friction Course, Type FC-1 Modified will be measured and paid as the actual number of tons of friction course incorporated into the completed and accepted work. The friction course will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

Furnishing asphalt binder for the mix will be paid as provided in Article 620-4 for *Asphalt Binder for Plant Mix*. Adjustments in contract unit price due to asphalt binder price fluctuation will be made in accordance with Section 620.

No direct payment will be made for providing and using the materials transfer vehicle or any associated equipment, as the cost of providing same shall be included in the contract unit bid price per ton for the mix type to be placed.

Payment will be made under:

Pay Item	Pay Unit
Open-Graded Asphalt Friction Course, Type FC-1 Modified	Ton

SECTION 652
PERMEABLE ASPHALT DRAINAGE COURSE, TYPES P-78M AND P-57

652-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, the construction of a plant mixed permeable asphalt drainage course (PADC) properly laid upon a prepared surface in accordance with these specifications and in conformity with the lines, grades, thickness and typical sections shown on the plans; producing, weighing, transporting, placing and rolling the plant mix as specified in Section 610; furnishing the asphalt binder, anti-strip additive and all other materials for the plant mix; furnishing and applying tack coat as specified in Section 605; furnishing scales; providing QC as specified in Section 609 as modified for PADC; making any repairs or corrections to the friction course that may become necessary; and maintaining the friction course until final acceptance of the project.

652-2 MATERIALS

Refer to Division 10.

Item	Section
Anti-strip Additives	1020-8
Asphalt Binder	1020-2
Coarse Aggregate	1012-1(B)
Fine Aggregate	1012-1(C)

The coarse aggregate shall meet Article 1012-1 except that that portion of the coarse aggregate retained on the No. 4 sieve shall contain at least 60% by weight of crushed pieces having two or more mechanically induced fractured faces.

652-3 COMPOSITION OF MIXTURE

(A) General

Formulate the PADC from a mixture of crushed aggregate, asphalt binder, anti-strip additive and other additives as required to produce a mix meeting Table 652-1.

At least 10 days before start of asphalt mix production, submit the mix design and proposed JMF targets for each required mix type and combination of aggregates to the Engineer for review and approval. The JMF will be established in accordance with Article 610-3. Establish the asphalt binder content at the midpoint of the range specified in Table 652-1 or as approved by the Engineer.

(B) Mix Design

Design PADC mixtures conforming to the gradation requirements and other mix design criteria in Table 652-1 for the mix type specified.

Use the asphalt binder grade shown in Table 652-1 for the mix type specified or as approved by the Engineer.

Use an anti-strip additive in all PADC mixes. It may be hydrated lime or a chemical additive or both. Add chemical anti-strip additive at a rate of 0.5% by weight of asphalt binder. Add hydrated lime at a rate of 1.0% by weight of dry aggregate. Use an approved source and grade.

The mixing temperature at the asphalt plant will be established on the JMF. The JMF mix temperature shall be within the ranges shown in Table 652-1 unless otherwise approved by the Engineer.

TABLE 652-1
PERMEABLE ASPHALT DRAINAGE COURSE
GRADATION AND MIX DESIGN CRITERIA

Sieve Size (mm)	Total Percent Passing	
	Type P-78M	Type P-57
37.5	-	100
25.0	-	95 - 100
19.0	100	-
12.5	95 - 100	25 - 60
9.50	75 - 100	-
4.75	20 - 45	10 - 20
2.36	3 - 15	5 - 10
0.075	1.0 - 3.0	1.0 - 3.0
Asphalt Binder Content, %	2.5 - 3.5	2.0 - 3.0
Asphalt Binder Grade	PG 64-22	PG 64-22
Mixing Temperature at Plant	240 - 270°F	260 - 290°F

652-4 CONSTRUCTION METHODS

Produce, transport to the site and place the asphalt plant mix in accordance with Section 610, except as otherwise provided herein.

Incorporate the asphalt binder into the asphalt plant mix in accordance with Section 620. Add the anti-strip additive to the asphalt binder in accordance with Article 620-3.

A prime coat or tack coat will not be required.

When the PADC is placed in trench sections, the rolling equipment and rolling sequences required by Article 610-9 will not apply.

Following placement of the PADC mixture to the appropriate line, grade and thickness, begin rolling when the mat has cooled sufficiently to support the weight of an 8 to 12 ton steel-wheel tandem roller. Mat temperature at the time of initial rolling shall be approximately 175°F to 225°F. The maximum number of roller passes shall be three. Consolidate the drainage layer sufficiently with rolling so as to support the weight of equipment that will place the next layer of pavement. Do not compact the drainage layer to the extent that it is not free draining or that the aggregate is crushed. Density acceptance testing is not required for this layer.

No construction traffic will be allowed to travel on any PADC layer. Only equipment necessary to place the next layer of pavement will be allowed on the drainage layer.

Do not place PADC that will not be covered with the next layer of pavement during the same calendar year or within 15 days of placement if the PADC is placed in January or February.

652-5 QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS

Produce the PADC in accordance with the Section 609, with the following exceptions.

Sample and test the completed mixture from each mix design per plant per year at the following minimum frequency during mix production:

Accumulative Production Increment	Number of Samples per Increment
500 tons	1

Record the following data on the standardized control charts and in accordance with the requirements of Section 7.4 of the *Asphalt QMS Manual*:

(a) Aggregate Gradation Test Results:
   1. 12.5 mm (Type P-57 Only)
   2. 9.5 mm (Excluding Type P-57)
   3. 4.75 mm
   4. 2.36 mm
   5. 0.075 mm Sieves

(b) Binder Content, %, P_b

652-6 MEASUREMENT AND PAYMENT

Permeable Asphalt Drainage Course, Type ____ will be paid as the actual number of tons of drainage course incorporated into the completed and accepted work. The drainage course will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

Asphalt Binder for Plant Mix will paid in accordance with Article 620-4.

Payment will be made under:

Pay Item	Pay Unit
Permeable Asphalt Drainage Course, Type P-78M	Ton
Permeable Asphalt Drainage Course, Type P-57	Ton

SECTION 654
ASPHALT PLANT MIX, PAVEMENT REPAIR

654-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, repairing of existing pavement with asphalt plant mix in order to provide a safe, passable and convenient condition for traffic, or to replace pavement removed in order to remove or to place pipe lines.

Perform the work by cutting the existing pavement to a neat vertical joint and uniform line; removing and disposing of pavement, base and subgrade material as approved or directed by the Engineer; coating the area to be repaired with a tack coat; furnishing, placing and compacting asphalt plant mix; and replacing of the removed material with asphalt plant mix.

Make the repairs in accordance with the plans, or as approved or directed by the Engineer.

654-2 MATERIALS

Where a pavement repair detail is not shown in the plans, use an approved asphalt plant mix.

Where a pavement repair detail is shown in the plans, the type of plant mix shall be in accordance with the pavement repair detail except where the specifications permit the substitution of another type of plant mix or where approved by the Engineer.

In areas where the existing pavement is not to be resurfaced, the Contractor will not be allowed to substitute a different type of surface course from that shown on the pavement repair detail.

654-3 CONSTRUCTION METHODS

(A) General

Perform repair of existing pavement as approved or directed by the Engineer. Coordinate the work with all other work and operations necessary to maintain traffic.

(B) Pipe Removal or Installation

Where traffic is to be maintained, perform the removal or installation of pipe in sections so that half the width of the roadway will be available to traffic. Immediately upon completion of the entire pipeline removal or installation, repair the pavement.

654-4 MEASUREMENT AND PAYMENT

Asphalt Plant Mix, Pavement Repair will be paid as the actual number of tons of asphalt plant mix, complete in place, used to make completed and accepted repairs, except for those repairs made necessary by the contractor's negligence. The asphalt plant mixed material will be measured by being weighed in trucks on certified platform scales or other certified weighing devices.

Furnishing asphalt binder will be paid as provided in Article 620-4 for *Asphalt Binder for Plant Mix* for each grade required.

Payment will be made under:

Pay Item	Pay Unit
Asphalt Plant Mix, Pavement Repair	Ton

SECTION 657
SEALING EXISTING PAVEMENT CRACKS AND JOINTS

657-1 DESCRIPTION

The work consists of sealing existing longitudinal and transverse pavement cracks and joints with hot applied joint sealer at locations as directed by the Engineer. The Contractor will not be required to seal the existing edge joints.

657-2 MATERIALS

Refer to Division 10.

Item	Section
Hot Applied Joint Sealer	1028-2

657-3 CONSTRUCTION METHODS

Install the sealant so that it forms a complete watertight bond with a high degree of elasticity, with maximum flexibility and longevity under extreme temperature ranges.

Clean cracks and joints using a hot compressed air lance to blast out any vegetation, dirt, dampness and loose materials from the cracks and joints. Equip the air compressor with suitable traps and filters to remove moisture and oil from the compressed air. Use the hot air lance to dry and warm the adjacent pavement immediately before sealing. Direct flame dryers are not allowed.

Heat and apply the sealant material according to the manufacturer's recommendations. Use a portable melting kettle for heating the material that is equipped with indirect heating (air-jacketed flow) and is capable of constantly agitating the joint sealer to maintain a uniform temperature. Equip the kettle with either mechanically operated paddles and/or a continuous circulating pump to maintain agitation. Use heating equipment capable of controlling the sealant material temperature within the manufacturer's recommended temperature range and that is thermostatically-control calibrated between 200°F to 600°F. Locate a thermometer on the kettle so the Engineer can safely check the temperature of the sealant material. Overheating of the sealant material will not be permitted.

Apply sealant in the prepared cracks and joints within the manufacturer's recommended temperature range, using a pressure screed shoe to completely fill the crack or joint, leaving a sealed 2 inch overband. Excessive overbanding or waste of sealant materials will not be tolerated. Immediately squeegee the crack seal material to minimize the height of the overband. All sealed cracks and joints shall have a minimum of 1/8 inch depth of sealant installed.

Do not apply the hot applied joint sealer when the surface temperature of the pavement is below 32°F. Follow manufacturer's recommendations.

After the crack or joint has been sealed, promptly remove any surplus sealer on the pavement. Do not permit traffic over the sealed cracks and joints without approval by the Engineer. When approved by the Engineer, place sand or other approved material over the crack or joint to prevent tracking.

657-4 MEASUREMENT AND PAYMENT

Sealing Existing Pavement Cracks and Joints will be measured and paid as the actual number of pounds of material that has satisfactorily been used to seal pavement cracks and joints in the designated highway. Any material spilled, used in excessive overbanding, wasted, misapplied or unsatisfactorily used in any way will be deducted in determining quantities for payment. The Engineer will determine the quantity, if any, to be deducted. The Engineer's decision on the quantity to be deducted will be final and binding.

Payment will be made under:

Pay Item	Pay Unit
Sealing Existing Pavement Cracks and Joints	Pound

SECTION 660
ASPHALT SURFACE TREATMENT

660-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, furnishing, hauling, spreading and rolling the emulsion and aggregate consisting of one or more applications of liquid asphalt material and one or more applications of aggregate cover coat material on a prepared surface; and maintaining and repairing the asphalt surface treatment (AST).

660-2 MATERIALS

Refer to Division 10.

Item	Section
Aggregates for Asphalt Surface Treatment	1012-2
Emulsified Asphalt, Grade CRS-2L	1020-3
Emulsified Asphalt, Grade CRS-2P	1020-3
Fine Aggregate	1014-1
Mineral Filler	1012-1(D)
Water	1024-4

Before any asphalt surface treatment is placed, obtain from the asphalt supplier and furnish to the Engineer a Certification of Compatibility of the emulsion with the aggregate proposed for use.

660-3 WEATHER AND SEASONAL LIMITATIONS

Do not place any asphalt surface treatment between October 15 and April 1, except for asphalt surface treatment that is to be overlaid immediately with asphalt plant mix.

Apply AST only when the surface to be treated is dry and when the air or surface temperatures, measured at the location of the AST operation away from artificial heat, is 55°F and rising. Do not place AST when air temperature is 98°F and rising.

When placing AST that is to be immediately overlaid with asphalt plant mix, the seasonal and temperature limitations of Article 610-4 shall apply.

Do not apply asphalt material when the weather is foggy or rainy.

660-4 SURFACE PREPARATION

Clean the surface to be treated of dust, dirt, clay, grass, and any other deleterious matter before application of the AST. Properly dispose of these materials as directed by the Engineer.

660-5 ACCEPTANCE OF ASPHALT MATERIALS

The acceptance of asphalt materials will be in accordance with Article 1020-1.

660-6 APPLICATION EQUIPMENT

Use asphalt application equipment that meets Article 600-5.

Apply aggregate by the use of a self-propelled, pneumatic-tire aggregate spreader capable of maintaining a specified rate with a uniform application for the width of asphalt material being covered. Tailgate spreaders will not be permitted. Areas that are inaccessible to the aggregate spreader shall be covered by hand spreading or other acceptable methods.

660-7 AGGREGATE TYPE AND APPLICATION RATES

Contractor shall provide aggregate types and rates as specified in the contract.

660-8 CONSTRUCTION METHODS

For any type of AST work, demonstrate that all equipment has been calibrated in the presence of the Engineer. Once calibrated, pave a minimum 500 foot test section. If approved by the Engineer, test section may be incorporated into the production section. If the test section is not feasible, submit a calibration plan to the Engineer with detailed information on equipment and a designated area for calibration. Perform calibration and construction of test strip at the beginning of the first day of production and then as directed by the Engineer.

(A) Asphalt Seal Coat

Use the type of seal coat as required by the contract. Seal coat aggregates shall be drained of free moisture and have an amount passing the #200 sieve no greater than 1.5% in accordance with Table 1005-1 before use. Place the seal coat in full-lane widths.

Place blotting sand in accordance with Section 818 when traffic is permitted on sections of the work in which the emulsion has not finished breaking. Aggregate is not an acceptable cover material on an AST Seal Coat.

Perform rolling of each layer immediately after the aggregate has been uniformly spread. Rolling will consist of at least three complete coverages with one pneumatic-tire roller followed by at least one complete coverage with a 5 to 8 ton steel-wheel roller. All roller coverages shall be completed within 5 minutes of the asphalt emulsion being placed. Do not allow crushing of the aggregate or picking up of the material by the rollers. Water spray bars on the rollers may be required by the Engineer if aggregate is being picked up from the finished surface.

The use of a combination steel-wheel and pneumatic-tire roller will be permitted instead of the 5 to 8 ton steel-wheel roller. Pneumatic tires on the combination roller or pneumatic tire roller must be smooth tread. Tractor, turf, or any aggressive tread pattern will not be allowed.

After the aggregate is thoroughly seated, broom all excess aggregate off of the surface of the seal coat after 3 calendar days but no more than 7 calendar days. If necessary, use a vacuum truck as directed by the Engineer. Traffic may be permitted on the seal coat immediately after the rolling is complete.

Clean driveways, ditches, turn lanes, and areas adjacent to the AST construction of excess aggregate, excess emulsion run off, over spray or debris from construction.

Blotting sand may be required as directed by the Engineer and shall be applied in accordance with Section 818. Contractor is required to supply at no cost to the Department a suitable material if bleeding occurs on a completed section.

Emulsion and/or aggregate applications greater than 6 inches onto the shoulder will not be allowed. Contractor will be required to remove this material and replace vegetation if required at no cost to the Department.

The construction of the various types of seal coats will be in accordance with the following additional requirements:

(1) Single Seal

Apply emulsion to the existing surface followed immediately by an application of aggregate as specified in the contract. Uniformly spread the full required amount of aggregate in one application and correct all non-uniform areas before rolling.

Immediately after the aggregate has been uniformly spread, perform rolling as previously described.

(2) Double Seal

Apply emulsion to the existing surface followed immediately by an application of aggregate as specified in the contract ensuring each is uniformly placed over the existing surface and rolled as previously described.

Immediately after the first application of seal aggregate has been made uniform and rolled, apply the second application of the required amount of emulsion and seal coat aggregate and roll as previously described.

(3) Triple Seal

Follow the procedure outlined in Subarticle 660-8(A)(2) and apply emulsion and aggregate as a third layer and roll as previously described.

(4) Sand Seal

Place the fully required amount of asphalt material in one application and immediately cover with the seal coat aggregate. Uniformly spread the fully required amount of aggregate in one application and correct all non-uniform areas before rolling.

Immediately after the aggregate has been uniformly spread, perform rolling.

Broom excess aggregate material from the surface of the seal coat.

(B) Asphalt Mat and Seal

Construct the mat coat in accordance with Subarticle 660-8(C) using the size aggregate required by the contract.

Construct the seal coat in accordance with Subarticle 660-8(A) using the type seal required by the contract.

(C) Asphalt Mat Coat for Soil Subgrade

The surface on which the mat coat is to be applied shall be approved by the Engineer before the mat coat emulsion is applied.

Place a string line guide for application equipment. Place the mat coat in full-lane widths.

Existing surface shall be damp prior to placement of the mat coat.

Immediately follow the application of emulsion with the spreading of the aggregate. No more than 5 minutes can elapse from the time the emulsion is applied and the rolling is completed when using CRS-2L or CRS-2P.

Mat coat aggregate shall be drained of free moisture and have an amount passing the #200 sieve no greater than 1.5% in accordance with Table 1005-1 before use. Spread the aggregate uniformly at the required rate and correct all non-uniform areas before rolling.

Roll immediately after the aggregate is uniformly spread. Rolling consists of at least three complete coverages with two 5 to 10 ton steel-wheel rollers. Continue rolling until the aggregate is thoroughly keyed into the emulsion. Do not allow crushing of the aggregate or picking up of the material by the rollers. A combination steel-wheel and pneumatic-tire roller will not be permitted. Use two individual steel-wheel rollers. The three coverages shall be completed within 5 minutes of the spraying of the emulsion.

At the discretion of the Engineer, at the beginning of each emulsion application, spread a paper over the end of the previously completed mat coat and begin the asphalt application on the paper. After application, remove and dispose of the paper.

After the aggregate is thoroughly seated, traffic may be permitted on the mat coat during construction of the adjacent lane at slow speeds under control of a pilot vehicle. Once the mat coat is applied to the second lane, the smaller aggregate shall be applied, properly rolled and set (broke) before turning traffic on the roadway. No brooming shall be performed on the mat coat or traffic allowed on the mat coat until a second layer of emulsion and aggregate is applied.

Correct defects or damage to the mat coat before the application of seal coat or plant mix overlay.

(D) Asphalt Mat Coat for Pavement Surfaces

For mat coats with an asphalt overlay, construct the mat coat in accordance with Subarticle 660-8(C). The same grade of emulsion used for the mat coat may be used for the tack coat of the asphalt overlay.

For mat coats constructed on existing pavement surfaces, construct the mat coat in accordance with Subarticle 660-8(C) using the size aggregate required by the contract and the application rates specified in the contract.

Application of the plant mix material should be placed after mat is seated or by the end of the day. No brooming shall be performed on the mat. No traffic shall be allowed on the mat until a second smaller emulsion and aggregate layer is applied or the plant mix material is applied. Plant mix thickness on overlays shall be at least 1.5 inches.

(E) Fog Seal

Apply an emulsified asphalt and water mixture to prevent aggregate loss or as a surface seal.

Fog Seal shall be delivered pre-mixed with water at a 1:1 ratio. Apply Fog Seal at a temperature of 130°F to 160°F. Complying with Weather and Seasonal Temperature Limits in Article 660-3, with the exception that Fog Seal should be applied at 60°F and rising to ensure bond to underlying surface.

Use asphalt application equipment compliant with Article 600-5.

Apply Fog Seal at the rate shown in the plans or as directed by the Engineer.

Remove loose material or debris from roadway prior to application. The pavement surface must be dry before applying the fog seal.

Open to traffic only after application has dried or as directed by Engineer.

660-9 TEMPORARY TRAFFIC CONTROL (TTC)

All AST operations shall be conducted in daylight hours.

Provide temporary traffic control for the asphalt surface treatment operations in accordance with the contract and in accordance with the provision RWZ-1 TEMPORARY TRAFFIC CONTROL (TTC) found elsewhere in the proposal except the following sections do not apply:

TRAFFIC OPERATIONS, Drop-Off Requirements and Time Limitations

TRAFFIC OPERATIONS, Project Requirements

Install advance/general warning work zone signs according to the Detail Drawing titled *Signing for Asphalt Surface Treatment* shown in the plans.

660-10 WARRANTY

The AST shall be warranted by the project payment and performance bonds for a period of 12 months.

(A) Warranty Period

The Department will conduct an inspection of the work and provide written acceptance in accordance with Article 105-17. Written acceptance of the work will constitute the start date for the 12 month AST warranty period.

(B) Situations Affecting the Warranty

During the warranty period, the Contractor will not be held responsible for distresses that are caused by factors not related to materials and workmanship. These include, but are not limited to, chemical and fuel spills, vehicle fires, base failures, and snow

plows. Other factors considered to be beyond the control of the Contractor, which may contribute to pavement distress, will be considered by the Engineer on a case by case basis upon receipt of a written request from the Contractor. Maintaining traffic on the pavement surface prior to the Engineer's acceptance will not be a condition for voiding the warranty.

(C) Emergency Repairs

If, in the opinion of the Department, a pavement condition covered by the warranty requires immediate attention for the safety of the traveling public, the Contractor will be notified immediately. If the Contractor cannot perform the work in a timely manner, the Department may directly perform or have the corrective work performed by another entity at the Contractor's expense. Any emergency work performed will not alter the requirements, responsibilities, or obligations of the warranty.

(D) Warranty Performance Criteria

TABLE 660-1
PERFORMANCE CRITERIA

Surface Defects	Severity	Extent (Per Lot)
Surface Patterns	Alternate lean and heavy lines streaking over the entire pavement surface.	Greater than 20% of a lot affected; distress spotted evenly over the lot or over localized areas within the lot.
Bleeding/ Flushing	Distinctive appearance (with excess asphalt binder already free).	Greater than 20% of the wheel tracks within a lot affected.
Loss of Cover Aggregate	Large patches of cover aggregate lost from the pavement surface.	Greater than 20% of a lot affected; distress spotted evenly over the lot or over localized areas within the lot.

Lot – A 1,000 foot section of pavement or portion thereof, a lane width wide, on which AST is constructed on a single map.

The beginning point of the first lot will be the beginning point of each day's operation or the beginning of a map, whichever is applicable.

The Department will review the AST and advise the Contractor of any required corrective work in writing prior to expiration of the warranty period.

The Department will approve all materials and methods used in warranty work.

The Department will determine if warranty work performed by the Contractor meets the contract and provide written acceptance of the warranty work when complete.

The Chief Engineer will review any disputes for corrective work covered under the warranty.

660-11 MAINTENANCE

Maintain the asphalt surface treatment in an acceptable condition until final acceptance of the project.

660-12 MEASUREMENT AND PAYMENT

Asphalt Surface Treatment: Single Seal, Double Seal, Triple Seal, Mat and Single Seal, Mat and Double Seal, Sand Seal, and Mat Coat, No.___Stone. All AST will be measured and paid at the contract unit price per square yard. Payment at the above prices will be made for replacing any satisfactorily completed AST when such replacement has been made necessary by defects in subgrade or base constructed by others.

Asphalt Surface Treatment, Fog Seal will be measured and paid at the contract unit price per square yard. Price adjustments for emulsion will not be made for *Asphalt Surface Treatment, Fog Seal*.

Emulsion for Asphalt Surface Treatment will be measured by the actual surface area of application and the specified application rate (gallon/sy) and paid at the contract unit price per gallon, which price will be full compensation for all materials including modifiers and additives, tack coat, labor, tools, equipment, and all other incidentals necessary to complete the work.

Vacuum truck will be measured and paid on a weekly basis for each week or any portion thereof that the Engineer directs the use of a vacuum truck.

Price adjustments herein shall apply concurrently; however, price adjustment will not apply in the event the material is rejected by the Engineer.

Furnishing and applying prime will be paid as provided in Article 600-9 for *Prime Coat*.

If included in the contract, furnishing and applying blotting sand will be paid as provided in Article 818-4 for *Blotting Sand*.

Adjustment for *Emulsion for AST* will be paid per the following formula:

$$A = B + ((D - C) / 235)\ 0.65$$

Where:

A = Adjusted Contract Unit Price of *Emulsion for AST* per gallon
B = Contract Unit Price of *Emulsion for AST* per gallon
C = Base Price Index of PG 64-22 per ton
D = Monthly Average Terminal F.O.B. Selling Price for PG 64-22 per ton

See Price Adjustment – Asphalt Binder Special Provision found elsewhere in this proposal for the base price index of PG 64-22 per ton.

Payment will be made under:

Pay Item	Pay Unit
Asphalt Surface Treatment, Single Seal	Square Yard
Asphalt Surface Treatment, Double Seal	Square Yard
Asphalt Surface Treatment, Triple Seal	Square Yard
Asphalt Surface Treatment, Mat and Single Seal	Square Yard
Asphalt Surface Treatment, Mat and Double Seal	Square Yard
Asphalt Surface Treatment, Sand Seal	Square Yard
Asphalt Surface Treatment, Mat Coat, No. __Stone	Square Yard
Asphalt Surface Treatment, Fog Seal	Square Yard
Emulsion for Asphalt Surface Treatment	Gallon
Vacuum Truck	Per Week

SECTION 661
ULTRA-THIN BONDED WEARING COURSE

661-1 DESCRIPTION

Produce and place an Ultra-thin Bonded Wearing Course (UBWC), including an application of a warm Polymer-Modified Emulsion Membrane (PMEM) followed immediately with an UBWC hot mix asphalt overlay. Spray PMEM immediately before applying hot mix asphalt.

The Contractor may elect to use an alternate method for the placement of the UBWC. As an alternate to spraying PMEM prior to placement of the asphalt mix with a spray paver, the Contractor may use a non-tracking hot-applied polymer asphalt tack coat material prior to placement of the asphalt mix. If the alternate method is selected, submit documentation and proposed plan to the Engineer prior to beginning any work.

Provide and conduct the QC and required testing for acceptance of the UBWC in accordance with the contract.

661-2 MATERIALS

Refer to Division 10.

Item	Section
Anti-strip Additives	1020-8
Coarse Aggregate	1012-1(B)
Fine Aggregate	1012-1(C)
Mineral Filler	1012-1(D)
Polymer Modified Asphalt Binder	1020-2
Polymer-Modified Emulsion Membrane (PMEM)	1020-4

Use either PG 70-28 or PG 76-22 binder conforming to Section 620 in the asphalt mix design. Ensure that the asphalt binder is compatible with the PMEM (or alternate) and the existing pavement.

Use an approved non-tracking hot applied (NTHA) polymer asphalt tack coat found on NCDOT's APL for *Non-Tracking Asphalt Tack Coat- Hot Applied (NTHA)*.

661-3 COMPOSITION OF MIX

Do not use crystalline limestone, crystalline-dolomitic limestone or marble for aggregates and do not use reclaimed asphalt pavement (RAP). Use a mixture of coarse and fine aggregate, asphalt binder, mineral filler and other additives when required. Size, uniformly grade and combine in such proportions such that the resulting mixture meets the gradation and physical requirements of Tables 661-1 and 661-2.

At least 20 days before start of asphalt mix production, submit the mix design and proposed JMF targets for each required mix type and combination of aggregates to the Engineer for review and approval. Establish the JMF target values within the mix design criteria specified in Table 661-2 for the particular type mixture.

Determine and certify compatibility of all asphalt emulsion, asphalt binder and aggregate components.

TABLE 661-1 UBWC GRADATION CRITERIA	
Sieves (mm)	**% Passing by Weight**
12.5	100
9.50	85 - 100
4.75	28 - 44
2.36	17 - 34
1.18	13 - 23
0.600	8 - 18
0.300	6 - 13
0.150	4 - 10
0.075	3.0 - 7.0

TABLE 661-2 UBWC MIX DESIGN CRITERIA	
Property	**Requirement**
Asphalt Content, %	5.0 (minimum)
Draindown Test, AASHTO T 305	0.1% max
Moisture Sensitivity, AASHTO T 283[A]	85% min
Application Rate, lb/sy	70 lb/sy
Approximate Application Depth, in.	5/8"
Asphalt PG Grade, AASHTO M 320	PG 70-28 or PG 76-22

A. Specimens for AASHTO T 283 testing are to be compacted using the gyratory compactor. The mixtures shall be compacted using 100 gyrations to achieve specimens approximately 95 mm in height. Use mixture and compaction temperatures recommended by the binder supplier.

661-4 CONSTRUCTION METHODS

(A) Equipment

Use asphalt mixing plants in accordance with Article 610-5. Furnish paving machine with the following capabilities:

(1) Self-priming paving machine capable of spraying the PMEM, applying the hot asphalt concrete overlay and screeding the surface of the mat to the required profile and cross section in one pass at any rate between 30 and 92 feet per minute.

(2) Receiving hopper, feed conveyor, storage tank for PMEM material, PMEM emulsion single variable-width spray bar and a variable width, heated, vibratory-tamping bar screed.

(3) Screed with the ability to be crowned at the center both positively and negatively and have vertically and horizontally adjustable extensions to accommodate the desired pavement profile and widths.

(4) Sprayer system capable of accurately and continuously monitoring the rate of spray and providing a uniform application across the entire width to be overlaid.

(5) Use pavers equipped with an electronic screed control that will automatically control the longitudinal profile and cross slope of the pavement. Control the longitudinal profile through the use of either a mobile grade reference(s), including mechanical, sonic and laser grade sensing and averaging devices, an erected string line(s) when specified, joint matching shoe(s), slope control devices or the approved methods or combination of methods. Unless otherwise specified, use a mobile grade reference system capable of averaging the existing grade or pavement profile over at least a 30 feet distance; or by non-contacting laser or sonar type ski with at least three referencing stations mounted on the paver at a minimum length of 24

feet. Establish the position of the reference system such that the average profile grade is established at the approximate midpoint of the system. The transverse cross slope shall be controlled as directed by the Engineer.

Use an erected fixed stringline for both and longitudinal profile and cross slope control when required by the contract. When an erected fixed string line is required, furnish and erect the necessary guide line for the equipment. Support the stringline with grade stakes placed at maximum intervals of 25 feet for the finished pavement grade.

Use the 30 feet minimum length mobile grade reference system or the non-contacting laser or sonar type ski with at least three referencing stations mounted on the paver at a minimum length of 24 feet to control the longitudinal profile when placing the initial lanes and all adjacent lanes of all layers, including resurfacing and asphalt in-lays, unless otherwise specified or approved by the Engineer. A joint matching device (short 6 inch shoes) may be used only when approved by the Engineer.

Use the automatic slope control system unless otherwise approved by the Engineer. The Engineer may waive the use of automatic slope controls in areas where the existing surface (subgrade, base, asphalt layer, etc.) exhibits the desired cross slope of the final surface. The Engineer may also waive the use of automatic slope controls in areas where the use of such equipment is impractical due to irregular shape or cross section (such as resurfacing). When the use of the automatic slope controls is waived, the Engineer may require the use of mobile grade references on either or both sides of the paver. Manual screed operation will be permitted in the construction of irregularly shaped and minor areas, subject to approval. Waiver of the use of automatic screed controls does not relieve the Contractor of achieving plan profile grades and cross slopes.

In the case of malfunction of the automatic screed control equipment, the paver may be manually operated for the remainder of the workday provided this method of operation produces acceptable results. Do not resume work thereafter until the automatic system is functional.

The Engineer will waive the requirement for use of pavers for spreading and finishing where irregularities or obstacles make their use impractical. Spread, rake and lute the mixture by hand methods or other approved methods in these areas.

Operate the paver as continuously as possible. Pave intersections, auxiliary lanes and other irregular areas after the main line roadway has been paved, unless otherwise approved by the Engineer.

Compact the wearing course with a steel double drum asphalt roller(s) with a minimum weight of 10 tons. Maintain rollers in reliable operating condition and equip with functioning water system and scrapers to prevent adhesion of the fresh mix onto the roller drums. Supply adequate roller units and compact promptly following the placement of the material.

Request approval of equipment before the start of any work. Maintain all equipment and tools in satisfactory working condition at all times.

(B) Surface Preparation

Perform the following items before the commencement of paving operations.

(1) Protect and cover manhole covers, drains, grates catch basins and other such utility structures with plastic or building felt before paving and reference for location and adjustment after paving.

(2) Remove thermoplastic traffic markings symbols, characters or other markings greater than 1/4 inch in thickness on the existing pavement.

(3) Clean and completely fill pavement cracks and joints greater than 1/4 inch wide. Do not overband the existing cracks and joints. Apply sealant per manufacturer's recommendation.

(4) Fill surface irregularities greater than 1 inch deep with a material approved by the Engineer.

(5) Thoroughly clean the entire pavement surface, giving specific attention to accumulated mud and debris. Pressurized water and/or vacuum systems may be required to ensure a clean surface.

(C) Application of Ultra-thin Bonded Wearing Course

Produce, transport to the site and place the UBWC in accordance with Section 610, except as otherwise provided below.

Use only one asphalt binder PG grade for the entire project, unless the Engineer gives written approval.

Do not place UBWC between October 31 and April 1 and when the air and surface temperature is less than 60°F.

Apply the UBWC mixture at the rate per square yard as shown in Table 661-2 for the mix type shown in the plans.

Spray the PMEM at a temperature of 140°F to 180°F. Provide a uniform application across the entire width. Use a target application rate of 0.20 gal/sy and adjust according to the mix design, existing pavement type and condition for the specified project, and the manufacturer's recommendations. Ensure the rate of application is approved by the Engineer before beginning work.

Do not allow wheels or other parts of the paving machine to touch the PMEM before the hot mix asphalt concrete wearing course is applied.

Place the hot asphalt concrete wearing course over the full width of the PMEM. Apply the hot mix asphalt concrete at a temperature of 300°F to 330°F and within a maximum of 3 seconds immediately after the application of the membrane.

Before opening to traffic, allow the pavement to sufficiently cool after the rolling operation to resist damage to the pavement.

For the alternate method, use distributor equipment to uniformly place the non-tracking hot applied polymer asphalt tack coat in accordance with Section 605 and shall be applied at a temperature in accordance with the manufacturer's recommendations and at a target residual application rate of 0.12 ± 0.02 gal/sy. For placing the asphalt mix, use of a spray paver is not required.

(D) Compaction

Compact the wearing course with at least two passes of a steel double drum asphalt roller before the material temperature has fallen below 185°F. Do not allow the rollers to remain stationary on the freshly placed asphalt concrete. Compact immediately following the placement of UBWC. A release agent (added to the water system) may be required to prevent adhesion of the fresh mix to the roller drum and wheels. Compact in the static mode.

661-5 QUALITY MANAGEMENT SYSTEM FOR ASPHALT PAVEMENTS

Produce the ultra-thin hot mix asphalt in accordance with Section 609 with the following exceptions.

Sample and test the completed mixture from each mix design per plant per year at the following minimum frequency during mix production:

Accumulative Production Increment	Number of Samples per Increment
500 tons	1

Record the following data on the standardized control charts and in accordance with the requirements of Section 7.4 of the *Asphalt QMS Manual*:

(a) Aggregate Gradation Test Results:
   1. 2.36 mm
   2. 0.075 mm Sieves

(b) Binder Content, %, P_b

661-6 MEASUREMENT AND PAYMENT

Ultra-thin Bonded Wearing Course will be measured and paid by the actual number of tons of mixture incorporated into the completed and accepted work. The hot mix asphalt pavement will be measured by being weighed in trucks on certified platform scales or other certified weighing devices. Application of Ultra-thin Hot Mix Asphalt shall be included in the per ton pay item for *Ultra-thin Bonded Wearing Course*.

Polymer Modified Asphalt Binder for Plant Mix will be paid in accordance with Article 620-4. Asphalt binder price adjustments when applicable will be based on Grade PG 64-22, regardless of the grade used.

Where PG 76-22 is being used in the production of ultra-thin, the grade of asphalt binder to be paid will be PG 70-28, unless otherwise approved by the Engineer.

For the alternate method, *Ultra-thin Bonded Wearing Course* will be measured and paid by the actual number of tons of mixture incorporated into the completed and accepted work. The hot mix asphalt pavement will be measured by being weighed in trucks on certified platform scales or other certified weighing devices. Non-tracking hot applied polymer asphalt tack coat shall be included in the per ton pay item for *Ultra-thin Bonded Wearing Course*. No other pay item shall be associated with this alternate method.

The above prices and payments will be full compensation for all work covered by this section including, but not limited to, furnishing all materials, producing, weighing, transporting, placing and compacting the polymer modified asphalt emulsion; maintaining the ultra-thin bonded wearing course until final acceptance of the project; performing QC as specified in the contract; and making any repairs or corrections to the surface of the pavement or adjacent landscape that may become necessary.

Payment will be made under:

Pay Item	**Pay Unit**
Ultra-thin Bonded Wearing Course	Ton

SECTION 665
MILLED RUMBLE STRIPS ON ASPHALT CONCRETE SHOULDERS

665-1 DESCRIPTION

Construct rumble strips on asphalt concrete shoulders in accordance with the plans and as directed by the Engineer. Work includes, but is not limited to, furnishing all labor, equipment and all incidentals necessary to complete the work satisfactorily and disposing of milled material.

665-2 EQUIPMENT

Provide equipment consisting of a rotary-type cutting head with an outside diameter of no more than 24 inches and at least 16 inches long. Provide a cutting head that has the cutting tips arranged to provide a relatively smooth cut. Provide a cutting head on its own independent suspension from that of the power unit to allow the tool to self align with the slope of the shoulder or any irregularities in the shoulder surface.

Provide a cutting tool equipped with guides to provide consistent alignment of each cut in relation to the roadway and to provide uniformity and consistency throughout the project.

665-3 CONSTRUCTION METHODS

Demonstrate the ability to achieve desired surface inside each depression without tearing or snagging the asphalt before beginning the work.

Provide rumble strips that have finished dimensions of 7 inches ± 1/2 inch wide in the direction of travel and are at least 16 inches long measured perpendicular to the direction of travel. Provide rumble strips having depressions with a concave circular shape with a minimum 1/2 inch depth at center (no more than an allowable depth 5/8 inch). Place rumble strips in relation to the roadway according to the patterns shown in the plans.

Material resulting from the operation becomes the property of the Contractor. Remove and dispose of this material in accordance with Section 802.

At the end of each working day remove all equipment to a location where it does not present a traffic hazard, clean pavement and reopen work area to traffic.

665-4 MEASUREMENT AND PAYMENT

Milled Rumble Strips (Asphalt Concrete) will be measured and paid at the contract unit price per linear foot for the actual number of linear feet of shoulder, measured longitudinally along the surface of each shoulder, where rumble strips have been constructed.

Payment will be made under:

Pay Item	Pay Unit
Milled Rumble Strips (Asphalt Concrete)	Linear Foot

DIVISION 7
CONCRETE PAVEMENTS AND SHOULDERS

SECTION 700
GENERAL REQUIREMENTS FOR
PORTLAND CEMENT CONCRETE PAVEMENT

700-1 DESCRIPTION

Perform the work covered by this section, which includes, but is not limited to, the construction of a single course non-reinforced Portland cement concrete pavement on a prepared base, in accordance with these *Standard Specifications* and with the lines, grades, thicknesses and typical sections shown on the plans or as directed by the Engineer.

The Department accepts concrete pavement with respect to strength, thickness and ride quality on a lot by lot basis subject to adjusted unit prices as provided in Sections 710 and 720.

Use any combination of equipment that shall effectively perform the necessary construction operations. Ensure the equipment is at the job site sufficiently ahead of the start of construction operations for the Engineer to examine thoroughly and approve.

Maintain all equipment in a satisfactory operating condition while in use on the work.

Submit to the Engineer for approval a Process Control Plan addressing all operations necessary in the production and placement of concrete pavement a minimum of 30 calendar days prior to placing concrete pavement.

700-2 CONCRETE PRODUCTION EQUIPMENT

Use batch plants, central mix plants and truck mixers that meet Section 1000.

700-3 CONCRETE HAULING EQUIPMENT

Transport concrete to the point of placement either in a truck agitator, a truck mixer operating at agitating speed or in non-agitating equipment meeting the provisions below. Bottom or belly dump equipment is prohibited. Provide and secure material covers on the equipment bodies for protection against detrimental environmental conditions.

Prevent the accumulation of hardened concrete in the delivery vehicles. Discharge all flushing water before charging with the next concrete load.

When using non-agitating hauling equipment, provide bodies which are smooth, watertight, metal containers with rounded internal corners equipped with vibrators and gates to discharge the concrete without segregation or damage.

For concrete hauled in a transit mix (ready mix) truck, use Table 1000-2 to determine the maximum elapsed time. For concrete hauled in other equipment, the elapsed time shall be 60 minutes or less, unless otherwise approved by the Engineer. Define the “elapsed time” as the period from first contact between mixing water and cement until the completion of the entire operation including placing, finishing, micro-surfacing and any necessary corrective work.

Deliver the concrete to the work site in a thoroughly mixed and uniform mass.

If at discharge, the concrete is not thoroughly mixed and homogeneous, the hauling distance, charging sequence, size of load, mixing time or any combination thereof shall be altered to meet these requirements; otherwise, use other equipment capable of delivering a thoroughly mixed and uniform concrete mass.

700-4 PREPARATION OF SUBGRADE AND BASE

Prepare the subgrade and base beneath Portland cement concrete pavement in accordance with the applicable sections of these specifications and with a grading tolerance of ± 1/4 inch from the established grade on mainline lanes and a grading tolerance of ± 1/2 inch in all other areas. Use approved automatically controlled grading and paving equipment to produce final subgrade and base surfaces meeting the lines, grades and cross sections required by the plans or as directed by the Engineer. When in the judgment of the Engineer the use of such equipment is impractical, this requirement will be waived.

Dampen the surface of the base at the time the concrete is placed. Sprinkle the base when necessary to provide a damp surface. Ensure that no free water or ponding is present at the time of concrete placement. Correct all damaged areas in the subgrade or base before placing concrete.

Do not allow traffic on the underlying asphalt courses other than necessary local traffic and essential construction equipment as authorized by the Engineer.

Unless otherwise approved by the Engineer, use and maintain a braided metal cable stringline reference to control the profile and alignment of the concrete pavement. Monitor the stringline for accuracy and tautness. Set pins at a distance no farther than 50 feet apart. When located on a vertical curve, set pins no farther than 25 feet apart.

700-5 PLACING CONCRETE

(A) General

Use a slip form paver to place concrete except where impractical due to irregular areas or areas of existing pavement adjacent to the proposed pavement.

Place concrete only in the presence of the Engineer or his authorized representative.

Handle concrete so as to prevent segregation and keep free from mud, soil or any other foreign matter.

Where finishing operations must be completed after dark, provide acceptable artificial light in accordance with Section 1413.

Do not pave when any of the following conditions exist:

(1) A descending air temperature at the location of the concrete paving operation and away from artificial heat reaches 35°F. Paving may resume when the weather forecast is projected to reach a high of 40°F on that day's operation and the morning ambient temperature is above 32°F.

(2) The subgrade or base course is frozen.

(3) Aggregates to be used in the mix contain frozen particles.

(4) Air temperature in the shade is 90°F and rising or the concrete temperature is greater than 95°F.

Where additional pavement, aggregate or soil must be placed adjacent to new pavement by machine methods, do not place it until the concrete has attained a compressive strength of at least 3,000 psi.

Construction equipment or hauling equipment will not be allowed over the pavement until the concrete has attained a compressive strength of 3,000 psi.

Spread the concrete uniformly over the entire area without segregation. Perform the spreading with a mechanical spreader independent of the paver except where hand methods are necessary due to pavement design, equipment breakdown or other emergencies.

(B) Slip Form Paver Method

Use a slip form paver that is an approved self-propelled machine designed to spread, consolidate, screed and float finish the concrete in one complete pass of the machine to provide a smooth, dense and homogeneous pavement with minimal hand finishing. Use a slip form paver equipped with forms of sufficient length and rigidity to support the edges of the slab to minimize hand finishing. Use a slip form paver equipped with both horizontal and vertical automatic controls. Operate the paver with continuous forward movement and coordinate all operations of mixing, delivering and spreading the concrete to provide uniform progress and minimize stopping and starting of the paver.

Provide concrete that has sufficient cohesion to prevent appreciable slumping at the edges of each slab. Longitudinal straight edge tolerance of 1/4 inch in 10 feet shall apply to the area within 6 inches of the edge. Edge slump shall be limited to no more than 1/4 inch.

(C) Fixed Form Method

Apply this section to all paving operations where a slip form paver is not being used.

Use forms made of metal and of such section and design that they will adequately support the concrete and the construction equipment.

Use forms that have a depth not less than the edge thickness of the pavement to be constructed and not more than 1 inch greater than the edge thickness of the pavement to be constructed. Use a form which has the base width at least equal to the height of the form.

Use a form in which the top face does not vary from a true plane more than 1/8 inch in 10 feet and the upstanding leg does not vary more than 1/4 inch.

Use straight forms that have at least 3 pin pockets per 10 feet in length and at least 2 pin pockets per 5 feet in length.

Use form pins that are metal and capable of holding the forms rigidly in place during construction operations. The Engineer may require pinholes in the base to be sealed before placing subsequent pavement.

Connect the form sections by a locking joint that will keep the forms free from vertical and horizontal movement.

Use straight forms 10 feet in length on tangents and on curves having a radius of 200 feet or more. For curves having a radius of between 50 feet and 200 feet use either straight forms 5 feet in length or flexible forms. Use flexible forms for curves having a radius of less than 50 feet.

Clean all forms before they are set. Oil all forms before placing concrete. Check the bearing of the forms and correct all areas of inadequate bearing.

Remove all rejected forms immediately from the project.

Set forms a sufficient distance in advance of the point where the concrete is being placed to provide for a continuous operation in placing the concrete and for proper inspection of line and grade.

All forms used for construction joints shall meet this section except provisions shall be made for inserting dowel bars where required.

700-6 VIBRATING CONCRETE

Uniformly vibrate the concrete after it has been spread. Consolidate the full width and depth of the concrete in a single pass.

Vibrators for full width vibration of concrete may be either the surface pan type or the internal type with either immersed tube or multiple spuds. Attach the vibrators to the spreader or the finishing machine, or mount the vibrators on a separate carriage.

Furnish an electronic vibrator monitoring device, displaying the operating frequency of each individual vibrator on the paving equipment. Operate the electronic vibrator monitoring device in areas where the mainline, ramp or loop pavement exceeds 600 feet in length. Record the time, station location, paver track speed and operating frequency of each individual vibrator after every 25 feet of paving or after each 5 minute time interval has elapsed. Provide a report of the vibrator data to the Engineer daily for the first 3 days of paving and weekly thereafter. The Engineer may determine that more frequent submissions are necessary, particularly if equipment is malfunctioning.

Set the internal vibrators to approximately mid slab depth and provide a locking device to avoid contact with any joint, load transfer device, tie bar, subgrade or side form. Provide an operating position locking device so that no part of the vibrating unit can be lowered to the extent that it will come in contact with dowel bars, dowel bar assemblies or tie bars while paving.

Set the horizontal spacing of vibrators to the manufacturer's recommendations, but in no case exceed 16 inches from center to center.

Operate internal and spud vibrators within a frequency range of 3,500 to 8,000 vpm and surface vibrators within a frequency range of 3,500 to 6,500 vpm. Operate vibrators to avoid separation of the mix ingredients. A reduction in vibrator frequency may be required when the forward motion of the paver is reduced to avoid separation of the mix. Either discontinue the use or remove from contact with the concrete, the machine mounted vibrators, whenever the forward motion of the machinery is stopped.

Should the electronic monitoring device fail to operate properly, immediately check the vibrators manually in the presence of the Engineer. If the vibrators are functioning properly, paving may continue. Repair the monitoring device within 3 production days or suspend paving.

700-7 FINISHING

Finish concrete pavement or concrete shoulders in accordance with Article 710-6 or 720-7, respectively. Do not use excessive water for finishing.

700-8 PROTECTION OF PORTLAND CEMENT CONCRETE PAVEMENT

(A) General

Protect the concrete pavement from environmental conditions. Remove and replace concrete pavement damaged as a result of environmental conditions.

Use protective covering that will protect the surface of the freshly placed pavement from rain or cold weather readily available each day at the location of each proposed day's operation before beginning work. Store an adequate quantity of these materials at the paving train.

(B) Cold Weather

When the temperature is projected to drop below 35°F for more than four hours, insulate the concrete pavement to prohibit the concrete surface temperature from dropping below 35°F during the curing period.

(C) Hot Weather

When the anticipated daily high temperature is above 90°F, place the concrete at the coolest temperature practical. Control concrete temperatures to assure proper placing, consolidation, finishing, curing and to prevent plastic shrinkage cracking.

(D) Rain

When rain appears imminent, stop all paving operations, and ensure all available personnel protect the surface of the unhardened concrete. Failure to properly protect the concrete pavement may constitute cause for removal and replacement of the damaged pavement.

700-9 CURING

(A) General

Immediately after finishing operations have been completed and surface water has disappeared, cover all exposed surfaces of the pavement by one of the curing methods herein or as approved by the Engineer.

Apply the selected curing method to the edges of the pavement immediately after the forms are removed.

Curing is required until the concrete compressive strength has exceeded 3,000 psi using the maturity method in accordance with Article 700-13.

(B) Membrane Curing Compound

After final finish and immediately after the free surface moisture has disappeared, use a minimum application rate of 0.0067 gal/sf when the application equipment is mechanically operated. Provide an inline flow-metering device to ensure the proper rate is applied. Apply the curing compound such that puddling or ponding does not occur on the fresh concrete surface.

Use mechanically operated application equipment designed to apply a uniformly agitated continuous flow of the curing compound at the prescribed rate to all concrete surfaces.

Hand spraying shall only be permitted for irregular widths or shapes and surfaces exposed by removal of forms. The rate of application for these areas shall be 0.01 gal/sf.

Do not expose newly placed concrete for more than 30 minutes before being covered with curing compound. Failure to cover the surfaces of the concrete shall be cause for immediate suspension of the paving operation.

Protect the membrane curing compound film at all times during the curing period and repair any damage immediately. Ensure a sufficient amount of polyethylene film, burlap or other approved material is available to provide for protection of the concrete during rain or when the application equipment fails to apply the curing compound uniformly to all surfaces.

Reapply curing compound to any concrete surfaces that received heavy rainfall within 3 hours after initial application.

(C) Polyethylene Film

Spread the sections of the film in a manner that will not damage the finished pavement surface. Securely tape or provide lap joints for the sections that are at least 12 inches wide, and take suitable precautions to prevent the circulation of air beneath the film. Cover all exposed surfaces and beyond the edge of the pavement surface.

Use black or dark plastic sheets when the daily high ambient temperature is between 40°F and 60°F. Use white opaque reflective plastic sheet when the daily ambient temperature is above 60°F. Plastic sheets will meet ASTM C171.

Check the film for damage when it is spread and during the curing period. Repair or replace any damaged sections immediately.

(D) Burlap

Spread the sections of burlap in a manner that will not damage the finished pavement surface. Provide lap joints that are at least 6 inches wide.

Use an amount of burlap that is not less than 12 ounces per running yard based on a 40 inch width. Use either one layer of Class 4 burlap or 2 layers of Class 1, 2 or 3 burlap.

Saturate the burlap thoroughly before placing on the concrete and keep thoroughly wet throughout the curing period.

700-10 REMOVING FORMS

Do not remove forms from freshly placed concrete for at least 12 hours after placement and until the concrete has hardened sufficiently to resist spalling, cracking or any other damage. Repair any honeycombed areas along the sides or edges of the slab by filling with mortar immediately after the forms have been removed. Use mortar consisting of one part cement to 2 parts fine aggregate.

700-11 JOINT CONSTRUCTION

(A) General

Construct all joints in accordance with these *Standard Specifications* and the details shown on the plans. Saw all transverse joints and seal them with joint sealer in accordance with the dimensions and details shown in the contract. Seal joints in accordance with Article 700-12.

Saw the concrete pavement as soon as it can support the weight of the equipment and operator without disturbing the final finish. Saw joints in a neat, vertical straight line without chipping, spalling, tearing or disturbing the final finish.

Ensure an adequate amount of sawing equipment is available to match the production and concrete paving operations. At least one standby sawing unit is recommended. Construct the joint groove using a 1/8 inch saw blade to a minimum depth of 4 inches or the design thickness divided by 3 whichever is less. Perform sawing as soon as the concrete has hardened sufficiently without undercutting, spalling and raveling to control random cracking. To estimate the time of sawing, it is recommended to use the latest version of FHWA's High Performance Paving software entitled HIPERPAV.

Immediately after sawing the joint to the dimensions shown on the plans, completely remove the resulting slurry from the joint without damaging the adjacent concrete. Immediately reapply curing membrane to areas damaged by the sawing operation.

Deviations from the method of joint construction specified in the contract requires prior approval in writing by the Engineer. Such approval is conditional and is subject to obtaining satisfactory results.

The Engineer may order any concrete pavement or shoulder where uncontrolled cracking has occurred before final acceptance to be removed and replaced at no cost to the Department. Where permitted, the Contractor may be allowed to repair the cracking in a manner acceptable to the Engineer.

Before placing either concrete pavement or concrete shoulders adjacent to a previously placed pavement, cover the transverse joint opening on the edge of the existing slab to prevent intrusion of grout into the opening.

(B) Transverse Contraction Joints

Construct transverse contraction joints in accordance with the details, dimensions and intervals as shown on the plans.

(C) Longitudinal Contraction Joints

Construct longitudinal contraction joints in all pavements wider than 16 feet in accordance with the details and dimensions shown on the plans.

(D) Transverse Construction Joints

(1) General

Construct transverse construction joints by use of an approved form at the end of each day's operations (planned joint) or whenever the placing of concrete is suspended for more than 30 minutes (emergency joint).

(2) Planned Transverse Construction Joints

Locate this type of joint at the same spacing required for contraction joints. Use dowel bars of the size and spacing shown on the plans.

(3) Emergency Transverse Construction Joints

Use this type of joint when the placing of concrete is suspended for more than 30 minutes. Use tie bars of the size and spacing shown on the plans.

Do not change the spacing of contraction joints due to emergency construction joints. Locate the emergency construction joints at least 6 feet from any contraction joint or planned construction joint.

(E) Longitudinal Construction Joints

Construct longitudinal construction joints using tie bars in accordance with the details shown on the plans.

(F) Transverse Expansion Joints

Construct transverse expansion joints in accordance with the details shown on the plans utilizing an approved joint assembly.

(G) Verification of Dowel Bar Alignment

Use either properly secured dowel baskets or a dowel bar inserter, provided the ability to correctly locate and align the dowels at the joints is demonstrated as described below.

Provide a calibrated magnetic imaging device that will document dowel bar location and alignment. Calibrate the magnetic imaging device to the type and size dowel bar used in the work. Use this device as a process control and make necessary adjustment to ensure the dowels are placed in the correct location.

Scan all of the joints in the initial 500 feet of placement each time the paving train is mobilized, relocated or altered. Scan joints as soon as practical after the pavement has been placed. Submit scanned data to the Engineer within 48 hours following placement of pavement. Mark scanned joints on the pavement.

Continue scanning no less than 25% of the joints after the initial placement until it is established that the dowel bar inserter or secured dowel basket assemblies are consistently placing the dowel bars at the correct location and meeting the tolerances defined in Table 700-1. Scanned data shall include longitudinal translation (side shift), horizontal translation, vertical translation (depth), horizontal skew or vertical tilt.. The contractor may reduce the percentage of scanned joints to no less than 10% by submitting a request to the Engineer for review and approval. Any time inconsistency in the placement of the dowel bars becomes evident, additional scanning may be required up to 100% of the joints. Materials and Tests Unit will provide Quality Assurance and random verification scans during the initial concrete placement to verify the Contractor’s scan results. The QA frequency will be at least 10% of the Contractor’s scan.

If consistency of the proper dowel bar alignment cannot be established within a reasonable time frame, the Engineer will have the option of suspending the paving operation.

Provide a report of the scanned joints within 48 hours of completing the day's production. The report should include the station and lane of the joint scanned, as well as the horizontal location, depth, longitudinal translation (side shift), horizontal skew and vertical tilt, and total misalignment, of each dowel bar in the joint. If a dowel bar inserter is used, the joint score described below should also be provided in the report.

Longitudinal translation (side shift) is defined as the position of the center of the dowel bar in relation to the sawed joint. The maximum allowable longitudinal translation (side shift) is 2 inches.

Horizontal translation is defined as difference in the actual dowel bar location from its theoretical position as detailed in the standard details. The maximum allowable horizontal translation is 2 inches.

Vertical translation (depth) is the difference in the actual dowel bar location from the theoretical midpoint of the slab. The maximum allowable vertical translation is 1/2 inch higher than the theoretical midpoint and 1inch lower than the theoretical midpoint.

Dowel bar misalignment, either vertical tilt or horizontal skew is defined as the difference in position of the dowel bar ends with respect to each other. Vertical tilt is measured in the vertical axis whereas horizontal skew is measured in the horizontal axis.

If a dowel bar inserter is used, determine a joint score for each joint scanned. The joint score is a measure of the combined effects from the dowel's horizontal skew or vertical tilt. The joint score is determined by summing the product of the weight shown in the Table 700-1 and the number of bars in each misalignment category and adding one. The vertical tilt and horizontal skew should be evaluated and the total misalignment shall be used in determining the joint score.

TABLE 700-1
TOLERANCE FOR DOWEL BAR ALIGNMENT[A]

Misalignment Category, inches (mm)	Weight
$0 \le \mathbf{d} \le 0.6\ (15)$	0
$0.6\ (15) < \mathbf{d} \le 0.8\ (20)$	2
$0.8\ (20) < \mathbf{d} \le 1.00\ (25)$	4
$1.00\ (25) < \mathbf{d} \le 1.50\ (38)$	5
$1.50\ (38) \le \mathbf{d}$	10

A. Where **d** is the individual dowel bar misalignment.

A joint that has a joint score of 12 or greater will be considered locked.

When a locked joint as defined above is discovered, scan the 2 joints immediately adjacent to the locked joint. If either of the adjacent joints are deemed to be locked, provide a written proposal to address the dowel misalignment for each locked joint. No corrective action should be performed without written approval by the Engineer.

700-12 SEALING JOINTS

(A) General

Seal all joints with an approved low modulus silicone sealant in the presence of the Engineer.

Install backer rod and sealant in accordance with the details shown in the plans and the manufacturer's recommendations.

Any failure of the joint material will be cause for rejection. Repair the failed joint material as approved by the Engineer.

When requested, have a representative of the silicone sealant manufacturer present on the project during the sealing operation.

(B) Age of Pavement

Do not seal the joints until the concrete is at least 7 calendar days old and concrete is dry based on sealant manufacturer's recommendations.

Do not perform final sawing and sealing of concrete pavement joints until after surface testing, correction of surface deficiencies and all adjacent earth and paved shoulder construction has been completed.

(C) Temperature

Do not place joint sealant when the air temperature near the joint is less than 45°F or is 45°F and falling.

(D) Sealing the Joint

Immediately after sawing the joint to the dimensions as shown on the plans, completely remove the resulting slurry from the joint by flushing with a jet of water under pressure. Use sand blasting to clean joint faces before applying sealant. Make as many passes with a sand blaster as are necessary to provide a clean joint wall.

Blow all joints clear of deleterious materials with air using a nozzle pressure of at least 90 psi before installing the backer rod. Use rotary screw compressors for this purpose that are equipped with traps capable of removing water and oil from the air. Maintain the traps in accordance with manufacturer's instructions.

Apply sealer only on thoroughly clean and dry joints. Place the sealer to closely conform to dimensions shown on the plans. Any unreasonable deviation will be cause for rejection.

(E) Cleaning Pavement

After a joint has been sealed, remove surplus joint sealer on the pavement as soon as possible.

700-13 USE OF NEW PAVEMENT OR SHOULDER

Traffic or other heavy equipment will not be allowed on the concrete pavement or shoulder until the estimated compressive strength of the concrete using the maturity method has exceeded 3,000 psi. Estimate the compressive strength of concrete pavement in accordance with ASTM C1074 unless otherwise specified.

Furnish thermocouples or thermistors and digital data logging maturity meters that automatically compute and display the maturity index in terms of a temperature-time factor (TTF). The maturity meters must be capable of storing at least 28 days worth of data and exporting data into an Excel® spreadsheet. Install loggers in slabs after every 2 lots approximately 4 inches from the concrete surface. Submit the proposed equipment to the Engineer for approval.

When establishing a strength-maturity relationship, perform compressive tests at ages 1, 3, 7, 14 and 28 days in accordance with AASHTO T 22.

Use the TTF maturity function to compute the maturity index from the measured temperature history of the concrete. Set the datum temperature at -10°C to calculate the TTF in Equation 1 of ASTM C1074.

Establish and submit a strength-maturity relationship in conjunction with each concrete pavement mix design. Determine the TTF corresponding to the strength-maturity relationship at 3,500 psi, TTF. Any changes to plant operations, material sources or mix proportions will affect the strength-maturity relationship. If any changes occur during production, develop a new strength-maturity relationship unless otherwise directed by the Engineer.

Validate the strength-maturity relationship and the correlation between cylinders and beams during the first day's production by casting cylinders and beams and performing strength tests. Use the TTF developed during the mix design process to verify the strength-maturity relationship.

Validate the strength-maturity relationship and the correlation between cylinders and beams by casting cylinders and beams and performing strength tests at least every 30 calendar days, or when the TTF varies by more than 10% from the latest approved maturity curve or there is a material change from the approved concrete mix design. If the verification sample's compressive strength when tested at TTF is less than 3,000 psi, immediately suspend early opening of traffic on pavement that has not obtained TTF until a new strength-maturity relationship is developed.

No permanent traffic will be allowed on the pavement until construction of the joints, including all sawing, sealing and curing that is required, has been completed.

Take particular care to protect the exposed pavement edges and ends.

700-14 CONTRACTOR'S RESPONSIBILITY FOR PROCESS CONTROL

Perform process control sampling and testing of concrete materials and operations in accordance with Article 1000-4. The Contractor's roadway foreman and all personnel involved in the batching, sampling, testing and acceptance of Portland cement concrete pavement shall be Department certified Portland cement concrete pavement technicians.

700-15 ACCEPTANCE TESTS FOR CONCRETE

(A) Responsibility

The Engineer will conduct acceptance sampling and testing of concrete. Provide access to all materials to be sampled and tested. The following tests will be performed on both concrete pavement and concrete shoulders to determine acceptance.

(B) Lot Definition

A lot for acceptance purposes is defined and described in Article 710-4.

(C) Air Content

The air content of the concrete will be determined on the roadway at a frequency established by the Engineer and in accordance with Subarticle 1000-4(B). The sample taken for determination of air content will be obtained immediately after the concrete has been discharged on the road.

Concrete failing to meet specification requirements for air content will be subject to rejection.

(D) Slump

The slump of the concrete will be determined in accordance with AASHTO T 119 at a frequency established by the Engineer. The sample taken for determination of slump will be obtained immediately after the concrete has been discharged on the road.

When the slump of the concrete is questionable by visual observation, do not place the concrete on the road until tested for slump by the Engineer.

Concrete failing to meet specification requirements for slump will be subject to rejection.

(E) Compressive Strength

Determine the compressive strength of concrete using one set of two 6 inch x 12 inch cylinders at 28 calendar days. Test samples will be made by the Engineer from the concrete as it comes from the mixer. The samples will be made and cured in accordance with AASHTO R 100. Test specimens will be tested by the Engineer in accordance with AASHTO T 22. Furnish curing facilities for the test samples in accordance with Section 725.

(F) Thickness

The thickness of the pavement will be determined by measurement of cores in accordance with AASHTO T 148.

Take 4 inch diameter cores in the presence of the Engineer. The Engineer will take immediate possession of the cores. Take the cores when the concrete has attained a compressive strength of at least 3,500 psi and at least 72 hours have elapsed since placement of the pavement. If the concrete has not attained a compressive strength of at least 3,500 psi, the gross vehicle weight rating of vehicles supporting the coring operation may not exceed 7,000 lbs. Take cores no later than 30 days after the pavement has been placed. The core locations for each lot will be selected at random by the Engineer.

Patch all core holes within 72 hours of taking the core, using an approved nonshrink grout compatible with the pavement or shoulder concrete.

(G) Surface Smoothness

Perform acceptance testing for surface smoothness on concrete pavements in accordance with Article 710-7. The Engineer will have a representative present during all testing and will take possession of the results at the completion of each day's testing.

700-16 MEASUREMENT AND PAYMENT

Remove and repair defects and damage to underlying asphalt course, Portland cement concrete and joints at no cost to the Department.

SECTION 710
CONCRETE PAVEMENT

710-1 DESCRIPTION

Perform the work covered by this section, including, but not limited to, designing the concrete mix; furnishing and placing concrete; furnishing of all admixtures and additives; constructing all joints and furnishing joint materials; marking the pavement; curing the pavement and furnishing all curing materials; furnishing concrete necessary for making test beams and cylinders; performing maturity testing; coring and patching the pavement; calibrating and checking the operation of batching equipment; taking actions necessary to prevent or to repair cracking; sawing and sealing joints; verifying dowel bar alignment; removing and replacing of defective pavement; and constructing Portland cement concrete pavement in accordance with these *Standard Specifications* and with the lines, grades and dimensions shown on the plans.

710-2 MATERIALS

Refer to Division 10.

Item	Section
Curing Materials	1026
Dowels and Tie Bars	1070-6
Joint Filler	1028-1
Low Modulus Silicone Sealant	1028-3
Portland Cement Concrete	1000
Water	1024-4

710-3 COMPOSITION OF CONCRETE

Design the concrete mix in accordance with Section 1000.

Before placement, produce a trial batch through the plant. The Engineer will make compressive and flexural samples from the trial batch for testing at 1, 3, 7, 14 and 28 days of age. Until the trial batch meets 650 psi flexural strength and 4,500 psi compressive strength, the Engineer will make acceptance samples for flexural and compressive tests for mix placed. If the trial batch test results meet strength requirements, flexural samples representing placed concrete will be discarded, and compressive samples will be used for acceptance. If the trial batch does not meet strength requirements, flexural samples will be used for acceptance until plant produced mix meets strength requirements.

If any major change as defined in Article 1000-1 is made to the mix design, this process shall be initiated again.

710-4 ACCEPTANCE OF CONCRETE

The Department will test the concrete pavement for acceptance with respect to compressive strength and thickness on a lot by lot basis in accordance with Article 700-15 and the requirements herein.

For all concrete pavement, including mainline, shoulders, ramps, tapers, intersections, entrances, crossovers and irregular areas not otherwise defined, produce a lot consisting of 1,333.3 sy or fraction thereof placed within 28 calendar days. From each lot, the Engineer will make at least one set of two 6 inch x 12 inch cylinders from a randomly selected batch of concrete. The average compression strength of the 2 cylinders is considered one test. If Department personnel make and test additional sets of cylinders for a lot, all sets will be averaged with the original set to determine the strength. In the case of low strength, the Engineer will perform an investigation.

710-5 CONSTRUCTION METHODS

Construct concrete pavement in accordance with Section 700.

Place concrete in 2 lane minimum widths in a single operation except as follows:

(A) Where the total number of lanes is an odd number, in which case one of the lanes may be placed in a separate operation.

(B) Areas such as ramps or auxiliary lanes where the total width is less than 2 lanes.

710-6 FINISHING

Screed and float finish the concrete to the required cross section that minimizes or eliminates hand finishing. Additional water for finishing will not be allowed. Hand finishing will not be permitted except under the following conditions:

(A) Narrow widths or irregular areas, where operation of mechanical equipment is impractical.

(B) If a breakdown of mechanical equipment occurs, hand methods may be used to finish only that concrete deposited on the base before the breakdown.

(C) Abnormal circumstances of short duration subject to approval by the Engineer.

Produce a final finish on the pavement surface true to grade and uniform in appearance and free of irregular, rough or porous areas.

Following the finishing of the pavement by screeding, floating and checking with straightedges, further finish the surface of the pavement by burlap dragging or other acceptable method to produce a uniform surface texture. Pull the burlap drag in a longitudinal direction.

Produce the final surface finish on all mainline pavement, auxiliary lanes, and ramps by mechanical equipment for longitudinally tined grooves while the concrete is plastic. The tining shall be done with a mechanical device such as a wire comb. The comb shall have a single row of tines. Each shall have a nominal width of 5/56 inch to 1/8 inch. The nominal spacing of the tines shall be 3/4 ± 1/8 inch center-to-center. The nominal depth of tined groove in the plastic concrete shall be 1/8 ± 1/32 inch.

Longitudinal tining shall be accomplished by equipment with automated horizontal and vertical controls to ensure straight, uniform depth tined grooves. The texture geometry shall be the same as imparted throughout the length of the tining comb. A 2 inch to 3 inch wide strip of pavement surface shall be protected from tining for the length of and centered about longitudinal joints.

The tining operation shall be done so that the desired surface texture will be achieved while minimizing displacement of the larger aggregate particles and before the surface permanently sets. Where abutting pavement is to be placed, the tining shall extend as close to the edge as possible without damaging the edge. If abutting pavement is not to be placed, the 6 inch area nearest the edge or 1 foot from the face of the curb shall not be tined. Hand-operated tining equipment that produces an equivalent texture may be used only on small or irregularly shaped areas. Tines shall be thoroughly cleaned at the end of each day's use and damaged or worn tines replaced.

When surface corrections for pavement smoothness are made in the hardened concrete, no additional texturing is required.

After final finishing, hand finishing may be required on the edges of pavement and joints whenever irregularities in surface texture or alignment occur. Care should be taken in hand finishing pavement edges to avoid ridges or high places that will prevent water from draining out of the transverse grooves.

The use of excessive water during the finishing operations will not be permitted.

Provide a textured surface with an average texture depth of 0.8 mm as tested in accordance with ASTM E965 with no single test having a texture depth of 0.5 mm or less. Perform 4 randomly located tests in accordance with ASTM E965 within the initial pavement lot of each mobilization in the presence of the Engineer. A "lot" is defined in Article 710-4. If the average of the 4 tests does not meet the above criteria, make appropriate changes to the surface texture operations and test the next lot as detailed above. Once the surface texture process is established to meet minimum texture requirements, maintain consistency within the operation to provide the above minimum texture depth. Perform additional sand patch tests in accordance with ASTM E965 when directed by the Engineer.

If the surface texture becomes damaged or reduced by rain or any other action, reestablish or restore surface texture by an approved method.

710-7 FINAL SURFACE TESTING

Use an Inertial Profiler to measure the longitudinal pavement profile for construction quality control and smoothness acceptance. Use a profiler with line laser technology as single-point

laser technology will not be allowed. Produce International Roughness Index (IRI) and Mean Roughness Index (MRI) values for measuring smoothness.

Use testing and recording software to produce electronic inertial road profiles in a format compatible with the latest version of FHWA's ProVAL (Profile Viewing and Analysis) software.

The Inertial Profiler shall be calibrated and verified in accordance with the most current version of AASHTO M 328. Provide certification documentation that the profiler meets AASHTO M 328 to the Engineer before the first day the Inertial Profiler is used on the project.

Configure the profiler to record the actual elevation of the pavement surface. Do not use the profiler's internal IRI calculation mode. The profile data shall be filtered with a 300 feet Butterworth high-pass filter. The interval at which relative profile elevations are reported shall be a maximum of 1 inch.

Provide IRI data in accordance with most current version of ASTM E1926. Use personnel trained to record and evaluate IRI data.

Provide an Inertial Profiler Operator that has been certified by the Department's Profiler and Operator Certification Program as administered by the Materials and Tests Unit. Provide the user selected Inertial Profiler settings to the Engineer for the project records.

In the presence of the Engineer, at the beginning of each day's data collection, perform a block test to verify the Inertial Profiler's ability to accurately collect elevation data is met and perform bounce test to verify that the Inertial Profiler's accelerometers are performing correctly.

Remove all objects and foreign material on the pavement surface prior to longitudinal pavement profile testing.

In the presence of the Engineer, operate the profiler at any speed as per the manufacturer's recommendations, however, the speed must be constant to within ± 3 mph of the intended speed and any required acceleration should be as gradual as possible. For example, if the intended speed were 30 mph, the acceptable range of speed for testing would be 27 to 33 mph.

Operate the Inertial Profiler in the direction of the final traffic pattern. Collect IRI data from both wheel paths during the same run. It is permissible to collect data one wheel path at a time if each wheel path is tested and evaluated separately. Define a "wheel path" as the 3 feet from the edge of the travel lane. MRI values are the average of the IRI values from both wheel paths. When using an inertial profiler that collects a single trace per pass, take care to ensure that the measurements from each trace in a travel lane start and stop at the same longitudinal locations. Unless otherwise specified, multiple runs are not necessary for data collection.

Operate the automatic triggering method at all times unless impractical. A tape stripe or traffic cone wrapped with reflective material may be used to alert the profiler's automatic triggering sensor to begin data collection. The profiler shall reach the intended operating speed before entering the test section. The runup and runout distances should be sufficient to obtain the intended operating speed and to slow down after testing is completed.

Divide the pavement surface for the project into sections which represent a continuous placement (i.e. the start of the project to bridge, intersection to intersection). Terminate a section 50 feet before a bridge approach, railroad track, or similar interruption. (Separate into 0.10-mile sections).

The evaluation of the profiles will be performed on a section basis. A section is 0.10 mile of a single pavement lane. For any section, which is less than 0.10 mile in length, the applicable pay adjustment incentive will be prorated on the basis of the actual length.

Mark the limits of structures and other special areas to be excluded from testing using the profiler's event identifier such that the exact locations can be extracted from the profile data file during processing.

Unless otherwise authorized by the Engineer, perform all smoothness testing in the presence of the Engineer. Perform smoothness tests on the finished surface of the completed project or at the completion of a major stage of construction as approved by the Engineer. Coordinate with and receive authorization from the Engineer before starting smoothness testing. Perform smoothness tests within 7 days after receiving authorization. Any testing performed without the Engineer's presence, unless otherwise authorized, may be ordered retested at the Contractor's expense.

After testing, transfer the profile data from the profiler portable computer's hard drive to a write once storage media (USB flash drive, external hard drive or electronic media method approved by the Engineer). Label the disk or electronic media with the Project number, Route, file number, date, and termini of the profile data. Submit the electronic data on the approved media to the Engineer immediately after testing and this media will not be returned to the Contractor.

Submit documentation and electronic data of the evaluation for each section to the Engineer within 10 days after completion of the smoothness testing. Submit the electronic files compatible with ProVAL and the evaluation in tabular form with each 0.10-mile segment occupying a row. Include each row with the beginning and ending station for the section, the length of the section, the original IRI values from each wheel path, and the MRI value for the section. Each continuous run for a section will occupy a separate table and each table will have a header that includes the following: the project contract number, county, the roadway number or designation, a lane designation, the dates of the smoothness runs, and the beginning and ending station of the continuous run. Summarize each table at the bottom.

Traffic control and all associated activities included in the pavement smoothness testing of the pavement surface will be the responsibility of the Contractor.

(A) Acceptance for Construction

IRI and MRI numbers recorded in inches per mile will be established for each 0.10-mile section for each travel lane of the finished pavement surface designated by the Contract.

Areas excluded from testing by the profiler will be tested by the Contractor and the Engineer using a 10-foot stationary straightedge furnished by the Contractor. Any location on the pavement selected by the Department shall be tested as well as all transverse joints. Apply the straightedge parallel to the centerline of the surface. Do not exceed 1/8 inch variation of the surface being tested from the edge of the straightedge between any 2 contact points. Correct areas found to exceed this tolerance by removal of the defective work and replacement with new material, unless other corrective measures are permitted by the Engineer. Provide the work and materials required in the correction of defective work.

Table 710-1 provides the acceptance quality rating scale of pavement based on the final rideability determination.

TABLE 710-1 MRI PRICE ADJUSTMENT PER 0.10-MILE SECTION	
MRI after Completion (Inches Per Mile)	**Price Adjustment Per Lane (0.10-Mile Section)**
45.0 and Under	$200.00
45.1-55.0	PA = 600 – (10 * MRI)
55.1-70.0	Acceptable (No Pay Adjustment)
70.1-90.0	PA = 650 – (10 * MRI)
Over 90.1	Corrective Action Required

This price adjustment will apply to each 0.10-mile section based on the Mean Roughness Index (MRI), the average IRI values from both wheel paths.

When corrections to the pavement surface are required, the Engineer shall approve the Contractor's method of correction. Methods of correction shall be diamond grinding, remove and replace, or other methods approved by the Engineer. To produce a uniform cross section, the Engineer may require correction to the adjoining traffic lanes or shoulders. Corrections to the pavement surface, the adjoining traffic lanes and shoulders will be at no cost to the Department.

Where corrections are made after the initial smoothness testing, the pavement will be retested by the Contractor to verify that corrections have produced the acceptable ride surface. No incentives will be provided for sections on which corrective actions have been required. The Contractor will have one opportunity to perform corrective action(s).

(B) Localized Roughness

Areas of localized roughness shall be identified through the "Smoothness Assurance Module" provided in the ProVAL software. Use the "Smoothness Assurance Module" to optimize repair strategies by analyzing the measurements from profiles collected using inertial profilers. The ride quality threshold for localized roughness shall be 165 inches per mile at the continuous short interval of 25 feet. Submit a continuous roughness report to identify sections outside the threshold and identify all localized roughness, with the signature of the Operator included with the submitted IRI trace and electronic files.

The Department will require that corrective action be taken regardless of final IRI. Re-profile the corrected area to ensure that the corrective action was successful. If the corrective action is not successful, the Department will assess a penalty or require additional corrective action.

$$\mathbf{PA} = (165 - \mathrm{LR\#})\ 5$$

Where:

PA = Pay Adjustment (dollars)

LR# = The Localized Roughness number determined from SAM report for the ride quality threshold

Corrective work for localized roughness shall be approved by the Engineer before performing the work and shall consist of either diamond grinding or other methods approved by the Engineer. Any corrective action performed shall not reduce the integrity or durability of the pavement that is to remain in place. Notify the Engineer 5 days prior to commencement of the corrective action.

Localized roughness correction work shall be for the entire traffic lane width. Pavement cross slope shall be maintained through corrective areas.

710-8 MARKING FOR STATION NUMBERS AND DRAINAGE OUTLETS

Mark the pavement at locations as shown on the plans with station numbers. Mark the pavement by pressing beveled-face metal dies between 4 inches and 6 inches high into the plastic concrete.

At locations where shoulder drain outlets are placed, mark the edge of pavement nearest the outlet with the letters "OL". Use the same marking procedure as for station numbers.

710-9 THICKNESS TOLERANCES

A lot for thickness acceptance testing is defined in Article 710-4.

To establish an adjusted unit price, if appropriate, for mainline pavement, take one 4 inch diameter core from each lot at a random location as directed by the Engineer. Other areas such as intersections, entrances, crossovers and ramps will each be considered as one lot and the thickness of each of these lots will be determined separately. Small irregular areas may be included as part of another lot. Take one core for each 1,333.3 sy of pavement or fraction thereof in the lot.

When the measurement of any core, original core or additional cores taken to calculate the average, is less than the plan thickness by more than 1.0 inch, the extent of the removal area due to thickness deficiency will be determined by taking additional exploratory cores at approximately 10 foot intervals parallel to the center line in each direction from the deficient core until an exploratory core is found in each direction which is within 1.0 inch of the plan thickness. The pavement between these exploratory cores will be removed full lane width wide and replaced with concrete of the thickness shown on the plans. Exploratory cores for deficient thickness will not be used in averages for adjusted unit price.

When the measurement of the core from a lot is deficient by 0.2 inch or less from the plan thickness, no pay reduction will be made for thickness. When such measurement is deficient by more than 0.2 inch from the plan thickness, take 2 additional cores at random locations within the lot and calculate the average thickness of the lot from the 3 cores.

In determining the average thickness of the pavement lot, the Engineer will use all 3 core measurements. Individual core measurements which are greater than the plan thickness + 0.2 inch will be considered as the plan thickness + 0.2 inch. Individual cores which are less than the plan thickness - 1.0 inch will be considered as the plan thickness - 1.0 inch. If the average measurement of the 3 cores is within 0.2 inch from the plan thickness, full payment will be made. If the average measurement of the 3 cores is deficient by more than 0.2 inch from the plan thickness, an adjusted unit price in accordance with Subarticle 710-10(B) will be paid for the lot represented.

Areas found deficient in thickness by more than 1.0 inch shall be removed and replaced with concrete of the thickness shown on the plans. Any full lane or full shoulder width repairs to the concrete pavement shall be performed in accordance with the *North Carolina Department of Transportation Partial and Full Depth Repair Manual* and not be less than 1/2 of the slab length.

Patch all core holes within 72 hours of taking the core, using a Department approved nonshrink grout compatible with the pavement concrete.

710-10 MEASUREMENT AND PAYMENT

(A) General

The quantity of Portland cement concrete pavement to be paid will be the actual number of square yards of concrete pavement completed and accepted. In measuring this quantity, the width of the pavement will be as called for on the plans or as directed by the Engineer. The length will be the actual length constructed, measured along the centerline of the pavement.

Separate measurement will be made of pavement that is deficient in thickness by more than 0.2 inch and of pavement that is deficient in compressive strength.

The quantities of Portland cement concrete pavement will be paid at the contract unit price per square yard for __" *Portland Cement Concrete Pavement, Through Lanes, (with dowels),* __" *Portland Cement Concrete Pavement, Ramps, (with dowels)* or __" *Portland*

Cement Concrete Pavement, Miscellaneous, (without dowels), or if applicable, at such contract unit prices adjusted in accordance with the requirements shown below. No unit price adjustments on lots will be made until a final determination of the lot strength and depth is made. Pavement will be classified as through lane, ramp or miscellaneous pavement in accordance with the classification shown on the plans.

Payment for all work of surface testing will be incidental to the contract unit price for *Portland Cement Concrete Pavement, Through Lanes, (with dowels)* for *Surface Testing Concrete Pavement*.

(B) Pavement Deficient In Thickness

The quantities of Portland cement concrete pavement which are deficient in thickness by more than 0.2 inch but not deficient by more than 1.0 inch, measured as provided in Article 710-10, will be paid at an adjusted contract unit price per square yard for __" *Portland Cement Concrete Pavement, Through Lanes, (with dowels),* __" *Portland Cement Concrete Pavement, Ramps, (with dowels)* or __" *Portland Cement Concrete Pavement, Miscellaneous, (without dowels)* completed in place and accepted.

The adjusted contract unit price is determined by the following formula, except no pay over 100% will be allowed:

$$\textbf{Pay Factor (\%)} = 110 - \left[50 \times \left(Plan\ Thickness - Average\ Core\ Thickness\right)\right]$$

Exploratory cores for deficient thickness will not be used in averages for adjusted unit price. Where pavement deficient by more than 1.0 inch is removed and replaced, the replacement pavement will be paid at the contract unit price per square yard for __" *Portland Cement Concrete Pavement, Through Lanes, (with dowels),* __" *Portland Cement Concrete Pavement, Ramps, (with dowels)* or __" *Portland Cement Concrete Pavement, Miscellaneous, (without dowels)* which price and payment will be full compensation for all work of placement, removal, restoration of subgrade and base and replacement.

(C) Concrete Pavement Varying In Strength

One of the following formulas will be used to calculate the concrete pavement pay factor.

(1) Compressive Strength

The pay factor for pavement achieving a compressive strength in 28 days of 4,500 psi or greater is 100%. The pay factor for pavement achieving a compressive strength in 28 days between 3,500 psi and 4,500 psi is determined by the following formula:

$$\textbf{Pay Factor (\%)} = 100.0 - \left[0.05 \times \left(4{,}500 - Compressive\ Strength\right)\right]$$

(pay factor rounded to nearest 0.1%)

(2) Flexural Strength

The pay factor for pavement achieving a flexural strength in 28 days of 650 psi or greater is 100%. The pay factor for pavement achieving a flexural strength in 28 days between 600 psi and 650 psi is determined by the following formula:

$$\textbf{Pay Factor (\%)} = 100.0 - \left(650 - Flexural\ Strength\right)$$

(pay factor rounded to nearest 0.1%)

The quantities of Portland cement concrete pavement that meet these criteria, will be paid at an adjusted unit price per square yard for __" *Portland Cement Concrete Pavement, Through Lanes, (with dowels),* __" *Portland Cement Concrete Pavement, Ramps, (with dowels)* or __" *Portland Cement Concrete Pavement, Miscellaneous, (without dowels)* completed in place and accepted. The adjusted contract unit price will be determined by

multiplying the contract unit price by the pay factor level determined for the average strength of concrete in each lot and will be applicable to the total square yards of concrete in each lot.

Any pavement that fails to attain 3,500 psi in compression is subject to removal. If allowed to remain in place, the pavement will be accepted at a reduced unit price based on a pay factor level of 50% as provided in Article 105-3.

Where pavement deficient in strength is removed and replaced, the replacement pavement, if acceptable, will be paid at the contract unit price for __" *Portland Cement Concrete Pavement, Through Lanes, (with dowels),* __" *Portland Cement Concrete Pavement, Ramps, (with dowels)* or __" *Portland Cement Concrete Pavement, Miscellaneous, (without dowels)* which price and payment will be full compensation for all work including placement, removal, restoration of subgrade and base and replacement.

(D) Multiple Adjustments in Price

Pavement found deficient in both thickness and strength will be evaluated by the Engineer to determine if it may be permitted to remain in place. Pavement permitted to remain in place will be paid at a reduced price determined by successively multiplying the contract price by the appropriate factor indicated for each deficiency.

(E) Compensation

Payment at the contract unit prices for __" *Portland Cement Concrete Pavement, Through Lanes, (with dowels)* and __" *Portland Cement Concrete Pavement Ramps, (with dowels)* and __" *Portland Cement Concrete Pavement, Miscellaneous, (without dowels)* will be full compensation for all work covered by this section.

(F) Pay Items

Payment will be made under:

Pay Item	Pay Unit
__" Portland Cement Concrete Pavement, Through Lanes (with dowels)	Square Yard
__" Portland Cement Concrete Pavement, Ramps (with dowels)	Square Yard
__" Portland Cement Concrete Pavement, Miscellaneous (without dowels)	Square Yard

SECTION 720
CONCRETE SHOULDERS

720-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, the construction of Portland cement concrete shoulders in accordance with this section and with the lines, grades and dimensions shown on the plans; designing the mix; furnishing and placing the concrete shoulders; furnishing maturity testing equipment; furnishing all admixtures and additives; constructing joints; furnishing joint materials; curing the shoulder and furnishing curing materials; coring and patching core holes; taking actions to prevent or repair cracking; and removing and replacing unsatisfactory shoulder.

720-2 MATERIALS

Refer to Division 10.

Item	Section
Curing Materials	1026
Dowels and Tie Bars	1070-6
Joint Filler	1028-1
Low Modulus Silicone Sealant	1028-3
Portland Cement Concrete	1000
Water	1024-4

720-3 COMPOSITION OF CONCRETE

Design the concrete mix in accordance with Section 1000.

720-4 ACCEPTANCE OF CONCRETE

The Engineer will test concrete shoulders for acceptance with respect to compressive strength and thickness on a lot by lot basis. A "lot" is defined in Article 710-4.

720-5 EQUIPMENT

Use equipment in the production and placement of the concrete shoulders in accordance with Section 700 and Section 1000.

720-6 CONSTRUCTION METHODS

Place the concrete shoulders only in the presence of an authorized representative of the Engineer. Construct concrete shoulders in accordance with Section 700.

Place the full width of the shoulder in a single operation.

720-7 FINISHING

Finish the shoulder surface with approved equipment. Hand finishing will be permitted when the use of mechanical finishing equipment is impractical.

Perform the final finishing of the shoulder surface by burlap dragging, brooming or other acceptable methods that will produce a similar surface texture acceptable to the Engineer.

720-8 JOINTS

Construct and seal all joints in accordance with Articles 700-11 and 700-12 except as provided in this article. Saw all joints in the concrete shoulder and seal with joint sealer as shown in the plans.

Dowels will not be required at the transverse joints in the concrete shoulder. Use tie bars between the concrete pavement and the concrete shoulder.

Match the transverse joints in the concrete shoulder with the transverse joints in the adjacent concrete pavement.

720-9 THICKNESS TOLERANCES

The Engineer will determine the thickness of the shoulder by measurement of cores in accordance with AASHTO T 148. A lot for thickness acceptance testing is defined in Article 710-4.

Take one 4 inch core from each lot at a random location as directed by the Engineer. Core each location in the presence of the Engineer. The Engineer will take immediate possession of the cores. Take cores with a diameter of 4 inches and deliver them to the Engineer for measurement. When the required thickness for the shoulder varies, each core will be measured and compared to the required thickness for the shoulder at the location of the core. The deviation of the measured core thickness from the required thickness will be recorded as a plus or minus value for each core. Thickness tolerances in Article 710-9 apply for concrete shoulders.

720-10 MEASUREMENT AND PAYMENT

(A) General

Concrete Shoulders Adjacent to __" Pavement will be measured and paid as the actual number of square yards of shoulders completed and accepted. In measuring this quantity, the width of the shoulders will be as called for on the plans or as directed by the Engineer. The length will be the actual length constructed, measured along the surface of the shoulders at the centerline of each shoulder.

(B) Shoulder Deficient in Thickness

Pay factors are determined in accordance with Subarticle 710-10(B). When the shoulder is deficient in thickness by more than 1 inch, the Engineer will determine if the shoulder can be left in place or be removed and replaced. Where the Engineer determines the shoulder can be left in place, the shoulder will be accepted at a reduced unit price not to exceed 50% as provided in Article 105-3.

(C) Concrete Shoulder Varying In Strength

Concrete shoulders shall meet the strength requirements of Subarticle 710-10(C).

The quantities of concrete shoulder that fail to meet 4,500 psi, measured as provided in Article 710-10, will be paid for at an adjusted unit price per square yard completed in place and accepted. The adjusted contract unit price will be determined by multiplying the contract unit price by the pay factor level in Subarticle 710-10(C).

Where concrete shoulder deficient in strength is removed and replaced, the replacement pavement, if acceptable, will be paid at the contract unit price for *Concrete Shoulders Adjacent to __" Pavement*, which price and payment will be full compensation for all work of placement, removal and replacement.

(D) Multiple Adjustments in Price

Concrete shoulder found deficient in both thickness and strength will be evaluated by the Engineer to determine if it may be permitted to remain in place. Concrete shoulder permitted to remain in place will be paid at a reduced price determined by successively multiplying the contract price by the appropriate factor indicated for each deficiency.

(E) Pay Items

Payment will be made under:

Pay Item	Pay Unit
Concrete Shoulders Adjacent to __" Pavement	Square Yard

SECTION 723
CONCRETE REPAIR

723-1 DESCRIPTION

Perform work covered by this section, including, patching concrete pavement spalls and repair of jointed concrete pavement slabs using very high early strength concrete.

Patch partial and full depth spalls in existing Portland cement concrete pavement by sawing and removing the broken, damaged or disintegrated concrete pavement from the spalled areas of the pavement surface and patch the areas with an approved patching material. Alternate methods and materials for patching concrete spalls may be submitted by the Contractor for approval by the Engineer.

Remove and satisfactory dispose of existing damaged jointed concrete pavement slabs, furnish and place new jointed concrete pavement slabs as shown in the plans or directed by the Engineer.

723-2 MATERIALS

Refer to Divisions 6, 7 and 10.

Item	Section
Curing Materials	1026
Dowels and Tie Bars	1070-6
Geotextile for Soil Stabilization	270
Joint Filler	1028-1
Low Modulus Silicone Sealant	1028-3
Portland Cement Concrete	1000
Select Material, Class IV	1016
Water	1024-4

For repair of jointed concrete pavement slabs, use Select Material, Class IV. If Select Material, Class IV does not meet the requirements of Section 1016, the Engineer may consider the material reasonable acceptable in accordance with Article 105-3.

Patching material shall be mixed and installed, handled and stored, and cured in accordance with the manufacturer's instructions. The Contractor may, at his option, use any approved material from the NCDOT APL or an approved equal as per the Engineer.

723-3 METHODS OF PRODUCTION

(A) Repair of Jointed Concrete Pavement Slabs

Repair the slabs in accordance with Section 700.

The concrete shall meet the requirements of Article 723-4. Repair of the slabs shall be conducted in one lane at a time and be accomplished with other operations in progress in the same area.

For all cases of slab removal, remove the entire 12 feet width and a minimum of 6 feet in the travel direction. Any remaining portion of a slab that is removed shall not be less than 6 feet in the travel direction.

As a result of the full depth sawing of the existing pavement to remove the distressed area, saw cuts that extend into the adjacent pavement shall be filled with epoxy prior to placing traffic on the new area. The epoxy shall meet the requirements of Section 1081, Type 3.

Take necessary measures to protect the exposed subgrade and base form damage resulting from surface water or rain during the period between the pavement removal and replacement. The Contractor shall submit his plan for removing the pavement areas to the Engineer for approval. The removal method shall minimize damage to the subgrade and to adjacent pavement and shoulders.

At locations as directed by the Engineer, the Contractor shall:

(1) Remove unsuitable aggregate base material and backfill with Select Material, Class IV as directed by the Engineer; or

(2) Remove unsuitable aggregate base material, undercut the subgrade, place Geotextile for Soil Stabilization per Section 270, and backfill with Select Material, Class IV as directed by the Engineer.

Thoroughly tamp any loosened subgrade or base material to the satisfaction of the Engineer before the pavement is replaced. New pavement shall be cast to match the thickness of the adjacent slabs.

Pneumatic or hydraulic drills and bits that will drill a hole in the existing concrete faces for placement of the dowels at location specified on the plans shall be used. The equipment shall be operated so as to prevent damage to the pavement being drilled. The

drilling procedure shall be approved by the Engineer. The drilled holes shall be thoroughly cleaned of all contaminants and the dowels of specified type and size shall then be set into the hardened concrete face of the existing pavement with an epoxy bonding compound meeting the requirements of a Type 3A epoxy detailed in Section 1081. The specified dowels shall be placed at locations noted on plan details with one-half of dowel protruding beyond the hardened face of existing pavement and placed at correct horizontal and vertical alignment with misalignment not to exceed 0.4 inches in the vertical or oblique plane. The epoxy shall be allowed to harden sufficiently prior to placing concrete to prevent any movement of the dowels during the placement of the concrete. A sufficient amount of epoxy must be placed in the back of the hole so that the entire cavity around the dowel is completely filled upon insertion of the dowel bars. Any excess epoxy shall be removed. The epoxy adhesive must be packaged in a cartridge with a mixing nozzle that thoroughly mixes the two components as they are dispensed (the mixing nozzle must be a minimum of 8 inches long) or may be placed with a machine which mixes the two components thoroughly and to the proper ratio as the material is being placed.

Use dowels of the type, size, spacing, and at the location specified in the *Roadway Standard Drawing*. At no time shall dowels be driven into a dowel hole with sledge hammers or other devices. In all cases, any dowel which cannot be freely inserted into a dowel hole will be rejected for use.

Prior to placing concrete, the vertical exposed faces of the existing slabs shall be thoroughly cleaned of contaminates using wire brushing or other methods approved by the Engineer. Extra care must be taken to remove all existing silicone or other joint sealant from the exposed concrete faces.

The concrete shall be deposited within the slab replacement area in such manner as to require as little re-handing as possible, to prevent segregation of the mix. Hand spreading shall be minimized as much as possible, but where necessary, shall be done with shovels, not rakes. Workers will not be allowed to walk in the fresh concrete with shoes coated with earth or other foreign substances. The replaced slab area shall be filled with concrete and thoroughly consolidated by rodding, spading, and sufficient vibration to form a dense homogeneous mass throughout the area. The final surface area shall be uniform in appearance and free of irregularities and porous areas.

The finished surface, including joints, shall meet a surface tolerance of 1/8 inch in 10 feet in any direction. Any necessary corrections shall be done by grinding. Any replaced slab which is low in relation to adjacent slabs may be ordered replaced by the Engineer. Replacement of such a slab would generally be required if, in the opinion of the Engineer, excessive grinding of the adjacent pavement is necessary to match the profile of the full depth slab replacement or if a drainage problem would be created by grinding the adjacent pavement.

The surface finish of the proposed concrete pavement shall be a burlap drag finish and conform to the cross-section of adjacent pavement. The method of finishing shall be approved by the Engineer. Immediately after finishing operations have been completed and surface water has disappeared, all exposed surfaces of the pavement shall be cured in accordance with the applicable provisions of Section 700-9 and Section 1026.

(B) Patching Concrete Pavement Spalls

When the Contractor is working under a lane closure, concrete patching operations shall be conducted in one lane at a time or as directed by the Engineer. The work shall be accomplished with other operations in progress within the same area.

Clean surfaces within the repair area free of oil, dust, dirt, deteriorated concrete and other contaminates immediately before placement of the epoxy and patching material. Apply epoxy to the vertical and flat surface of the cleaned spall areas prior to placing concrete.

The pavement shall not be opened to traffic until the concrete is appropriately cured per the manufacturer's recommendations.

723-4 Very High Early Strength Concrete for Concrete Pavement Repair

Submit mix designs for Very High Early Strength Concrete for Concrete Pavement Repair in terms of saturated surface dry weights on *Materials & Tests Form 312U* for acceptance at least 30 days before proposed use. Mix designs shall meet the design requirements provided in Article 1000-5 and Table 1000-7 for Very High Early Strength Concrete for Concrete Pavement Repair.

Design and produce a concrete mix that can produce 400 psi flexural strength in approximately 4 hours. The timing of the addition of hydration control admixtures is critical to the performance of this concrete; therefore, an admixture representative shall be present on the job when Very High Early Strength Concrete is batched. With permission of the Engineer, compressive strength testing and maturity testing may be used in lieu of or concurrent with flexural strength testing to determine the acceptability of the concrete in the field.

723-5 MEASUREMENT AND PAYMENT

The quantity of *Repair of Jointed Concrete Pavement Slab* to be paid for at the unit price established herein will be the actual number of square yards of jointed concrete pavement with dowels which has been completed and accepted. In measuring this quantity, the width of the repair will be measured perpendicular to the centerline of the lane. The length will be the actual length constructed, measured along the centerline of the pavement.

The unit price for *Repair of Jointed Concrete Pavement Slabs* will be full compensation for all work covered including furnishing all labor, materials, tools, equipment, and incidentals for doing all work involved in placement of the concrete including but not limited to furnishing placing, and curing concrete; dowel bars; sawing and removing concrete; and filling saw cuts around the pavement repair.

The quantity of *Select Material, Class IV* to be paid for at the unit price established herein will be the actual number of tons of aggregate which has been incorporated into the completed and accepted work. The aggregate will be measured by being weighed in trucks on certified platform scales or other certified weighing devices. No deductions will be made for any moisture contained in the aggregate at the time of weighing.

The unit price for *Select Material, Class IV* will be full compensation for all work including but not limited to, removing of existing aggregate base course and backfilling with *Select Material, Class IV.*

The quantity of material removed from beneath the base course as *Undercut Excavation* will be measured and paid for in accordance with Article 225-7.

The quantity of *Geotextile for Soil Stabilization* furnished and placed as directed by the Engineer will be measured and paid for in accordance with Article 270-4.

Patching Concrete Pavement Spalls to be paid will be the actual number of square feet of existing concrete which has been patched and accepted. The actual length and width of each completed patch will be measured along the surface of the patch. The price and payment will be full compensation for work involved including furnishing labor, materials, tools, equipment and incidentals for sawing concrete pavement, removing deteriorated concrete, cleaning surfaces, epoxying, furnishing, placing, finishing, and curing concrete patch.

Payment will be made under:

Pay Item	Pay Unit
Repair of Jointed Concrete Pavement Slabs	Square Yard
Select Material, Class IV	Ton
Patching Concrete Pavement Spalls	Square Foot

SECTION 724
NONWOVEN GEOTEXTILE INTERLAYER

724-1 DESCRIPTION

Furnish and install a non-woven geotextile interlayer at locations shown on the plans. Schedule a Pre-Pave Meeting with the Engineer at least 3 weeks prior to paving to discuss installation and construction procedures for the nonwoven geotextile interlayer with representatives from the Contractor including Paving Superintendent, Subcontractor and Geotextile Manufacturer. Submit for approval a Process Control Plan addressing the nonwoven geotextile interlayer certification process in accordance with Article 700-1.

724-2 MATERIALS

The geotextile interlayer shall be constructed of a non-woven needle-punched geotextile, with no thermal treatment (calendaring or IR). The material shall be resistant to chemicals, mildew, and rot and shall not have any tears or holes that will adversely affect the in-situ performance and physical properties of the installed material.

Furnish with each shipment a Type 3 Certification in accordance with Article 106-3 certifying that the paving mat is a non-woven needle-punched geotextile with no thermal treatment (calendaring or IR) meeting the requirements in Table 724-1.

TABLE 724-1

PHYSICAL PROPERTIES OF NON-WOVEN GEOTEXTILE INTERLAYER

Property	Test Method	Units	Value
Minimum Mass per unit area	ASTM D 5261	oz/yd^2	15.0
Minimum thickness under load (a) at 2 kPa (0.29 psi) (b) at 20 kPa (2.9 psi) (c) at 200 kPa (29 psi)	ASTM D 5199	in	(a) 0.12 (b) 0.10 (c) 0.04
Minimum wide-width tensile strength	ASTM D 4595	lb/ft	685
Maximum wide-width elongation	ASTM D 4595	%	130
Minimum water permeability in normal direction under load (pressure) at 20 kPa (2.9 psi)	Mod. ASTM D 5493 or ASTM D 4491	ft/s	$3.3x10^{-4}$
Minimum in-plane water permeability (transmissivity) under load (pressure) (a) at 20kPa (2.9 psi) (b) at 200kPa (29 psi)	Mod. ASTM D 6574 or ASTM D 4716	ft/s	(a) $1.6x10^{-3}$ (b) $6.6x10^{-4}$
Minimum weather resistance retained strength	ASTM D 4355 at 500 hrs. exposure	%	60
Alkali resistance, minimum polypropylene/polyethylene	Manufacturer certification of polymer	%	96

Requirements must be met for 95% of the samples.

724-3 GENERAL REQUIREMENTS

A trained and experienced installer, certified by the Geotextile Manufacturer, shall be present on-site during the installation of the geotextile and until the Engineer accepts that the crew has a comfort level working with this material. Handle and store geotextiles in accordance with Article 1056-2.

Ensure that any potential for keying of the two cementitious layers is minimized through proper repair techniques. Clean the underlying surface to remove loose debris before applying the interlayer. Roll the geotextile out on the underlying layer. The geotextile shall be tight and without excess wrinkles and folds. No more than 650 feet of geotextile shall be installed in advance of the paving operation at a given time. The interlayer shall be placed no more than 24 hours before concrete placement, unless otherwise approved by the Engineer.

Keep driving on the interlay to a minimum, restricted to concrete paving operations only. Tight radius turns and excessive acceleration and braking shall be avoided.

The geotextile shall be secured to the underlying layer with pins or nails punched through 2 to 2.75 inch galvanized washers or disks every 6 feet or less. Additional fasteners shall be used as needed to ensure that the geotextile does not shift or fold before or during concrete

placement. Edges of the geotextile shall overlap by 8 inches ± 2 inches. No more than 3 layers of geotextile shall overlap at any location. Transverse seams of adjacent rolls shall be staggered to prevent 4 layers from coinciding at any location. The free edge of the geotextile shall extend beyond the edge of the new concrete into a location that facilitates drainage.

724-4 MEASUREMENT AND PAYMENT

Nonwoven Geotextile Interlayer will be measured and paid at the contract unit price per square yard. In measuring this quantity, the length will be the actual length installed, measured along the surface. The width will be the width measured along the underlying layer that has been acceptably placed. No separate measurement will be made for the overlapping fabric.

The contract prices for this section shall include but not be limited to, furnishing all labor, materials, tools, equipment and other incidentals necessary to perform the required work.

Payment will be made under:

Pay Item	Pay Unit
Nonwoven Geotextile Interlayer	Square Yard

SECTION 725
FIELD LABORATORY FOR PORTLAND CEMENT CONCRETE PAVEMENT

725-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, providing and maintaining the building or trailer and the curing shelter for the exclusive use of the Engineer at concrete plants producing Portland cement concrete for use in pavement to be constructed on the project; furnishing water, heat, electricity and other utility services; and any other equipment that may be necessary.

725-2 GENERAL REQUIREMENTS

Furnish and maintain for the exclusive use of the Engineer a field office and laboratory in which to house and use all testing equipment needed. Only Department representatives will have unattended access to these facilities.

Provide a field office that is dust and water tight, floored, and has an adequate foundation so as to prevent excessive floor movement. Provide a field office that contains 6 or more 110 V electrical double outlets properly grounded and spaced; a telephone with telephone service; Internet Connection Service with modem with ethernet port for Wi-Fi; at least 2 windows, satisfactory locks on all doors and windows; adequate lighting, heating and air conditioning; sink; running water to sink; and satisfactory exhaust fan. Provide an OSHA compliant field office that meets the following approximate minimum requirements: 200 sf of floor space; 9 feet interior width; 6.5 feet interior height; 20 sf of counter space, 2.5 feet to 3 feet high and 2 feet deep with cabinets or drawers below the counter top; and 6 sf of desk space not enclosed with cabinets. Locate the office in a position that will permit full view of the plant from the interior of the office. At or near the office, furnish toilet facilities, with waste disposal, available for use of the Department personnel. Maintain these toilets in a neat and clean condition.

Provide a laboratory trailer adjacent to the field office that is at least 400 sf in area, approximately 20 feet wide, 20 feet long and 7 feet in height. Provide a laboratory trailer that contains 6 or more 110 V electrical double outlets properly grounded and spaced; satisfactory locks on all doors and windows; adequate lighting, heating and air conditioning; sink; running water to sink; and satisfactory exhaust fans. Provide two workbenches that are approximately 10 feet long, 2 feet wide and 2.5 feet high. One workbench shall be installed inside the trailer and the other across the end of the trailer. Provide a shelter or roof over the outside

workbench to provide protection from weather. Provide, in the laboratory, an adequate number of water storage tanks to hold all acceptance beams and cylinders and any additional beams and cylinders made for the purpose of determining early strengths.

Construct the water storage tanks of non-corroding materials and have requirements for automatic control of the water temperature. Maintain the water in the tank at a temperature of 73°F ± 3°F. Equip each tank with a recording thermometer with its bulb located in the water. Provide sufficient tank volume to maintain all beams and cylinders, stored with the long axis vertical, in a fully submerged condition for the duration of the required curing period. Furnish a wooden mixing board at least 3/4 inch thick and approximately 4 feet wide and 4 feet long that is covered on one side with sheet metal of at least 22 gauge, at the shelter. Provide facilities to maintain the test beams and cylinders at temperature between 60°F and 80°F during initial curing.

725-3 MEASUREMENT AND PAYMENT

Field Laboratory Rental, Portland Cement Concrete Pavement will be paid at the contract lump sum price which will be made for furnishing and maintaining all field laboratories available for use by the Engineer at any concrete plant producing Portland cement concrete for use in pavement to be constructed on the project. Partial payments for field laboratory rental will be made with the first and last partial pay estimates which include concrete pavement or concrete shoulders. Payments will be made at the rate of 50% of the lump sum price for *Field Laboratory Rental, Portland Cement Concrete Pavement* on each of these partial pay estimates.

Payment will be made under:

Pay Item	Pay Unit
Field Laboratory Rental, Portland Cement Concrete Pavement	Lump Sum

SECTION 730
MILLED RUMBLE STRIPS ON CONCRETE SHOULDERS

730-1 DESCRIPTION

Mill rumble strips on Portland cement concrete shoulders in accordance with the plans, and as directed by the Engineer.

730-2 EQUIPMENT

Provide equipment consisting of a rotary type cutting head with an outside diameter of no more than 24 inches and no less than 16 inches long. Provide a cutting head that has the cutting tips arranged in such a pattern as to provide a relatively smooth cut as well as a cutting head that is on its own independent suspension from that of the power unit to allow the tool to self-align with the slope of the shoulder and/or any irregularities in the shoulder surface. Provide a cutting tool equipped with guides to establish consistent alignment and uniformity of each cut in relation to the roadway.

730-3 CONSTRUCTION METHODS

Demonstrate the ability to achieve desired surface inside each depression without tearing or snagging the Portland cement concrete prior to beginning the work.

Provide rumble strips that have finished dimensions and pattern in accordance with the *Roadway Standard Drawings*.

Material resulting from the operation shall become the property of the Contractor. Remove and dispose of material in accordance with Section 802.

Remove all equipment to a location where it does not present a traffic hazard and clean pavement before reopening work area to traffic.

730-4 MEASUREMENT AND PAYMENT

Milled Rumble Strips (Concrete Shoulder) will be measured and paid as the actual number of linear feet of shoulder, measured longitudinally along the surface of each shoulder, where rumble strips have been constructed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Milled Rumble Strips (Concrete Shoulder)	Linear Foot

DIVISION 8
INCIDENTALS

SECTION 800
MOBILIZATION

800-1 DESCRIPTION

This work consists of preparatory work and operations to mobilize personnel, materials and equipment to the project site.

800-2 MEASUREMENT AND PAYMENT

Mobilization will be paid as contract lump sum price.

Partial payments for *Mobilization* will be made with the first and second partial pay estimates paid on the contract and will be made at the rate of 50% lump sum price on each of these partial pay estimates, provided the amount bid for *Mobilization* does not exceed 5% of the total amount bid for the contract. Where the amount bid for *Mobilization* exceeds 5% of the total amount bid for the contract, 2.5% of the total amount bid will be paid on each of the first two partial pay estimates. That portion exceeding 5% will be paid on the last partial pay estimate.

As an exception to the above, where the work covered by the contract is limited exclusively to the resurfacing of an existing pavement, payment of the entire lump sum price for *Mobilization* will be made with the first partial pay estimate paid on the contract, provided the amount bid does not exceed 5% of the total amount bid for the contract. Where the amount bid for *Mobilization* exceeds 5% of the total amount bid for the contract, 5% of the total amount bid will be paid on the first partial pay estimate. That portion exceeding 5% will be paid on the last partial pay estimate.

Such price and payment includes, but is not limited to, the movement of personnel, equipment, supplies and incidentals to the project site, for the establishment of offices, buildings and other facilities necessary for work on the project; the removal and disbandment of those personnel, equipment, supplies, incidentals or other facilities that were established for the prosecution of work on the project; and for all other work and operations that shall be performed for costs incurred before beginning work on the various items on the project site.

For projects that have a delayed availability date of 90 calendar days or more after contract execution, the first mobilization payment may be for the verified actual cost of paid bond premiums. This payment will only be made upon request by the contractor with supporting documentation including invoice and proof of payment. This payment will be limited to 1% of the amount bid for the contract and the subsequent mobilization payment will be reduced by an equal amount to follow the payment schedule as shown above. In no case will more than 5% of the amount bid for the contract be paid before the last partial pay estimate.

Payment will be made under:

Pay Item	Pay Unit
Mobilization	Lump Sum

SECTION 801
CONSTRUCTION STAKES, LINES AND GRADE

801-1 DESCRIPTION

When required by the contract, provide all construction layout, surveying, stakeout, supplemental surveying and engineering necessary for the proper control of construction operations in accordance with this section and the *Manual for Construction Layout*. Provide a stakeout of areas where an environmental permit is required before performing any construction in or adjacent to these areas. Stake out limits of the permitted work areas according to the approved permit drawings. Provide clear delineation by use of highly visible flagging. Ensure construction limits do not exceed approved permitted work areas. Immediately notify the Engineer of any variations of the stakeout limits when compared to the approved permit drawings.

The *Manual for Construction Layout* and the *Guidelines for Drainage Studies and Hydraulic Design* is available on the Department's website.

801-2 CONSTRUCTION METHODS

(A) General

Furnish personnel who are under the direct supervision of the Contractor's project engineer or a land surveyor licensed by the State of North Carolina in conformance with NCGS § 89C.

Furnish personnel who are experienced in highway construction surveying and are capable of accurately establishing all line and grade points necessary to complete the work in accordance with the plan dimensions within the precision established in the *Manual for Construction Layout*. Consult the Engineer for clarifications of the plans.

Perform work in safe manner and conform to Article 107-21. Perform all flagging operations in accordance with Section 1150.

The Contractor may elect to use global positioning system (GPS) surveying, either static or kinematic. Perform GPS surveys with same or higher order of accuracy as conventional surveys detailed in the *Manual for Construction Layout*. Department projects use a localized coordinate system developed by the Location and Surveys Unit specifically for each individual project. Obtain the control information that the Location and Surveys Unit used in establishing the localized coordinate system, specifically the rotation, scaling, translation and coordinates for the azimuth pairs. Newly developed GPS procedures and techniques that do not conform to this section may be used, if approved.

Investigate the plan horizontal alignment, vertical profile and super elevation of existing facilities that tie to proposed roadways. Investigate 100 feet beyond all paving limits and revise grades as needed to establish smooth transitions to the existing facilities.

Tie existing driveways to proposed facilities within the limits detailed in the plans and within the gradients detailed in the *Roadway Standard Drawings*.

The Engineer reserves the right to check, correct where necessary or require any layout work to be revised. The Engineer will perform checks to ensure the roadway, structure and incidental items are surveyed in accordance with the plans and the *Manual for Construction Layout*.

The Department's review of the Contractor's work in no way relieves the Contractor of responsibility for conformance with the contract. Failure by the Engineer or inspector to point out unsatisfactory work, from lack of discovery or for any other reason, in no way prevents later rejection or corrections to the unsatisfactory work, when discovered. No claims will be allowed for losses suffered due to any necessary removals or repairs resulting from the unsatisfactory work.

When requested by the Engineer, check the accuracy of the stakeout. Correct all inaccuracies in the construction stakeout before performing the affected work.

When the Contractor proposes an alteration to the plans to rectify a construction stakeout error, submit alterations to the Engineer for review and approval. Include design calculations and drawings sealed by an engineer licensed by the State of North Carolina along with a narrative describing justification for the alteration.

When surveying is required, which in the Contractor's opinion could not have been reasonably anticipated and is not customary or inherent to the construction industry, notify the Engineer in writing before beginning such surveying. After investigation, the following will occur:

(1) When the Engineer determines that the surveying could not have been anticipated or is not customary or inherent to the construction industry, the Contractor will be notified in writing that the work is considered supplemental and measurement and payment will be made in accordance with Article 801-3.

(2) When the Engineer determines that the surveying could have been anticipated or is customary or inherent to the construction industry, he will notify the Contractor, in writing, of his determination. If the Contractor intends to file a claim for additional compensation by reason of such surveying, notify the Engineer in writing of such intent before beginning any of the alleged supplemental surveying. Strictly adhere to Subarticle 104-8(B).

(B) Records

Submit proposed method for setting up survey books or electronic data files to the Engineer before beginning work to assure clarity and adequacy.

Promptly make available to the Engineer all requested survey records.

Provide updates to the Engineer monthly of the electronic and/or manuscript survey records. Submit remaining records upon completion of the work. Attest the work was performed in accordance with the contract by providing all receivable information signed by an engineer or land surveyor licensed by the State of North Carolina and in responsible charge.

(C) Horizontal and Vertical Control

The Department will provide azimuth pairs to be used as primary horizontal and vertical control at approximately 1 mile intervals along the project corridor, and secondary horizontal baseline control on approximate 1,000 foot intervals and secondary vertical control on approximate 2,500 foot intervals within the project limits. Obtain a copy of the electronic survey control files from the Engineer.

Clearing limits may be established during original traverse of baseline control provided the accuracy ratio does not exceed 1 foot per 5,000 feet of perimeter and all Department established baseline control is protected and preserved during clearing operations. Before performing any additional construction layout, verify the horizontal baseline control by a closed traverse survey or alternate approved method based on the established azimuth pairs. The horizontal accuracy ratio shall not exceed an error of closure of 1 foot per 20,000 feet of perimeter. Verify the vertical control by performing a closed loop survey using differential leveling. For the vertical error of closure, do not exceed 0.05 feet times the square root of the miles:

$$\textbf{Error of Closure} \leq 0.05\,ft\sqrt{(x)miles}\ .$$

Notify the Engineer of any discrepancies in either the horizontal or vertical control. Reference, outside of the proposed construction limits and evenly distributed throughout

the project limits, a minimum of 50% of the Department's horizontal and vertical control. Provide reference information to the Engineer.

If GPS is used, occupy the azimuth pairs with the base station during verification of baseline control, otherwise, occupy baseline. Verify remaining baseline control using a Rover. Submit coordinate data showing differences between supplied baseline coordinates and field obtained GPS coordinates. Include report detailing the use of preliminary input data, specifically rotation, scaling and translation.

Using the horizontal and vertical control established by the Department, provide surveying necessary to construct all roadway, structure and miscellaneous items as detailed in the plans. Perform staking in accordance with the *Manual for Construction Layout*. Layout the work and provide all measurements that may be required for the execution of the construction in conformity with the contract.

(D) Right of Way, Control of Access and Easements

The Department will establish the location of all proposed right-of-way markers, control-of-access markers and permanent easements. Validate the position of the markers and permanent easement locations with those detailed in the plans. Report any discrepancies to the Engineer.

Reference the location of all proposed markers and permanent easements. Restore right-of-way and control-of-access monument positions after completion of construction. Set a right-of-way or control-of-access monument cap on an 18 inch (minimum) long #5 reinforcing bar and a carsonite witness stake unless concrete right-of-way and control-of-access markers are specified in the contract. The Department will provide the monument cap and witness stake. Re-establish location of permanent easements after completion of construction and install a permanent easement cap on 18 inch (minimum) long #5 reinforcing bar for monumentation.

Re-establishment and verification of existing monuments or the replacement of existing monuments with other material (concrete R/W markers, new iron pins, etc.), shall be performed under the responsible charge of a North Carolina Professional Land Surveyor (PLS). Verify all right of way, permanent easement, and control-of-access monument positions after completion of construction with signed and sealed attestation by PLS of said verification in accordance with the *Manual for Construction Layout*.

(E) Cross sections for Earthwork Quantities

The Engineer may elect to obtain cross sections either by hand or aerial methods. If the Engineer elects to obtain cross sections by aerial methods, furnish materials and install photogrammetric control panels in accordance with the *Manual for Construction Layout* or as otherwise directed by the Engineer.

(1) Borrow Pits

Establish a baseline alignment or establish horizontal and vertical control on approximate 1,000 foot intervals within each borrow pit, as necessary, to allow the Engineer to obtain measurement of quantities for payment. Stake these alignments just before field cross sections are taken by the Engineer for original, intermediate and final cross sections.

(2) Roadway

Unless otherwise directed, stakeout the survey lines for original and final cross sections. The stakeout of the survey lines will consist of surveying and staking all alignments within the plans on 50 foot intervals, including all cardinal points. When the alignments are inaccessible, install offset alignments. Begin the staking of these alignments within 48 hours of the Engineer's notice to proceed. Upon the completion of the entire project, with the exception of the survey line for final cross sections, and

upon request by the Contractor, the project may be accepted for maintenance by the Department, excluding the survey line.

(F) Drainage and Utility Construction Systems

(1) General

Where underground conflicts are suspected, contact utility owners and locate all utilities horizontally and vertically. Consider the utilities' locations and elevations in the layout of the drainage systems and utility construction systems. Utilities may exist that are not depicted in the plans.

Submit an electronic copy of all layout drawings for drainage systems and utility construction systems to the Engineer for his review and approval. The Engineer will note the review and approval by adding an appropriate note to the drawings along with the date and his signature. The Engineer will retain a copy of the drawings and a copy will be returned to the Contractor.

(2) Drainage Systems

Provide construction layout of drainage systems, as depicted in the plans and in accordance with the *Guidelines for Drainage Studies and Hydraulic Design*. Consider the locations and elevations of all existing and proposed utilities, proposed utility construction and existing and proposed drainage systems, in the layout of the drainage system. Modifications of the drainage plan may be necessary to properly collect and transport water. Advise the Engineer if modifications are needed to achieve the original design functionality and the intent of the drainage plans, such as adjusting the location of a drainage structure, adding a drainage structure and increasing or decreasing pipe lengths. The Engineer will review any major modifications.

Provide layout drawing of the drainage system including calculations of flow line elevations for all drainage structures; pipe invert elevations, both inlet and outlet of the drainage structure; grade of each pipe within the drainage system; elevation of any existing facility connection, such as stream or pipe; headwall location, if depicted in the plans; and locations and elevations of any existing or proposed utilities to the Engineer for review and approval at least 7 days before beginning work on the drainage system. Modification of the submitted drainage layout drawing by the Engineer will not eliminate the Contractor's liability for the accuracy of the information submitted. Any restaking or additional staking required to conform to the approved drainage layout drawing is incidental to the work.

(3) Utility Construction

Provide utility construction layout as detailed in the contract. Consider the locations and elevations of all existing and proposed utilities, proposed utility construction and existing and proposed drainage systems in the layout of the utility construction. Advise the Engineer if modifications to the utility construction plans are necessary. The Engineer will review any major modifications.

Provide layout drawing of the utility construction system including elevations of any existing utilities, drainage systems and/or proposed drainage systems to the Engineer for review and approval at least 7 days before beginning work on the utility construction system. Modification of the submitted utility construction layout drawing by the Engineer will not eliminate the Contractor's liability for the accuracy of the information submitted. Any restaking or additional staking required to conform to the approved utility layout drawing is incidental to the work.

(G) Structures

Provide surveying and calculations necessary to construct structures in accordance with the plans. Provide staking in accordance with the *Manual for Construction Layout*. Establish

horizontal alignment of entire structure. Set at least one benchmark adjacent to the structure site that will be retained throughout the structure construction. The Engineer will furnish the finished construction elevations for use in determining the required construction elevations for bridges. Provide method for computing buildups over beams, screed grades and overhang form elevations to the Engineer for review before staking these items to assure clarity and adequacy.

Submit an electronic copy of structure layout drawings to the Engineer for his review and approval. The Engineer will independently verify and accept the structure layout before the structure construction may begin. The Engineer will note the review and approval by adding an appropriate note to the drawings along with the date and his signature. The Engineer will retain a copy of the drawings and a copy will be returned to the Contractor.

If structure phasing or damaged stakes require significant resurveying during the life of the structure, provide revised layout drawing for the Engineer's verification and acceptance.

(H) Signs

Stake horizontal locations of all overhead and Type A and B ground-mounted signs for Engineer's verification before obtaining S-dimensions. Measure or calculate overhead and ground-mounted sign S-dimensions in accordance with the plans and the *Manual for Construction Layout*. Perform investigation of proposed sign locations and notify the Engineer of any obstructions, either existing or proposed, that may interfere with the proposed sign installation. Provide an 11 inch x 17 inch drawing depicting the theoretical finished section at each proposed overhead sign assembly location. Include within the submittal the roadway, shoulder and slope gradients. Include the proposed finish elevations of the edges of pavement, each lane line and the ground at each proposed sign footing location. Set a slope stake at each proposed overhead sign location to ensure the slopes are constructed as calculated and detailed in the above submittal. Submit sign information to the Engineer. Stake horizontal locations of all ground mounted and barrier mounted signs.

801-3 MEASUREMENT AND PAYMENT

Construction Surveying will be paid at the contract lump sum price for the work detailed in this section.

Partial payments will be made on each particular payment estimate based upon the percentage complete of *Construction Surveying* as determined by the Engineer. The Contractor shall submit a certified statement each month indicating the percentage of *Construction Surveying* work completed. The Engineer will determine if the amount indicated is reasonably correct and the Engineer will pay accordingly on the next partial pay estimate.

Establishment of baseline alignments within each borrow pit is incidental to *Construction Surveying.*

Supplemental Field Surveying will be measured and paid as the actual number of hours the Contractor's survey crew is actively engaged in performing the following:

(A) Investigative surveying, in excess of 100 feet of horizontal alignment, vertical profile and superelevation of existing facilities that tie to proposed roadways.

(B) Surveying specifically for the relocation of utility conflicts.

(C) Investigation of a previous stakeout when such stakeout is found to be correct.

(D) Surveying that the Engineer has deemed could not have been anticipated or is not customary or inherent to the construction industry.

(E) The stakeout of the roadway survey alignments for intermediate cross sections when deemed necessary by the Engineer.

If the Engineer determines intermediate cross sections are not necessary for computing partial payments, the intermediate stakeout of the survey line is incidental to the work.

Supplemental Surveying Office Calculations will be measured and paid as the actual number of hours the Contractor's survey personnel is actively engaged in performing office calculations specifically associated with Subarticles 801-3(A) through 801-3(E).

Supplemental Surveying Office Calculations will be paid at the stated price of $85.00 per hour. *Supplemental Field Surveying* will be paid at the stated price of $145.00 per hour. The payment includes furnishing personnel, all surveying equipment, stakes, layout drawings, calculations, stakeout records and any materials and equipment necessary to perform the surveying and engineering work.

If the Engineer directs that the accuracy of the original stakeout be checked and the stakeout is found to be in error, perform the work required to check and correct the stakeout at no cost to the Department.

Exploratory Excavation required to locate a utility not identified in the plans will be paid in accordance with Article 104-7.

Work Zone Signs (Portable) will be paid in accordance with Article 1110-4.

Flaggers will be paid by the day in accordance with Article 1150-4.

Any payments for *Supplemental Field Surveying* or *Supplemental Surveying Office Calculations* required by this section will be paid on the appropriate partial payment estimate.

Payment will be made under:

Pay Item	Pay Unit
Construction Surveying	Lump Sum
Supplemental Field Surveying	Hour
Supplemental Surveying Office Calculations	Hour

SECTION 802
DISPOSAL OF WASTE AND DEBRIS

802-1 DESCRIPTION

The work consists of the disposal of waste and debris including, but not limited to, furnishing any waste areas; providing and implementing a Development, Use and Reclamation Plan; any right of access to waste areas; disposing of waste and debris; dressing and shaping of waste areas; furnishing and spreading earth material over debris, rock, broken pavement and masonry; clearing and grubbing of waste areas; hauling waste and debris to waste areas or permitted landfills; assessment for wetlands and endangered species; obtaining required permits or certifications; and any tipping fees required for disposal in permitted landfills.

Define "waste" as all excavated materials that are not used in the construction of the project, including overburden from borrow sources and soil-type base course sources.

Define "debris" as all undesirable material encountered on the project.

802-2 GENERAL REQUIREMENTS

Follow the most recent reclamation procedures found on the Department's website for all waste sites. Before the removal of any waste from any project, obtain certification from the State Historic Preservation Officer of the State Department of Cultural Resources certifying that the deposition of the waste material to the proposed waste area will have no effect on any known district, site building, structure or object, architectural or archaeological, that is included, or eligible for inclusion, in the National Register of Historic Places. Furnish a copy of this certification to the Engineer before performing any work in the proposed waste site.

Provide an area and dispose of waste and debris outside of the right of way, unless otherwise allowed by written request. Limit the materials placed in non-permitted disposal areas to clean soil, rock, concrete, brick, other inert materials and bituminous asphalt when placed at least 4 feet above the water table. Mixtures of soil and vegetation, that are primarily soil, may be placed in non-permitted disposal areas. Place all other debris in sites permitted by the Solid Waste Management Division of NCDEQ, unless otherwise approved.

Maintain the earth surfaces at all waste areas in a manner that will effectively control erosion and siltation until final acceptance of the project.

Shape the waste or disposal area to drain such that no water will collect or stand. Provide a functioning drainage system.

Shape rock and earth waste to contour and blend with the adjacent topography. Cover all rock, concrete, broken pavement and masonry with a minimum 6 inch thick layer of earth material from the project or borrow. Earth material should be tested to insure it will support long-term growth of the proposed ground cover and should be amended as necessary to support permanent growth. As an exception, side slopes constructed of all rock material will not require earth covering. Construct all slopes, other than rock, 2:1 or flatter. Construct rock slopes on a stable angle of repose.

Where the Engineer has granted permission to dispose of waste within the right of way, the Engineer will have the authority to establish whatever additional requirements may be necessary to insure the satisfactory appearance and drainage of the completed project.

Where electing to dispose of waste or debris in active public waste or disposal sites, provide evidence satisfactory to the Engineer that the Solid Waste Management Division of NCDEQ has permitted the proposed area or site.

Where electing to dispose of waste in a waste or disposal area, other than active public waste or disposal areas permitted by the Solid Waste Management Division of NCDEQ or on the Department's right of way or an existing borrow pit, submit jointly with the property owner a notarized Development, Use and Reclamation Plan for each waste or disposal area proposed for use.

As part of the Reclamation Plan, perform the following before wasting:

(A) Material Description

Detail the type of waste material proposed in the area. Only material originating from the Department's projects and complying with the Solid Waste Disposal Act will be permitted within the proposed waste or disposal area.

(B) Topography

Detail the existing topography and locations of the proposed access and egress haul roads. Detail the proposed final topography of the waste or disposal area showing any proposed drainage systems. If a pond is to be constructed or remain, the minimum depth shall be at least 4 feet as determined from the water table at the time the reclamation plan is executed. The slope of the soil below the water shall be between 5:1 and 2:1. The slope of the sides above the water line shall be 2:1 or flatter.

(C) Slopes

Rock and earth waste shall be shaped to contours that are compatible to and blend with the adjacent topography. Cover all rock with a minimum 6 inch layer of earth material either from project waste or from borrow. As an exception, side slopes constructed of all rock material will not require earth covering. Construct all slopes at a 2:1 or flatter except rock slopes that shall be on a stable angle of repose.

(D) Construction Debris

Cover construction debris and all broken pavement and masonry with a minimum 6 inch thick layer of earth waste material from the project or borrow. Shape the completed waste area as required above for the disposal of earth or rock waste.

(E) Erosion Control

Detail the temporary and permanent erosion control measures, along with design calculations, that are intended during use of the site and as part of the reclamation. Unless considered impractical due to special circumstances, provide in the plan for the use of staged permanent seeding and mulching and appropriate fertilizer topdressing on a continual basis during site use and the immediate total reclamation of the site when the site is no longer needed. Define the seed mixture proposed for establishing temporary and/or permanent vegetation. Establish permanent stand of vegetation before acceptance of project.

(F) Evaluation for Potential Wetlands and Endangered Species

Hire an experienced environmental consultant on the Department's approved list to perform an assessment of the waste site for potential conflicts with wetlands, areas of environmental concern, federally listed threatened or endangered species, and federal species of concern.

Delineate the boundaries of any wetlands or jurisdictional surface waters (streams) encountered. Follow the standard practice for documenting the wetland delineation including completion of the USACE's approved *Wetland Determination Data Form*. Document information including data regarding soil, vegetation and hydrology. Maintain a minimum 25 foot buffer adjacent to all sides of the wetland boundary and a minimum 50 foot buffer adjacent to any stream. Depict the limits of the delineated wetland and surrounding buffer on the Reclamation Plan. Do not dispose of waste and debris in any area under the USACE' or any other environmental agencies' regulatory jurisdiction unless and until the NCDOT permit has been modified to permit such disposal activity in the jurisdictional area.

Perform a site assessment for federally listed threatened or endangered species to include habitats that may support these species. Provide to the Engineer a detailed report on the assessment findings. If federally listed threatened or endangered species, or habitat that may support such species, exist on the proposed waste site, notify the Engineer before continued pursuit of such site.

(G) Buffer Zones

Allocate sufficient area between the nearest property line and the tie-in of the slope to natural ground to allow for the operation of excavation, hauling, and seeding equipment and for the installation of any and all erosion control devices required. Leave additional undisturbed area between the source and any watercourse or body to prevent siltation of the watercourse or body and the movement of the shore line either into the watercourse or body or into the waste areas. Determine if the adjoining property owners or other government agencies require any additional buffer zones and comply with those requirements. [Suggested minimum distances are 10 feet from property lines and 50 feet from water bodies or watercourses.] Do not place waste material within the 100-year floodplain unless superseded by an environmental permit.

(H) Approval

Obtain written approval from the Engineer before wasting within the proposed waste or disposal area.

Submit a revised or additional reclamation plan to the Engineer if the non-permitted waste or disposal area is expanded by more than one acre or is significantly changed from the previously approved submittal.

802-3 MEASUREMENT AND PAYMENT

Seeding and mulching, fertilizer topdressing and establishing erosion control measures for waste or disposal areas will be measured and paid at the contract unit prices for the items established in the contract.

When permitted to waste within the right of way and when the waste area requires additional covering material before seeding, provide covering material at no cost to the Department.

When waste areas are located outside the right of way, no payment will be made for any borrow used to cover rock, broken pavement, masonry or other inert materials.

Except as otherwise provided above, no direct payment will be made for the work covered by this section. Payment at the contract prices for the various items in the contract will be full compensation for all work covered by this section.

SECTION 806
RIGHT-OF-WAY AND CONTROL-OF-ACCESS MARKERS

806-1 DESCRIPTION

Furnish and install precast concrete or granite markers to mark the boundaries of the right of way or the control of access in accordance with the contract.

806-2 MATERIALS

Refer to Division 10.

Item	Section
Steel Bar Reinforcement	1070-2
Precast Concrete Units	1077

The Contractor may, at his option, use either granite or concrete markers. Make granite markers from granite that is hard and durable, of a light color, free from seams which impair its structural integrity, and of a good, smooth splitting appearance.

806-3 CONSTRUCTION METHODS

Precast the right-of-way and control-of-access markers in watertight forms of a size and shape that will produce a completed marker of the dimensions shown in the *Roadway Standard Drawings*. Construct the forms so as to impress the concrete with the lettering and markings shown in the contract.

Cure the concrete in accordance with Article 420-15. Give that portion of the marker that will be above the surface of the ground ordinary surface finish in accordance with Subarticle 420-17(B).

If using granite markers, quarry and finish the markers to the dimensions indicated in the contract. Drill holes will be permitted in the sides and bottom.

Install the markers vertically in the ground to the depth and locations specified in the contract. Thoroughly tamp backfill material.

806-4 MEASUREMENT AND PAYMENT

Right-of-Way Markers will be measured and paid in units of each for the actual number of right-of-way markers furnished, installed and accepted.

Control-of-Access Markers will be measured and paid in units of each for the actual number of control-of-access markers furnished, installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Right-of-Way Markers	Each
Control-of-Access Markers	Each

SECTION 808
OBLITERATION OF EXISTING ROAD

808-1 DESCRIPTION

The work covered by this section consists of the obliteration of an existing road outside of the construction limits.

808-2 CONSTRUCTION METHODS

Remove any existing pavement as directed. Fill or grade and shape the entire roadway to a degree that will blend with the adjacent topography and suitable for the application of vegetative cover.

808-3 MEASUREMENT AND PAYMENT

Removal of Existing Asphalt Pavement and *Removal of Existing Concrete Pavement* will be measured and paid in accordance with Article 250-3. The work includes, but is not limited to, all breaking up, removing, and disposing of pavement; all plowing of the roadbed; and all grading and excavation necessary to reshape the roadway.

All materials excavated in obliterating the abandoned roadway will be paid at the contract price for *Unclassified Excavation* in accordance with Article 225-7.

Any additional material that is required to complete the reshaping of the roadway will be paid at the contract unit price for *Unclassified Excavation* in accordance with Article 225-7 or at the contract unit price for *Borrow Excavation* in accordance with Article 230-5, depending on the source of the material.

All seeding and mulching performed on obliterated areas will be paid at the contract unit prices for the items established in the contract.

SECTION 815
SUBSURFACE DRAINAGE

815-1 DESCRIPTION

Construct subsurface drains, underdrains, blind drains and other types of drains in accordance with the contract or as directed by the Engineer. Install painted markers to locate concrete pads for drains as shown in the plans. This section does not apply to shoulder drains; see Section 816.

815-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextile for Subsurface Drains, Type 1	1056
Pavement Marker Paint	1087
Portland Cement Concrete, Class B	1000
Select Material, Class V	1016
Steel Marker Paint	1080-11
Steel Markers	1072-2
Subsurface Drainage Materials	1044

Use Class B concrete for concrete pads. Provide Type 1 geotextile for filtration geotextiles. Provide subdrain coarse aggregate for subsurface drains and subdrain fine aggregate for

underdrains and blind drains. For drain pipes, use pipes with perforations that meet Article 1044-6 or 1044-7.

815-3 CONSTRUCTION METHODS

Excavate trenches as necessary in accordance with the contract or as directed. Install blind drains at a depth of 4 to 6 feet below subgrade elevation. Install subdrain pipes for subsurface drains and underdrains at a depth of 4 to 6 feet below subgrade elevation unless the subgrade will be proof rolled. For subsurface drains and underdrains in subgrades that will be proof rolled, install subdrain pipes at a depth of 6 feet below subgrade elevation.

Do not leave filtration geotextiles exposed for more than 7 days before covering with material. For subsurface drains, line trench with filtration geotextiles and overlap adjacent geotextiles at least 18 inches. Overlap geotextile closures on top of subdrain coarse aggregate at least 6 inches and secure with mechanical ties.

Install continuous perforated drain pipes with perforations point down. Provide subdrain pipes with positive drainage towards outlets. Firmly connect subdrain pipes together as needed. Place perforated subdrain pipes with perforations down except for pipes in dry materials, in which case turn perforations up or use non-perforated pipes. For concrete pipes in dry materials, construct joints that meet Subarticle 300-6(A).

Place subdrain aggregate beneath, around and over subdrain pipes such that pipes are covered by at least 6 inches of aggregate unless shown otherwise in the plans. Do not displace or damage subdrain pipes while placing and compacting subdrain aggregate. Lightly compact backfill material such that settlement is minimized.

Use solvent cement for connecting Schedule 40 PVC outlet pipes and fittings such as wyes, tees and elbows. Provide connectors for outlet pipes and fittings that are watertight and suitable for gravity flow conditions. Cover open ends of outlet pipes with rodent screens as shown in the plans.

Connect drains to concrete pads or existing drainage structures at ends of outlet pipes. Construct concrete pads and provide an ordinary surface finish in accordance with Section 825. Install steel and pavement markers at concrete pads as shown in the plans.

Allow drains to function for up to 30 days or a sufficient time as determined by the Engineer before undercutting, proof rolling or constructing embankments over drains.

815-4 MEASUREMENT AND PAYMENT

Subdrain Excavation will be measured and paid in cubic yards. Excavation will be measured based on the trench width shown in the plans or approved by the Engineer and the actual trench depth as determined by the Engineer. The contract unit price for *Subdrain Excavation* will be full compensation for excavating trenches and backfilling above subdrain aggregate.

Geotextile for Subsurface Drains will be measured and paid in square yards. Filtration geotextiles in a trench will be measured in place based on the subdrain aggregate width shown in the plans or approved by the Engineer and the actual aggregate depth as determined by the Engineer. No additional payment will be made for overlapping geotextiles. The contract unit price for *Geotextile for Subsurface Drains* will be full compensation for supplying, transporting and installing filtration geotextiles and mechanical ties.

Subdrain Fine Aggregate and *Subdrain Coarse Aggregate* will be measured and paid in cubic yards. Subdrain aggregate in a trench will be measured in place based on the aggregate width shown in the plans or approved by the Engineer and the actual aggregate depth as determined by the Engineer. When subdrain aggregate is not placed in a trench, aggregate will be measured in place based on the aggregate dimensions shown in the plans or as determined by the Engineer. The contract unit prices for *Subdrain Fine Aggregate* and *Subdrain Coarse Aggregate* will be full compensation for furnishing, hauling, handling, placing, compacting and maintaining subdrain aggregate.

__" *Perforated Subdrain Pipe* and __" *Outlet Pipe* will be measured and paid in linear feet. Pipes will be measured in place as the pipe length, including fittings, to the nearest 0.1 feet with no deduction for fittings. The contract unit prices for __" *Perforated Subdrain Pipe* and __" *Outlet Pipe* will be full compensation for supplying, transporting and installing pipes, fittings and rodent screens and making joint connections.

Subdrain Pipe Outlets will be measured and paid in units of each. Outlets will be measured as the number of concrete pads or connections to existing drainage structures. The contract unit price for *Subdrain Pipe Outlets* will be full compensation for concrete pads including furnishing concrete, constructing pads and providing and placing markers and connecting pipes to existing drainage structures including cutting into structures, removing existing paved ditches and grouting around connections.

Payment will be made under:

Pay Item	Pay Unit
Subdrain Excavation	Cubic Yard
Geotextile for Subsurface Drains	Square Yard
Subdrain Fine Aggregate	Cubic Yard
Subdrain Coarse Aggregate	Cubic Yard
__" Perforated Subdrain Pipe	Linear Foot
__" Outlet Pipe	Linear Foot
Subdrain Pipe Outlet	Each

SECTION 816
SHOULDER DRAINS

816-1 DESCRIPTION

Construct shoulder drains and furnish and install painted pavement markers and vertical markers to locate concrete pads for the drains in accordance with the requirements of the contract.

816-2 MATERIALS

Refer to Division 10.

Item	Section
Corrugated Plastic Pipe and Fittings	1044-7
Corrugated Steel Pipe and Fittings	1044-5
Geotextile for Shoulder Drains, Type 1	1056
Outlet Pipe	1044-8
Pavement Marker Paint	1087
PVC Pipe	1044-6
Portland Cement Concrete, Class B	1000
Shoulder Drain Aggregate, No. 57 Stone	1005
Steel Marker	1072-2
Steel Marker Paint	1080-11

Use Class B concrete for concrete pads. Provide Type 1 geotextile for filtration geotextiles. Material for shoulder drain pipe and fittings may be concrete, corrugated steel or corrugated plastic.

816-3 CONSTRUCTION METHODS

Excavate the trench to the width, depth, lines and grades shown in the plans unless otherwise directed.

Do not leave filtration geotextiles exposed for more than 7 days before covering with material. Overlap adjacent filtration geotextiles at least 18 inches. Overlap geotextile closures at the top of the trench at least 6 inches and secure with mechanical ties. Where outlet pipes pass through

geotextiles, wrap a separate piece of geotextile around the outlet pipe, flare against the side of the filled drain and secure with anchor pins.

Anchor field splices of geotextile with anchor pins to ensure that required overlap is maintained.

Perform aggregate placement operations and the pipe installation to prevent damage to filtration geotextiles. Replace damaged sections of geotextiles.

Firmly join together corrugated steel pipe sections with coupling bands, a smooth sleeve type coupler or other approved mechanical methods.

Solvent cement the Schedule 40 PVC pipe and fittings together. Connect the HDPE pipe with watertight neoprene connectors that are suitable for gravity flow conditions. Obtain approval for all pipe fittings from the Engineer before delivery. Protect the open end of all outlet pipes with a galvanized rodent screen as shown in plans. When the pipe perforations are not distributed uniformly over the circumference of the pipe, lay perforated pipe with the perforated segments of the pipe down. When plain pipe is called for by the plans, turn the perforations up or use non-perforated pipe.

Install outlet fittings and outlet pipes with aggregate shoulder drains. Provide shoulder drain pipes with positive drainage towards outlets. Establish positive drainage within 72 hours of beginning trenching for installation of a given section of aggregate shoulder drain. Failure to comply with this requirement may result in the Engineer restricting installation of additional sections of aggregate shoulder drain until such time as the Contractor completes appropriate outlet installations.

Compact the aggregate to a degree acceptable to the Engineer by the use of a vibratory compactor before making the geotextile closure at the top of the trench.

Carefully place the backfill material after the pipe has been laid, so that the pipe will not be disturbed by the backfilling operation. Firmly tamp all earth backfill material.

Connect the shoulder drains to existing drainage structures or to concrete pads at the outlet end of the shoulder drain. Construct the concrete pad in accordance with Section 825 and give an ordinary surface finish.

Furnish and install steel markers in accordance with the plans and use at all concrete pads.

816-4 MEASUREMENT AND PAYMENT

Shoulder Drain will be measured and paid as the actual number of linear feet that has been completed and accepted, measured to the nearest foot along the centerline of the completed shoulder drain aggregate. No measurement will be made along the outlet pipe.

__" *Shoulder Drain Pipe* will be measured and paid in linear feet of all pipe that has been incorporated into the completed and accepted work. Measurement will be made along the pipe installation, including fittings, to the nearest 0.1 feet with no deduction made for fittings.

__" *Outlet Pipe for Shoulder Drain* will be measured and paid in linear feet of all pipe that has been incorporated into the completed and accepted work. Measurement will be made along the pipe installation, including fittings, to the nearest 0.1 feet with no deduction made for fittings.

Concrete Pad for Shoulder Drain Pipe Outlet will be measured and paid in units of each for the actual number of pads completed and accepted.

Such price and payment includes, but is not limited to, furnishing, hauling and placing all pipe, fittings, shoulder drain aggregate, filtration geotextiles, concrete and other materials; making all joint connections; cutting into and making connections to existing drainage structures; grouting around the pipe where it enters existing drainage structures; pavement and vertical markers; and all excavation and backfilling.

Replacement of damaged geotextile is incidental to the work in this section.

Payment will be made under:

Pay Item	Pay Unit
Shoulder Drain	Linear Foot
__" Shoulder Drain Pipe	Linear Foot
__" Outlet Pipe for Shoulder Drain	Linear Foot
Concrete Pad for Shoulder Drain Pipe Outlet	Each

SECTION 818
BLOTTING SAND

818-1 DESCRIPTION

Furnish and uniformly spread the blotting sand, as directed to prime coat, asphalt surface treatment or asphalt curing seal.

818-2 MATERIALS

Refer to Division 10.

Item	Section
Blotting Sand	1012-3

818-3 CONSTRUCTION METHODS

Apply blotting sand upon completion of the asphalt application, when directed. Provide relatively dry blotting sand. Spread uniformly, as directed, on the same day as the application of prime coat, asphalt surface treatment or asphalt curing seal. Apply at the rate of 10 lbs. / sy of surface area, unless otherwise directed.

818-4 MEASUREMENT AND PAYMENT

Blotting Sand will be measured and paid in tons that have actually been placed. The quantity will be measured by weighing in trucks on certified platform scales or other certified weighing devices. No deduction will be made of any moisture in the sand at the time of weighing. No measurement of *Blotting Sand* will be made when it is part of a *Drag Seal* or a *Sand Seal*.

Payment will be made under:

Pay Item	Pay Unit
Blotting Sand	Ton

SECTION 825
INCIDENTAL CONCRETE CONSTRUCTION

825-1 DESCRIPTION

This section consists of the general requirements for the construction of all incidental concrete construction. The provisions of Sections 838, 840, 846, 848, 850, 852, 854, 857 and 858 will prevail over any conflicting requirements of this section.

825-2 FORMS

(A) General

Maintain forms true to the required lines, grades and dimensions. Construct forms with material of such strength and with sufficient rigidity to prevent any appreciable deflection between supports. Provide mortar-tight forms with a fillet at sharp corners when indicated in the plans.

Design clamps, pins, metal spacers, anchorages and other connecting devices to hold the forms rigidly together. Construct or install any metal spacers or anchorages that are

required within the forms so that the metal work can be removed to a depth of at least 1 inch from the exposed surface of the concrete without injury to the surface. The recess thus formed in the concrete shall have a diameter no greater than 1.5 times the depth.

Maintain the shape, strength, rigidity and surface smoothness of forms that are to be re-used at all times. Thoroughly clean all dirt, mortar and foreign material from forms before reusing. Thoroughly coat all inside form surfaces with commercial quality form oil or other equivalent coating before placing concrete.

(B) Wood Forms

Provide forms with a smooth and uniform texture. Make joints between forms tight and even so that no appreciable form marks remain after the forms are removed.

Do not use plywood sheets showing torn grain, worn edges, patches or other defects that impair the texture of concrete surfaces exposed to view.

(C) Metal Forms

Use metal forms of such thickness and rigidity that the forms will remain true to shape. Counter-sink bolt and rivet heads. Use only metal forms that present a smooth surface and line up properly. Keep metal forms free from all foreign matter that will discolor the concrete.

825-3 REINFORCEMENT

Furnish and place reinforcement as shown in the plans and in accordance with Section 425.

825-4 PLACING CONCRETE

Do not place concrete until the foundation, the adequacy of the forms, the placing of reinforcement and other embedded items have been inspected and approved.

Place concrete in daylight unless an approved lighting system is provided.

Remove all debris from the interior of forms in preparation for placing concrete. Moisten earth or base course surfaces on which concrete is to be placed immediately before placing concrete. Do not place concrete on excessively wet or frozen surfaces.

Place concrete in its final position in the forms within the time stipulated in Subarticle 1000-3(E).

Place concrete to avoid segregation of the materials and the displacement of the reinforcement. Thoroughly work the concrete during placement. Bring mortar against the forms to produce a smooth finish, substantially free from water and air pockets or honeycombs.

Do not place concrete when the air temperature, measured at the location of the concrete operation in the shade away from artificial heat, is below 35°F unless permission is otherwise granted. When such permission is granted, uniformly heat the aggregates and water to a temperature no higher than 150°F. Place the heated concrete at a temperature of at least 55°F and no more than 80°F.

825-5 SLUMP TESTS

Test the slump of the concrete in accordance with Article 420-6.

825-6 FINISHING

(A) General

Provide the type of finish required by the contract directly applicable to the work being constructed.

(B) Ordinary Surface Finish

Remove all form ties or metal spacers to a depth of at least 1 inch below the surface of the concrete and clean and fill the resulting holes or depressions with grout. Metal devices with exposed cross-sectional area not exceeding approximately 0.05 sq. inches on surfaces permanently in contact with earth fill may be broken off flush with the surface of the concrete.

Remove all fins caused by form joints and other projections. Remove stains and discoloration. Clean all pockets and fill with grout as directed. Thoroughly soak the surface of all concrete with water before the application of a grout repair.

Use grout consisting of one part cement and two parts sand. Use cement from the same source as originally incorporated in work. Cure the grout for at least 3 days. After the grout has thoroughly hardened, rub the patch with a carborundum stone as required to match the texture and color of the adjacent concrete.

On surfaces that are to be backfilled or surfaces that are enclosed, the removal of form marks, fins and pockets; the rubbing of grouted areas to uniform color; and the removal of stains and discoloration will not be required.

(C) Sidewalk Finish

Strike off fresh concrete and compact until a layer of mortar is brought to the surface. Finish the surface to grade and cross section with a float, trowel smooth and finish with a broom.

(D) Rubbed Finish

After the ordinary surface finish has been completed, thoroughly wet and rub the entire surface. Use a coarse carborundum stone or other equally good abrasive to bring the surface to a smooth texture and remove all form marks. Carefully stroke the surface with a clean brush to finish the paste formed by rubbing. Alternatively, spread the paste uniformly over the surface and allow it to take a reset. Finish by floating with a canvas, carpet-faced or cork float or rub down with dry burlap.

(E) Float Finish

Finish the surface with a rough carpet float or other suitable device leaving the surface even but distinctly sandy or pebbled in texture.

825-7 REMOVING FORMS

Do not remove forms from freshly placed concrete until it has hardened sufficiently to resist spalling, cracking or any other damage.

825-8 PROTECTION FROM COLD WEATHER

When it is anticipated that the atmospheric temperature will fall below 35°F, protect concrete in accordance with Subarticle 420-7(C). Protect concrete containing fly ash or ground granulated blast furnace slag for at least 7 curing days. Protect all other concrete for at least 3 curing days.

825-9 CURING

Cure concrete in accordance with Subarticle 700-9(B) immediately after finishing operations are completed and surface water has disappeared. Where forms are removed before the expiration of the required curing period, apply the curing compound immediately after the forms are removed.

Cure each mass for 7 curing days. A “curing day” shall be defined as any consecutive 24 hour period, after finishing operations of the mass is completed, when the air temperature adjacent to the mass does not fall below 40°F.

825-10 JOINTS

(A) General

Construct joints at right angles to the surface of the concrete. Locate joints at right angles to the longitudinal centerline of curb, curb and gutter, gutter, island, median, median barrier and all paved areas, except where different joint locations are called for in the plans.

Where concrete is to be placed adjacent to any existing slab or pavement that has a broken or irregular edge, provide a reasonably vertical edge by sawing.

(B) Grooved Contraction Joints

Form grooved contraction joints by a tool specifically constructed for this purpose or by sawing with an approved concrete saw.

Groove contraction joints to the depth shown in the plans and to a width between 1/4 inch and 1/2 inch, unless otherwise shown in the plans. If formed by a tool, make a radius of 1/8 inch at the corners of the adjacent concrete.

(C) Expansion Joints

Fill construction joints with an expansion joint filler. Cut the filler into the shape necessary to fill the joint. Make the filler 1/2 inch thick unless indicated otherwise in the plans. After the concrete has hardened cut the filler away to a depth of 1/2 inch to provide space for the joint sealer.

Install an expansion joint adjacent to any existing slab, pavement or structure against which new concrete is placed and at other locations detailed in the plans.

(D) Construction Joints

Construct construction joints as shown in the plans or where otherwise approved.

(E) Sawing Joints

Saw joints after the concrete has hardened sufficiently to be sawed without spalling and raveling but no more than 24 hours after the concrete has been placed.

(F) Sealing Joints

Seal all contraction and expansion joints, except otherwise specified, before the backfill is placed.

Thoroughly clean the joint to remove all foreign matter. Dry joints before sealing.

Entirely fill joints to within 1/8 inch to 1/4 inch of the surface of the concrete with joint sealer. Immediately remove any sealer spilled on the surface of the concrete.

Place joint sealer with equipment meeting the specifications of the manufacturer of the sealer material.

825-11 MEASUREMENT AND PAYMENT

There will be no direct payment for the work covered by this section.

Payment at the contract prices for the various items covered by those sections of the *Standard Specifications* directly applicable to the work being constructed will be full compensation for all work covered by this section.

SECTION 828
TEMPORARY STEEL COVER FOR MASONRY DRAINAGE STRUCTURES

828-1 DESCRIPTION

Install temporary steel plate covers on masonry drainage structures in accordance with the details shown in the plans and as directed by the Engineer.

828-2 MATERIALS

Provide materials that are Grade A36 steel and the size and thickness shown on the detail in the plans.

828-3 MEASUREMENT AND PAYMENT

Temporary Steel Plate Covers for Masonry Drainage Structures will be measured and paid in units of each for the actual number of these items incorporated into the completed and accepted work.

Payment will be made under:

Pay Item	Pay Unit
Temporary Steel Plate Covers for Masonry Drainage Structures	Each

SECTION 830
BRICK MASONRY CONSTRUCTION

830-1 DESCRIPTION

This work consists of the general requirements for all unreinforced brick masonry construction. The requirements of Sections 838, 840 and 858 will prevail over any conflicting requirements of this section.

830-2 CONSTRUCTION METHODS

Construct all concrete footings and all other concrete elements of the structure in accordance with Section 825.

830-3 MORTAR

Machine mix mortar in accordance with Article 1040-9 for at least 90 seconds. Remove and dispose of any mortar that has developed initial set or lost plasticity.

830-4 LAYING BRICK

Dampen brick when necessary to reduce the rate of absorption. Build brick masonry plumb and true to the required dimensions. Place a header course approximately mid height of the structure in structures less than 9 courses high. Place a header course every third course on structures 9 courses high or higher. Use other types of bonding where indicated in the plans.

Completely fill brick joints and cavities with mortar. Make mortar joint thickness at least 3/8 inch and no more than 5/8 inch. Finish joints that will remain exposed after backfill with a concave jointer. Flush cut all other joints.

Use spalls or bats only when shaping around irregular openings or when unavoidable to finish out a course. Place a full brick at the corner and place the bat in the interior of the course when necessary to finish out the course.

Clean spilled mortar from exposed exterior surfaces not backfilled.

830-5 PROTECTION FROM COLD WEATHER

Do not place masonry when the temperature is below 35°F unless adequate protection is provided by a pre-approved method.

When it is anticipated that the atmospheric temperature will fall below 35°F protect masonry, in accordance with Subarticle 420-7(C), for at least 3 curing days.

Define a "curing day" as any consecutive 24 hour period, beginning when the last masonry unit is placed in the completed structure, during which the air temperature adjacent to the structure does not fall below 40°F.

830-6 MEASUREMENT AND PAYMENT

There will be no direct payment for the work covered by this section.

Payment at the contract prices for the various items covered by those sections of the *Standard Specifications* directly applicable to the work being constructed will be full compensation for all work covered by this section.

SECTION 832
REINFORCED BRICK MASONRY CONSTRUCTION

832-1 DESCRIPTION

This work shall consist of the general requirements for all reinforced brick masonry construction. The requirements of Section 838 will prevail over any conflicting requirements of this section.

832-2 CONCRETE CONSTRUCTION

Construct concrete footings and all other concrete elements of the structure in accordance with Section 825. Furnish and place reinforcement as shown in the plans and in accordance with Section 425. Use Class A concrete for footings unless otherwise indicated in the plans. Use Class B concrete in reinforcement cavities. Rod Class B concrete in reinforcement cavities to provide a dense, homogeneous concrete. Do not vibrate.

832-3 MORTAR

Machine mix mortar that meets Article 1040-9 for at least 90 seconds. Remove and dispose of any mortar that has developed initial set or lost plasticity.

832-4 LAYING BRICK

Dampen brick when necessary to reduce the rate of absorption. Construct the type of bond called for in the plans. Build reinforced brick masonry plumb and true to the required dimensions.

Lay brick with completely filled mortar joints. Make mortar joint thickness at least 3/8 inch and no more than 5/8 inch. Finish joints that will remain exposed after backfill, with a concave jointer. Flush cut all other joints.

Use spalls or bats only when shaping around irregular openings. Place a full brick at the corner and place the bat in the interior of the course when necessary to finish out a course.

Clean spilled mortar from exposed exterior surfaces not backfilled.

832-5 PROTECTION FROM COLD WEATHER

Refer to Article 830-5.

832-6 MEASUREMENT AND PAYMENT

There will be no direct payment for the work covered by this section.

Payment at the contract unit prices for the various items covered by those sections of the Specifications directly applicable to the work being constructed will be full compensation for all work covered by this section.

SECTION 834
BLOCK MASONRY CONSTRUCTION

834-1 DESCRIPTION

This work consists of constructing concrete block masonry. The requirements of Sections 840, 858 and 859 will prevail over any conflicting requirements of this section.

834-2 CONCRETE CONSTRUCTION

Construct concrete footings and all other concrete elements of the structure in accordance with Section 825.

834-3 MORTAR

Machine mix mortar in accordance with Article 1040-9 for at least 90 seconds. Remove and dispose of any mortar that has developed initial set or has lost plasticity.

834-4 LAYING CONCRETE BLOCK

Build block masonry plumb and true to the required dimensions. Stagger vertical joints. Set the block with the cells vertical. Spread mortar on the bearing members and fill the vertical joints with mortar. Dampen block when necessary to reduce the rate of absorption.

Make joints straight, level, plumb, and neat at intersection. Make mortar joint thickness at least 3/8 inch and no more than 5/8 inch. Finish joints that will remain exposed after backfill, with a concave jointer. Flush cut all other joints. Clean exposed exterior surfaces of spilled mortar that are not backfilled.

834-5 PROTECTION FROM COLD WEATHER

Refer to Article 830-5.

834-6 MEASUREMENT AND PAYMENT

There will be no direct payment for the work covered by this section.

Payment at the contract prices for the various items covered by those sections of the *Standard Specifications* directly applicable to the work being constructed will be full compensation for all work covered by this section.

SECTION 836
SLUICE GATE

836-1 DESCRIPTION

Construct a sluice gate on an endwall in accordance with the details in the contract and the manufacturer's recommendations. Sluice gate includes other types of gates such as shear gates, ball valves, butterfly valves or other alternatives approved by the Engineer.

836-2 MATERIALS

Sluice gates shall meet the manufacturer's recommendations for the corresponding pipe size. Due to variations in individual manufacturer's products, a slight variation from the size specified may be allowed. Submit the proposed catalog cut to the Engineer for approval prior to use.

836-3 CONSTRUCTION METHODS

Provide a gate that forms a watertight seal when closed.

836-4 MEASUREMENT AND PAYMENT

____" *Sluice Gate* will be measured and paid as each for the actual number of sluice gates incorporated into the completed and accepted work. Such prices and payment will be full compensation for all materials, labor, tools, equipment and incidentals necessary to complete the work.

The endwall will be measured and paid in accordance with Article 838-4.

Payment will be made under:

Pay Item	Pay Unit
____" Sluice Gate	Each

SECTION 838
ENDWALLS

838-1 DESCRIPTION

Perform the work covered by this section including but not limited to excavation, hauling, disposal of materials, furnishing and placing backfill materials, subsurface drainage, concrete, brick masonry, mortar, grout, and furnishing and placing reinforcing steel to construct Portland cement concrete or brick masonry endwalls, either plain or reinforced, in accordance with the contract.

838-2 MATERIALS

Refer to Division 10:

Item	Section
Brick	1040-1
Curing Materials	1026
Mortar	1040-9
Precast Concrete Units	1077
Portland Cement Concrete, Class A	1000
Steel Bar Reinforcement	1070-2
Select Materials	1016
Subsurface Drainage Materials	1044

Use Portland cement concrete, brick masonry or precast concrete for the endwall unless otherwise specified in the plans.

If precast sections are proposed, submit in writing for approval.

838-3 CONSTRUCTION METHODS

(A) Foundation

Do not place concrete or masonry until the foundation is approved by the Engineer.

Excavate foundation to a firm surface, make level or stepped and clean surfaces of loose material. Make excavation true to lines and dimensions shown on plans.

Where the foundation material is found to be of poor supporting value or of rock, the Engineer may make minor adjustments in the location of the structure to provide a more suitable foundation. Where this is not practical, undercut the foundation and condition by backfilling with an approved select material.

(B) Concrete and Masonry

Construct concrete in accordance with Section 825 and give an ordinary surface finish. Construct brick masonry in accordance with Sections 830 and 832. Furnish and place reinforcing steel in accordance with Section 425.

Provide the class of concrete indicated in the plans.

Obtain approval if field conditions necessitate a variance from the plan dimensions of the structure and footings.

Construct endwalls on the end of a full joint of pipe and in accordance with the details in the plans.

Any endwall that incorporates an opening for circular pipe 54 inches or greater shall be reinforced.

(C) Backfill

Complete endwall construction, and remove all forms. Backfill with approved material after the concrete or brick masonry has cured for at least 7 curing days unless otherwise permitted. A "curing day" is defined in Article 830-5. Within 4 calendar days after the completion of the 7 day curing period, shape, compact and complete backfill in accordance with the contract.

838-4 MEASUREMENT AND PAYMENT

Endwalls will be measured and paid in cubic yards of concrete or brick completed and accepted. This quantity will be computed from the dimensions shown in the plans or from revised authorized dimensions. Where precast concrete units have been approved and are used instead of cast-in-place units the quantity to be paid will be computed the same as if cast-in-place units were used, as no reduction in pay quantity will be made due to the use of precast instead of cast-in-place endwalls.

Reinforced Endwalls will be measured and paid in cubic yards of concrete or brick completed and accepted. This quantity will be computed from the dimensions shown in the plans or from revised authorized dimensions. Where precast concrete units have been approved and are used instead of cast-in-place units the quantity to be paid will be computed the same as if cast-in-place units were used, as no reduction in pay quantity will be made due to the use of precast instead of reinforced cast-in-place endwalls.

Payment will be made under:

Pay Item	Pay Unit
Endwalls	Cubic Yard
Reinforced Endwalls	Cubic Yard

SECTION 840
MINOR DRAINAGE STRUCTURES

840-1 DESCRIPTION

Perform the work covered by this section including, but not limited to, excavation; providing protection of employees in excavation; hauling; disposal of materials; removing existing pipe and drainage structures at the site of the work; furnishing, transporting and placing foundation conditioning material, backfill material, subsurface drainage, concrete, brick masonry, block masonry, precast units, mortar, grout, reinforcing steel, hardware, castings and miscellaneous metal; fabrication; welding; and galvanizing to construct cast-in-place concrete, brick masonry, block masonry or precast concrete inlets, catch basins, junction boxes, spring boxes, manholes, concrete aprons and other minor drainage structures excluding endwalls, with all necessary metal grates, covers, frames, steps and other hardware, in accordance with the contract.

Use cast-in place concrete, brick masonry, block masonry or precast concrete construction as shown on approved plans.

840-2 MATERIALS

Refer to Division 10.

Item	Section
Brick	1040-1
Concrete Block	1040-2
Curing Materials	1026
Fabricated Steel Grates	1074-9
Gray Iron Castings	1074-7
Joint Filler	1028-1
Joint Sealers	1028-2, 1028-3
Mortar	1040-9
Precast Drainage Structure Units	1077
Portland Cement Concrete, Class B	1000
Reinforcing Steel	1070
Select Materials	1016
Steps	1074-8
Structural Steel	1072

Use grout in precast structures consisting of one part Portland cement to two parts of mortar sand.

Use foundation conditioning material meeting Article 1016-3 for Class V or VI select material as shown in the contract or as directed.

840-3 CONSTRUCTION METHODS

(A) Excavation

Perform excavation with equipment of adequate weight, size and capability. Where necessary, provide a competent person and protection of personnel in excavation by sloping, shoring or bracing in accordance with Federal, State or local standards and Article 107-1.

(B) Foundation

Do not place masonry drainage structure until the foundation has achieved adequate strength.

Where the foundation material is found to be of poor supporting value or of rock, minor adjustments in the location of the structure may be approved to provide a more suitable foundation. Where this is not practical, undercut the foundation and condition by backfilling with an approved select material.

Set precast structure foundations to within ± 1/2 inch of grade on a 2 inch to 3 inch thick bed of compacted foundation conditioning material.

(C) Cast-In-Place Concrete, Brick and Block Masonry

Install drainage structures to plan line and grade or approved to meet drainage conditions. Do not modify the drainage structure by corbeling or use of concrete slabs unless otherwise directed by the Engineer.

Construct concrete in accordance with Section 825 and give an ordinary surface finish. Construct brick masonry in accordance with Section 830. Construct block masonry in accordance with Section 834. Furnish and place reinforcing steel in accordance with Section 425.

Obtain approval if field conditions necessitate a variance from the plan dimensions of the structure or footings.

(D) Installation of Precast Units

Install drainage structures to plan line and grade or approved to meet drainage conditions. Do not modify the drainage structure by corbeling or use of concrete slabs unless otherwise directed by the Engineer.

Assemble the precast drainage structure units in accordance with the manufacturer's instructions. Subarticle 840-3(C) applies where it is necessary to use cast-in-place concrete, brick masonry or block masonry construction as part of the structure. Fill any void greater than 1 inch with a brick or block bat fully encased in mortar.

Obtain approval if field conditions necessitate a variance from the plan dimensions of the structure or footings.

(E) Fittings and Connections

As the work is built up, accurately space, align and thoroughly bond fittings that enter the structure.

Make pipe connections so the pipe does not project beyond the inside wall of the drainage structure and grout as necessary to make smooth and uniform surfaces on the inside of the structure.

Set metal frames for grates and covers in full mortar beds or secure by approved methods.

(F) Backfill

Complete drainage structure and remove all forms and falsework. Backfill with approved material, compacted to the density required by Subarticle 235-3(C), after the drainage structure has cured for at least 7 curing days, unless otherwise permitted. Define a “curing day” in accordance with Article 825-9 for concrete or Article 830-5 for brick or block masonry.

(G) Pipe Collars and Pipe Plugs

Construct pipe collars and pipe plugs in accordance with the details shown in the plans or as directed by the Engineer.

Use any class of Portland cement concrete contained within Section 1000 for pipe collars.

Construct pipe plugs with either brick masonry or any class of Portland cement concrete contained within Section 1000.

(H) Concrete Aprons

Construct concrete aprons in accordance with the details in the plans. Use Class B or higher compressive strength concrete.

840-4 MEASUREMENT AND PAYMENT

Masonry Drainage Structure that incorporate an opening for circular pipe not exceeding 48 inches in diameter will be measured and paid in units of each for the actual number completed and accepted.

Masonry Drainage Structure exceeding a height of 5.0 feet will be measured and paid in linear feet for the portion of the drainage structure exceeding a height of 5.0 feet. The height will be measured vertically to the nearest 0.1 feet from the top of the bottom slab to the top of the wall. For that portion of *Masonry Drainage Structure* measured above a height of 10.0 feet, payment will be made at 1.3 times the contract unit price per linear foot for *Masonry Drainage Structure*.

Masonry Drainage Structures that incorporate an opening for circular pipe exceeding 48 inches in diameter, or for pipe arch of any size, will be measured and paid on a volume basis as provided below.

Masonry to be paid will be the number of cubic yards of cast-in-place concrete brick or block that has been incorporated into the completed and accepted structure. This quantity will be computed from the dimensions shown in the plans or from revised dimensions authorized by the Engineer. Where the wall thickness is greater than the wall thickness shown in the plans due to the use of oversize brick or for any other reason, the wall thickness shown in the plans will be used to compute quantities except where an increase in wall thickness has been authorized by the Engineer.

Pipe Collars will be measured and paid in cubic yards of concrete or brick that has been incorporated into the completed work. The cubic yards of pipe collars will be computed from the dimensions shown in the plans or from revised dimensions authorized by the Engineer.

Pipe Plugs will be measured and paid in cubic yards of concrete or brick that has been incorporated into the completed and accepted pipe plug. The cubic yards of pipe plugs will be computed from the dimensions shown in the plans or from revised dimensions authorized by the Engineer.

Frame with Grate and Hood, Std. ____ will be measured and paid in units of each for actual number of assemblies incorporated into the completed work. No separate measurement will be made of grates, hoods, and covers that are part of the assembly, as the grates, hoods and covers will be considered to be part of the complete assembly.

Frame with Grate, Std. ____ will be measured and paid in units of each for actual number of assemblies incorporated into the completed work. No separate measurement will be made of grates, hoods, and covers that are part of the assembly, as the grates, hoods and covers will be considered to be part of the complete assembly.

Frame with Two Grates, Std. ____ will be measured and paid in units of each for actual number of assemblies incorporated into the completed work. No separate measurement will be made of grates, hoods, and covers that are part of the assembly, as the grates, hoods and covers will be considered to be part of the complete assembly.

Frame with Cover, Std. ____ will be measured and paid in units of each for actual number of assemblies incorporated into the completed work. No separate measurement will be made of grates, hoods, and covers that are part of the assembly, as the grates, hoods and covers will be considered to be part of the complete assembly.

Steel Frame with Two Grates, Std. ____ will be measured and paid in units of each for the actual number of fabricated steel grates incorporated into the completed work.

No separate payment will be made for concrete aprons shown in *Roadway Standard Drawings* No. 840.17, 840.18, 840.19, 840.26, 840.27 and 840.28, as this work will be incidental to the other work in this section.

Foundation Conditioning Material, Minor Structures will be paid as provided in Article 300-9.

The above prices and payments will be full compensation for all work covered by this section.

Payment will be made under:

Pay Item	Pay Unit
Masonry Drainage Structures	Each
Masonry Drainage Structures	Linear Foot
Masonry Drainage Structures	Cubic Yard
Pipe Collars	Cubic Yard
Pipe Plugs	Cubic Yard
Frame with Grate and Hood, Std. ____	Each
Frame with Grate, Std. ____	Each
Frame with Two Grates, Std. ____	Each
Frame with Cover, Std. ____	Each
Steel Frame with Two Grates, Std. ____	Each

SECTION 846
CONCRETE CURB, CURB AND GUTTER, CONCRETE GUTTER, SHOULDER BERM GUTTER, CONCRETE EXPRESSWAY GUTTER AND CONCRETE VALLEY GUTTER

846-1 DESCRIPTION

Construct Portland cement concrete curb, concrete curb and gutter, concrete gutter, shoulder berm gutter, concrete expressway gutter and 4 inch concrete valley gutter as shown in the contract.

846-2 MATERIALS

Refer to Division 10.

Item	Section
Curing Materials	1026
Joint Filler	1028-1
Joint Sealers	1028-2, 1028-3
Portland Cement Concrete, Class B	1000

846-3 CONSTRUCTION METHODS

(A) General

Construct concrete in accordance with Section 825, except as provided herein.

Give surface a light broom finish with brush marks parallel to the curb line or gutter line.

Prepare foundation and compact base or subgrade to the degree required by the applicable section of the *Standard Specifications* before placing forms.

(B) Forms

Use forms that have no more than 1/8 inch in 10 feet deflection from true line horizontally and vertically to adequately support the concrete and construction equipment.

Obtain approval before placing concrete.

(C) Joints

Locate joints as shown in the plans except as provided herein.

Space joints no closer than 5 feet.

Locate joints to line up with the joints in concrete pavement when placed adjacent to concrete pavement.

Form grooved contraction joints as required by Subarticle 825-10(B).

Construct grooved butt joint between the work and adjacent pavement except where expansion joints are required by the plans. Form butt joints as required by Subarticle 825-10(B) for grooved contraction joints and seal.

Seal all joints except for joints in curb sections not having an integral gutter.

Fill joints in gutter with joint sealer to the top surface of the gutter.

Seal joints before backfilling or performing adjacent operations.

(D) Surface Tolerances

Finish surface within 1/4 inch when checked longitudinally with a 10 foot straightedge.

(E) Backfilling

Do not place backfill or pavement adjacent to the curb, curb and gutter, gutter, shoulder berm gutter, expressway gutter or concrete valley gutter until at least 3 curing days, as defined in Article 825-9, have elapsed.

Complete backfill within 4 calendar days after the completion of the 3 day curing period unless otherwise approved.

Compact backfill to an approved density.

(F) Opening to Traffic

Vehicles may be permitted on the completed work after the following curing days, as defined in Article 825-9, have elapsed. For regular strength concrete, cure for at least 7 curing days. For high early strength concrete, cure for at least 3 curing days.

846-4 MEASUREMENT AND PAYMENT

__" *x* __" *Concrete Curb* will be measured and paid in linear feet, accepted in place, along the surface of the top of the curb.

__' __" *Concrete Curb and Gutter* will be measured and paid in linear feet, accepted in place, along the surface of the top of the curb.

__' *Concrete Gutter* will be measured and paid in linear feet accepted in place, along the surface of the top of the gutter.

Shoulder Berm Gutter will be measured and paid in linear feet, accepted in place, along the surface of the top of the gutter.

Concrete Expressway Gutter will be measured and paid in linear feet, accepted in place, along the surface of the top of the gutter.

Concrete Valley Gutter will be measured and paid in linear feet, accepted in place, along the surface of the top of the gutter.

Work includes providing all materials, placing all concrete, excavating and backfilling, forming, finishing, constructing and sealing joints, and all incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
__" x __" Concrete Curb	Linear Foot
__' __" Concrete Curb and Gutter	Linear Foot
__' Concrete Gutter	Linear Foot
Shoulder Berm Gutter	Linear Foot
Concrete Expressway Gutter	Linear Foot
Concrete Valley Gutter	Linear Foot

SECTION 848
CONCRETE SIDEWALKS, DRIVEWAYS AND CURB RAMPS

848-1 DESCRIPTION

Construct Portland cement concrete sidewalks, driveways and curb ramps in accordance with the contract.

848-2 MATERIALS

Refer to Division 10.

Item	Section
Curing Materials	1026
Joint Filler	1028-1
Joint Sealers	1028-2, 1028-3
Portland Cement Concrete, Class B	1000

Detectable warning for curb ramps shall consist of raised truncated domes. Use material for detectable warning systems as shown herein. Material and coating specifications must be stated in the Manufacturers Type 3 Certification and all Detectable Warning systems must be on the NCDOT APL.

Install detectable warnings created from one of the following materials: precast concrete blocks or bricks, clay paving brick, gray or ductile iron castings, mild steel, stainless steel, and engineered plastics, rubber or composite tile. Only one material type for detectable warning will be permitted per project, unless otherwise approved by the Engineer.

Detectable Warnings shall consist of a base with integrated raised truncated domes, and when constructed of precast concrete they shall conform to the material requirements.

Detectable Warnings shall consist of a base with integrated raised truncated domes, and may be comprised of other materials including, but not limited to, clay paving brick, gray iron or ductile iron castings, mild steel, stainless steel, and engineered plastics, rubber or composite tile, which are applied directly to the curb ramps by incorporating into or attaching to the existing ramp floor. The material shall have an integral color throughout the thickness of the material. The detectable warning shall include fasteners, anchors, or adhesives for attachment in the existing ramp and shall be furnished as a system from the manufacturer.

Prior to installation, the Contractor shall submit to the Engineer assembling instructions from the manufacturer for each type of system used. The system shall be furnished as a kit containing all consumable materials and consumable tools, required for the application. They shall be capable of being affixed to or anchored in the concrete curb ramp, including green concrete (concrete that has set but not appreciably hardened). The system shall be solvent free and contain no volatile organic compounds (VOC). The system shall be resistant to deterioration due to exposure to sunlight, water, salt or adverse weather conditions and impervious to degradation by motor fuels, lubricants and antifreeze.

When steel or gray iron or ductile iron casting products are provided, only products that meet the requirements of Subarticle 106-1(B) may be used. Submit to the Engineer a Type 6 Certification, catalog cuts and installation procedures at least 30 days prior to installation for all.

848-3 CONSTRUCTION METHODS

Where it is necessary to remove a portion of existing sidewalks or driveways, saw a neat edge along the pavement to be retained approximately 2 inches deep with a concrete saw before breaking the adjacent pavement away.

Construct concrete in accordance with Section 825 and give a sidewalk finish, except as otherwise provided herein.

Broom the concrete surface in a transverse direction to traffic. Make joint spacing no less than 5 feet. Where existing sidewalks are being widened, line up new transverse joints with existing joints in the adjacent sidewalk. Seal expansion joints where sidewalk and curb ramps are placed adjacent to concrete curb and/or gutter. Do not seal grooved joints.

Do not place backfill adjacent to the sidewalk, driveway or curb ramp until at least 3 curing days, as defined in Article 825-9, have elapsed unless otherwise approved by the Engineer. Compact backfill to a degree comparable to the adjacent undisturbed material.

Do not place vehicles on the completed work until 7 curing days, as defined in Article 825-9, have elapsed. When high early strength concrete is used, vehicles will be permitted on the completed work after 3 curing days have elapsed.

Install detectable warnings for proposed curb ramps in accordance with the contract.

Prior to placing detectable warnings in existing concrete curb ramps, saw cut to the full depth of the concrete, for other material remove as necessary, and adjust the existing subgrade to the proper grade.

Place all detectable warnings in accordance to manufacturer's recommendations.

848-4 MEASUREMENT AND PAYMENT

__" *Concrete Sidewalk* will be measured and paid in square yards, measured along the surface of the completed and accepted work. Such price includes, but is not limited to, excavating and backfilling, sawing the existing sidewalk, furnishing and placing concrete, and constructing and sealing joints.

__" *Concrete Driveway* will be measured and paid in square yards, measured along the surface of the completed and accepted work. Such price includes, but is not limited to, excavating and backfilling, sawing the existing driveway, furnishing and placing concrete, and constructing and sealing joints.

Concrete Curb Ramps will be measured and paid in units of each. Such price includes, but is not limited to, excavating and backfilling, sawing the existing sidewalk or driveway, furnishing and placing concrete, curb and gutter, constructing and sealing joints and furnishing and installing truncated domes shown in the *Roadway Standard Drawings*.

Retrofit Existing Concrete Curb Ramps with detectable warnings constructed of any type material will be paid as the actual number of retrofitted curb ramps, completed and accepted. Such price and payment will be full compensation for excavating and backfilling; sawing, repairing and replacing portions of the existing curb ramp within the pay limits for retrofit shown on the detail; pavement repairs; furnishing and placing detectable warnings, construction joints and removing and disposing of portions of the existing curb ramp when required and for all materials, labor, equipment, tools and incidentals necessary to complete the work.

Remove and Replace Concrete Curb Ramps will be measured and paid in units of each. Such price includes, but is not limited to, excavating, removing and backfilling, sawing the existing sidewalk or driveway and furnishing and installing truncated domes and constructing the new curb ramp. Removal and disposal of existing curb ramps will be incidental to the work performed.

Payment will be made under:

Pay Item	**Pay Unit**
__" Concrete Sidewalk	Square Yard
__" Concrete Driveway	Square Yard
Concrete Curb Ramps	Each
Retrofit Existing Concrete Curb Ramps	Each
Remove and Replace Concrete Curb Ramps	Each

SECTION 850
CONCRETE PAVED DITCH

850-1 DESCRIPTION

Construct Portland cement concrete paved ditches as shown in the plans for the various types of ditches. Work includes, but is not limited to, all excavating and backfilling, furnishing and placing concrete, constructing curtain walls and constructing and sealing joints.

850-2 MATERIALS

Refer to Division 10.

Item	Section
Curing Materials	1026
Joint Filler	1028-1
Joint Sealers	1028-2, 1028-3
Portland Cement Concrete, Class B	1000

850-3 CONSTRUCTION METHODS

Construct concrete in accordance with Section 825 and give a sidewalk finish, except as otherwise provided herein.

Broom the concrete surface transverse to the longitudinal centerline of the paved ditch. Make joint spacing no less than 5 feet.

Do not place backfill adjacent to the paved ditch until at least 3 curing days have elapsed, unless otherwise approved by the Engineer. Compact backfill to a degree comparable to the adjacent undisturbed material.

850-4 MEASUREMENT AND PAYMENT

__" *Concrete Paved Ditch* will be measured and paid in square yards that is completed and accepted. Longitudinal measurements will be made along the surface of the pavement at the centerline of the ditch and transverse measurements will be made along the surface of the pavement at right angles to the centerline. No measurement will be made of curtain walls at the beginning or ends of the paved ditches.

Payment will be made under:

Pay Item	Pay Unit
__" Concrete Paved Ditch	Square Yard

SECTION 852
TRAFFIC ISLANDS AND MEDIANS

852-1 DESCRIPTION

Construct traffic islands and medians of the type required by the plans. Perform the work in accordance with the contract.

852-2 MATERIALS

Refer to Division 10.

Item	Section
Curing Materials	1026
Herbicide	1060-13
Joint Filler	1028-1
Joint Sealers	1028-2, 1028-3
Portland Cement Concrete, Class B	1000

852-3 CONSTRUCTION METHODS

Construct curb and gutter and curb, in accordance with Section 846.

Uniformly grade and compact the earth or base course under any island or median to the same requirements as the surrounding material.

Where necessary, treat aggregate and subgrade beneath other types of bases or directly beneath any concrete with a herbicide in accordance with Article 1670-7.

Construct concrete in accordance with Section 825 and give a sidewalk finish, except as otherwise provided herein. Broom concrete surfaces in medians transverse to the direction of traffic unless otherwise directed. Locate joints in island and median covers to line up with the joints in the curb and curb and gutter wherever possible. Locate joints in monolithic concrete islands and medians constructed adjacent to concrete pavement to line up with the joints in the concrete pavement wherever possible. Seal all joints.

Form openings in the island or island cover to accommodate sign posts.

852-4 MEASUREMENT AND PAYMENT

__" *Concrete Island Cover* will be measured and paid in square yards of concrete island cover that has been placed and accepted. Measurement will be made along the top surface of the completed island cover. This work includes, but is not limited to, excavation and backfilling, constructing base, furnishing and placing concrete, forming holes for signposts and constructing and sealing joints.

__" *Monolithic Concrete Islands ( )* will be measured and paid in square yards of concrete island that has been placed and accepted. Measurement will be made parallel to the bottom surface of the island or median. This work includes, but is not limited to, excavation and backfilling, constructing base, furnishing and placing concrete, forming holes for signposts and constructing and sealing joints.

__" *Monolithic Concrete Median ( )* will be measured and paid in square yards of concrete median that has been placed and accepted. Measurement will be made parallel to the bottom surface of the island or median. This work includes, but is not limited to, excavation and backfilling, constructing base, furnishing and placing concrete, forming holes for signposts and constructing and sealing joints.

Concrete Transitional Section for Catch Basin will be measured and paid in units of each.

Concrete Transitional Section for Drop Inlet will be measured and paid in units of each.

Payment for constructing earth fill will be made in accordance with Article 225-7 for *Unclassified Excavation* or Article 230-5 for *Borrow Excavation*, depending on the source of the material.

Payment for establishing a grass cover in unpaved island areas will be in accordance with Article 1660-8.

Payment for constructing *Concrete Curb* and *Concrete Curb and Gutter* will be made in accordance with Article 846-4.

Payment will be made under:

Pay Item	**Pay Unit**
__" Concrete Island Cover	Square Yard
__" Monolithic Concrete Islands ( )	Square Yard
__" Monolithic Concrete Median ( )	Square Yard
Concrete Transitional Section for Catch Basin	Each
Concrete Transitional Section for Drop Inlet	Each

SECTION 854
CONCRETE BARRIER

854-1 DESCRIPTION

Construct Portland cement concrete barrier in accordance with the contract. The concrete barrier may be cast in place, slip formed or precast, unless otherwise specified in the contract.

854-2 MATERIALS

Refer to Division 10.

Item	Section
Connector Pins and Eye Assemblies	1072
Curing Materials	1026
Grout, Type 3	1003
Guardrail and Barrier Delineators	1088-2
Joint Filler	1028-1
Low Modulus Silicone Sealant	1028-3
Portland Cement Concrete, Class AA	1000
Steel Bar Reinforcement	1070-2

Galvanize connector assemblies in accordance with Section 1076.

Use clear curing compound.

854-3 CONSTRUCTION METHODS

(A) Cast in Place or Slip Formed

Construct concrete in accordance with Section 825 and give an ordinary surface finish, except as otherwise provided herein.

Construct joints in accordance with the details shown in the plans. Fill with joint filler and seal with joint sealer.

(B) Precast

Construct concrete in accordance with Section 825 and give an ordinary surface finish, except as otherwise provided herein.

Do not handle or remove the forms from barrier until the strength of the concrete reaches at least 2000 psi as evidenced by nondestructive tests made in place by a rebound hammer in accordance with ASTM C805.

Construct the base beneath the precast units to be equivalent to the adjacent pavement structure.

Lift and place precast units using a two-point pick up, or other approved method that will not overstress or damage the concrete. Do not use connectors for lifting purposes. Do not use lifting devices or methods that will mar the surface of the concrete. Do not use any precast unit that has been cracked, damaged, chipped, scarred or otherwise disfigured.

(C) Barrier Delineators

Use any of the several alternate delineator types for barrier shown in the plans, but only one delineator type for barrier at any one time throughout the project.

The delineators consist of a reflector and base or casing. Attach the delineator to the barrier as shown in the plans. Only one attachment position will be permitted throughout the project length.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in the median and on the left side of one-way ramps, loops or other one-way facilities. Use

white delineators on the right side of divided highways, ramps, loops and all other one-way or two-way facilities. In all cases, the color of the delineator shall supplement the color of the adjacent edgelines.

854-4 MEASUREMENT AND PAYMENT

Concrete Barrier, Type ____ will be measured and paid in linear feet of barrier that has been completed and accepted. Measurement will be made along the top surface at the centerline of the barrier completed and in place with no deduction made for joints.

Variable Height Concrete Barrier, Type ____ will be measured and paid in linear feet of barrier that has been completed and accepted. Measurement will be made along the top surface at the centerline of the barrier completed and in place with no deduction made for joints.

Concrete Barrier Transition Section will be measured and paid in units of each for transitions completed and accepted.

Median Hazard Protection will be measured and paid for per linear feet that are completed and accepted. Such price and payment will be full compensation for all labor, materials (including, but not limited to, concrete barrier, earth material, #57 stone, concrete cover, galvanized bar and grout) and incidentals necessary construct the *Median Hazard Protection*.

There will be no measurement made of barrier delineators as they are incidental to the other pay items in this section.

No direct payment will be made for the work of constructing any footing beneath the concrete barrier or concrete barrier transition sections as payment at the various contract unit prices for concrete barrier or concrete barrier transition sections will be full compensation for all such work.

Price and payment includes, but is not limited to, excavating, furnishing and placing concrete, reinforcing steel, grout and hardware; transporting and placing precast units; galvanizing; constructing and sealing joints; and furnishing and installing barrier delineators.

Payment will be made under:

Pay Item	Pay Unit
Concrete Barrier, Type ____	Linear Foot
Variable Height Concrete Barrier, Type ____	Linear Foot
Concrete Barrier Transition Section	Each
Median Hazard Protection	Linear Foot

SECTION 857
PRECAST REINFORCED CONCRETE BARRIER – SINGLE FACED

857-1 DESCRIPTION

Construct precast reinforced Portland cement concrete barrier in accordance with the contract.

857-2 MATERIALS

Comply with Article 854-2.

857-3 CONSTRUCTION METHODS

Construct concrete in accordance with Section 825 and give an ordinary surface finish, except as otherwise provided herein.

Lift and place precast units using a two-point pick up or other approved method that will not overstress or damage the concrete. Do not use lifting devices or methods that will mar the surface of the concrete. Do not set any precast unit that is cracked, damaged, chipped, scarred or otherwise disfigured.

When barrier is being constructed near traffic, do not start installation of the precast concrete barrier until all components are prepared for a complete continuous installation, including the guardrail and guardrail anchors approaching the barrier. Once work has begun on a barrier installation, continue the work to its completion unless weather or other conditions beyond the control of the Contractor interfere with the work.

Use any of the several alternate delineator types for barrier shown in the plans, but only one delineator type for barrier at any one time throughout the project.

The delineators consist of a reflector and base or casing. Attach the delineator to the barrier as shown in the plans. Only one attachment position will be permitted throughout the project length.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in the median and on the left side of one-way ramps, loops or other one-way facilities. Use white delineators on the right side of divided highways, ramps, loops and all other one-way or two-way facilities. In all cases, the color of the delineator shall supplement the color of the adjacent edgelines.

857-4 MEASUREMENT AND PAYMENT

There will be no measurement made of barrier delineators as they are incidental to the other pay items in this specification.

Precast Reinforced Concrete Barrier, Single Faced will be measured and paid in linear feet of barrier that has been completed, placed on the road and accepted. Measurement will be made along the top surface at the centerline of the barrier with no deduction made for joints. Price includes, but is not limited to, furnishing and placing concrete and reinforcing steel, transporting and placing precast units, grout, joint filler, hardware, galvanizing, constructing joints and furnishing and installing barrier delineators.

Concrete Barrier Transition Section will be paid in accordance with Section 854-4.

Payment will be made under:

Pay Item	Pay Unit
Precast Reinforced Concrete Barrier, Single Faced	Linear Foot

SECTION 858
ADJUSTMENT OF CATCH BASINS, MANHOLES, DROP INLETS, METER BOXES AND VALVE BOXES

858-1 DESCRIPTION

Raise or lower existing catch basins, manholes, drop inlets, meter boxes and valve boxes encountered within the limits of the project to match the adjacent finished work.

858-2 MATERIALS

Refer to Division 10.

Item	Section
Asphalt Plant Mix	1020
Brick	1040-1
Concrete Block	1040-2
Curing Materials	1026
Grout, Type 3	1003
Joint Filler	1028-1
Joint Sealers	1028-2, 1028-3
Mortar	1040-9
Portland Cement Concrete, Class B	1000

Item	Section
Precast Risers	1077
Reinforcing Steel	1070
Steps	1074-8

858-3 CONSTRUCTION METHODS

Perform the adjustment with brick masonry, block masonry or Portland cement concrete on existing walls in accordance with Subarticle 840-3(C).

Adjust manholes, meter boxes and valve boxes as provided above by using approved fittings. When fittings are used, leave the existing walls in place and securely attach the fittings to the existing walls or install in a manner that will eliminate movement of the fitting. Reconstruct manhole structures where the chimney and frame and cover height will exceed 24 inches.

Pre-cast manholes shall be reconstructed by removing cone and/or straight section(s) and replacing with a section(s) of such length that the manhole cover will be at the correct elevation or can be raised to the correct elevation by the addition of adjusting rings. In the case of brick-type top sections, replace with brickwork. Brick manholes are reconstructed by removing all the brick courses that make up the cone or tapered section. By increasing or decreasing the height of the brickwork in the straight section of the manhole, the rebuilt brick cone section will position the manhole cover at the correct elevation, or it can be raised. Should a junction box with a manhole ring and cover need to be adjusted, break down the junction box and rebuild so that the adjustment, including ring and cover and the thickness of any top slab, does not exceed 24 inches. Construct in accordance with the contract.

Backfill excavated areas in an existing pavement with Portland cement concrete. High early strength concrete may be used. Wait at least 72 hours after the placement of the concrete before placing any surfacing or resurfacing material over the concrete. This time period will not be required where the strength of the concrete is at least 2,500 psi as evidenced by nondestructive tests made in place by a rebound hammer in accordance with ASTM C805. Thoroughly compact backfill of other excavated areas.

In areas to be opened to traffic, construct a temporary ramp of asphalt plant mix 360° around the adjusted structures within one calendar day after completing the adjustment. Construct the ramp with a tapered slope of not less than one foot per inch of height in traffic sections with a speed limit of less than 35 mph and 1.5 feet per inch of height to a maximum of 3 feet from the structure in traffic sections with a speed limit of 35 mph or higher. Construct the ramp using any type of asphalt surface course plant mix meeting the requirements of any job mix formula issued by the Department for a Department project. Compact to an approved density.

Place bituminous plant mix flush with the top of the raised structure within 7 days after raising the structure.

Make the adjustments before the final layer of surfacing material is placed in areas to be surfaced or resurfaced. Salvage and reuse existing frames, grates, manhole covers, rings, meter boxes and valve boxes in the adjustment.

858-4 MEASUREMENT AND PAYMENT

Adjustment of Catch Basins will be measured and paid in units of each for catch basins satisfactorily adjusted.

Adjustment of Drop Inlets will be measured and paid in units of each for drop inlets satisfactorily adjusted.

Adjustment of Manholes will be measured and paid in units of each for manholes satisfactorily adjusted. Payment will not be made for both an adjustment and reconstruction.

Adjustment of Meter Boxes or Valve Boxes will be measured and paid in units of each for meter boxes or valve boxes satisfactorily adjusted.

Reconstruct Manhole Structures will be measured and paid in units of each for manhole structures satisfactorily reconstructed. Payment will not be made for both an adjustment and reconstruction.

Adjustment of Oversized Manholes will be measured and paid in units of each for oversized manholes satisfactorily adjusted and accepted. Manholes with a frame and cover diameter greater than 30 inches and/or frame height greater than 12 inches shall be considered as oversized.

Where any catch basin, drop inlet, manhole, meter box or valve box is adjusted more than once because of milling operations, each adjustment will be measured and paid.

Where a catch basin, drop inlet, meter box or valve box is raised more than 2 feet, the number of linear feet exceeding 2 feet that such structure has been raised will be measured and paid per linear foot as provided in Article 840-4 for *Masonry Drainage Structure*. Measurement will be made by subtracting the elevation at the highest point of the original structure from the elevation at the highest point of the adjusted structure and then subtracting 2 feet from the results.

Manholes shall not be adjusted where the chimney exceeds 2 feet, including the top of the ring and cover to the bottom of the chimney after adjustment. If the chimney including ring and cover is to exceed 2 feet, the manhole shall be reconstructed and payment shall be made under *Reconstruct Manhole Structures*.

Such price includes, but is not limited to, excavation and backfilling, removal of a portion of the existing structure, brick masonry, mortar, grout, concrete, reinforcing steel, fittings, manhole steps, furnishing and hauling asphalt plant mix and any other materials and placing, maintaining, removing and disposing of traffic ramps.

Payment will be made under:

Pay Item	Pay Unit
Adjustment of Catch Basins	Each
Adjustment of Drop Inlets	Each
Adjustment of Manholes	Each
Adjustment of Meter Boxes or Valve Boxes	Each
Adjustment of Oversized Manholes	Each
Reconstruct Manhole Structures	Each

SECTION 859
CONVERTING EXISTING CATCH BASINS, DROP INLETS AND JUNCTION BOXES

859-1 DESCRIPTION

Convert existing catch basins, drop inlets and junction boxes to catch basins, drop inlets or junction boxes, including all necessary construction and reconstruction in accordance with the contract.

859-2 MATERIALS

Refer to Division 10.

Item	Section
Brick	1040-1
Concrete Block	1040-2
Curing Materials	1026
Grout, Type 3	1003
Joint Fillers	1028-1
Low Modulus Silicone Sealant	1028-3
Mortar	1040-9

Item	Section
Portland Cement Concrete, Class B	1000
Reinforcing Steel	1070
Steps	1074-8
Stone, No. 78M	1005
Structural Steel	1072

859-3 CONSTRUCTION METHODS

Perform work in accordance with Article 840-3 and the details shown in the plans. Raise or lower the existing catch basins and drop inlets as required by the plans and provisions.

859-4 MEASUREMENT AND PAYMENT

Convert Existing Catch Basin to Junction Box will be measured and paid in units of each drainage structure that has been acceptably converted.

Convert Existing Catch Basin to Drop Inlet will be measured and paid in units of each drainage structure that has been acceptably converted.

Convert Existing Catch Basin to Junction Box with Manhole will be measured and paid in units of each drainage structure that has been acceptably converted.

Convert Existing Drop Inlet to Junction Box will be measured and paid in units of each drainage structure that has been acceptably converted.

Convert Existing Drop Inlet to Catch Basin will be measured and paid in units of each drainage structure that has been acceptably converted.

Convert Existing Drop Inlet to Junction Box with Manhole will be measured and paid in units of each drainage structure that has been acceptably converted and accepted by the Engineer.

Convert Existing Junction Box to Drop Inlet will be measured and paid in units of each drainage structure that has been acceptably converted.

Convert Existing Junction Box to Catch Basin will be measured and paid in units of each drainage structure that has been acceptably converted.

If grates and frames are necessary in converting either catch basins or drop inlets or if frames and covers are necessary for junction boxes, separate payment will be made for the grates and frames or cover and frame in accordance with Section 840.

Such price will include, but is not limited to, excavating, hauling, removal of a portion of the existing structures, disposal of materials, furnishing, transporting, placing backfill material, subsurface drainage, concrete, brick masonry, mortar, grout, reinforcing steel, hardware, casting, miscellaneous metal, fabricating, welding and galvanizing.

Payment will be made under:

Pay Item	Pay Unit
Convert Existing Catch Basin to Junction Box	Each
Convert Existing Catch Basin to Drop Inlet	Each
Convert Existing Catch Basin to Junction Box with Manhole	Each
Convert Existing Drop Inlet to Junction Box	Each
Convert Existing Drop Inlet to Catch Basin	Each
Convert Existing Drop Inlet to Junction Box with Manhole	Each
Convert Existing Junction Box to Drop Inlet	Each
Convert Existing Junction Box to Catch Basin	Each

SECTION 862
GUARDRAIL

862-1 DESCRIPTION

Construct either permanent or temporary steel beam guardrail, in accordance with the contract and at the locations designated in the plans or as directed by the Engineer.

862-2 MATERIALS

Refer to Division 10.

Item	Section
Anchors	1046-5
Guardrail and Barrier Delineators	1088-2
Guardrail End Delineation	1088-3
Guardrail Steel Post	1046-3
Hardware	1046-4
Organic Zinc Repair Paint	1076-7
Posts and Offset Blocks	1046-3
Rail Elements	1046-2
Select Material, Class VI	1016
Welded Wire Reinforcement	1070-3

Supply material in accordance with the Department's Brand Certification program for guardrail, listed on Department's pre-approved producer/suppliers list and NCDOT APL. The preapproved list is available on the Department's website. Units shall not be modified by the manufacturer and installer once approved and on the NCDOT APL.

Prior to installation the Contractor shall submit to the Engineer certified working drawings and assembling instructions from the manufacturer for each guardrail end unit in accordance with Article 105-2.

Perform installation in accordance with the details in the plans, and details and assembling instructions furnished by the manufacturer.

Temporary guardrail shall be of the type called for in the plans and shall be fabricated from plates that are at least 12 gauge in thickness. Used materials are acceptable for temporary guardrail construction provided their condition is approved by the Engineer.

862-3 CONSTRUCTION METHODS

Erect the rail elements to produce a smooth continuous rail paralleling the line and grade of the highway surface or as shown in the plans. Lap the rail elements in the direction of traffic. Re-lap the rail elements if required by traffic phasing. Field drill holes for special details. Field punching holes is allowed. Attach terminal sections, when required, to the ends of each installation and lap on the face of the rail.

Install shop curve guardrail in accordance with the plans.

Posts may be power driven, or set by hand. Protect the top of steel posts by a suitable driving cap if power driven. If set by hand, dig post holes to the depth and at the locations shown in the plans. Thoroughly ram the bottom of the post holes so that the posts will have a stable foundation. Set the posts plumb and accurately space and line. Backfill the post holes in 6 inch layers with suitable material and thoroughly compact.

Where rock interferes with the proper installation of the post, excavate a shaft in the rock at least 9 inches wide, parallel to the roadway, by 23 inches long, perpendicular to the roadway and 24 inches deep. Place the post against the roadside edge of the shaft and fill in behind the post with Class VI select material, up to the top elevation of the rock. Fill the remainder of the hole with earth material. Where timber posts are to be driven in fill slopes 1.5:1 or steeper and

the fill height is 15 feet or more, auger a 6 inches diameter pilot hole to the full depth of the post before driving.

Where steel posts are required to be installed at box culverts, weld the post to the anchor plate, cut off and align in accordance with the details shown in the plans or as directed by the Engineer.

Use the same type of guardrail posts and offset blocks throughout the project unless otherwise directed by the Engineer or detailed in the plans.

Extra length guardrail posts shall be installed in accordance with the contract.

The 25 foot Clear Span Guardrail Sections shall be constructed in accordance with the *Roadway Standard Drawings*.

After galvanized guardrail has been erected, repair damaged coating in accordance with Article 1076-7.

When guardrail is being constructed near traffic, conduct operations to constitute the least hazard to the public. Schedule and conduct operations to construct and complete each individual continuous guardrail installation in the least possible time.

Do not begin work on any section of new guardrail until preparations are made to fully complete the installation of the section as a continuous operation. Once work begins on a section, pursue the work to its completion unless inclement weather or other conditions beyond the control of the Contractor interfere with the work. Begin attachment of the rail elements at the approach end of the guardrail and continue in the same direction as the movement of traffic.

When directed by the Engineer, install guardrail posts and blocks at locations that are in addition to those required by the plans.

Install tubular triple corrugated steel beam guardrail on concrete bridges or driven posts or at locations shown in the plans in accordance with the details shown in the plans and as directed by the Engineer. Where the tubular triple corrugated steel beam guardrail is to be mounted on concrete, use steel posts, weld the post to the anchor plate, cut off and align in accordance with the details shown in the plans or as directed by the Engineer.

862-4 GUARDRAIL DELINEATORS

Use any of the several alternate delineator types for guardrail shown in the plans, but only one delineator type for guardrail at any one time throughout the project.

The delineators consist of a reflector and base or casing. Attach the delineator to the guardrail as shown in the plans. Only one attachment position will be permitted throughout the project length.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in the median and on the left side of one-way ramps, loops or other one-way facilities. Use white delineators on the right side of divided highways, ramps, loops and all other one-way or two-way facilities. In all cases, the color of the delineator shall supplement the color of the adjacent edgelines.

862-5 TEMPORARY GUARDRAIL

Temporary guardrail may be reused if it is in satisfactory condition. After temporary guardrail is no longer needed, it becomes the property of the Contractor. Remove the temporary guardrail from the project.

862-6 MEASUREMENT AND PAYMENT

Steel Beam Guardrail will be measured and paid in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of either the

outermost post or the w-beam midspan panel splice point of the guardrail in the length of guardrail being measured.

Steel Beam Guardrail, Shop Curved will be measured and paid in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of either the outermost post or the w-beam midspan panel splice point of the guardrail in the length of guardrail being measured.

Steel Beam Guardrail, Double Faced will be measured and paid in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of either the outermost post or the w-beam midspan panel splice point of the guardrail in the length of guardrail being measured.

Triple Corrugated Steel Beam Guardrail will be measured and paid in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of either the outermost post or the w-beam midspan panel splice point of the guardrail in the length of guardrail being measured.

20 Inch Tubular Triple Corrugated Steel Beam Guardrail will be measured and paid in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of either the outermost post or the w-beam midspan panel splice point of the guardrail in the length of guardrail being measured.

Temporary Steel Beam, Guardrail will be measured and paid in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of either the outermost post or the w-beam midspan panel splice point of the guardrail in the length of guardrail being measured.

Temporary Steel Beam Guardrail, Shop Curved will be measured and paid in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of either the outermost post or the w-beam midspan panel splice point of the guardrail in the length of guardrail being measured.

Temporary Steel Beam Guardrail, Double Faced will be measured and paid in linear feet of guardrail that has been satisfactorily completed and accepted exclusive of that length of guardrail that is within the pay limits of guardrail anchors. Measurement will be made from center to center of either the outermost post or the w-beam midspan panel splice point of the guardrail in the length of guardrail being measured.

Steel Beam Guardrail Terminal Section and *Temporary Steel Beam Guardrail Terminal Sections* will be measured and paid in units of each completed and accepted, exclusive of terminal sections that are within the pay limits of guardrail anchors.

Triple Corrugated Steel Beam Guardrail Terminal Sections will be measured and paid in units of each completed and accepted, exclusive of terminal sections that are within the pay limits of guardrail anchors.

Guardrail End Units, Type ____ and *Temporary Guardrail End Units Type ____* will be measured and paid as units of each completed and accepted. No separate measurement will be made of any rail, terminal sections, posts, offset blocks, concrete, hardware or any other components of the completed unit that are within the pay limits shown in the plans for the unit as all such components will be considered to be part of the unit.

Guardrail Anchor Units, Type ___ and *Temporary Guardrail Anchor Units Type ___* will be measured and paid as units of each completed and accepted. No separate measurement will be

made of any rail, terminal sections, posts, offset blocks, concrete, hardware or any other components of the completed unit that are within the pay limits shown in the plans for the unit as all such components will be considered to be part of the unit.

W-TR Steel Beam Guardrail Transition Sections will be measured and paid in units of each completed and accepted.

The quantity of *25′ Clear Span Guardrail Sections* will be measured and paid in units of each which have been completed and accepted.

Extra Length Guardrail Post (__′ Steel) will be measured and paid for in units of each that have been installed and accepted.

Additional Guardrail Posts will be measured and paid in units of each for additional posts required but not shown in the plans.

Temporary Additional Guardrail Posts will be measured and paid for in units of each for additional posts required but not shown on the plans that have been installed and removed after the temporary additional guardrail posts are no longer needed on the project.

There will be no measurement or payment made for guardrail delineators or guardrail end delineation as they are incidental to the other pay items in this section.

Such price and payment includes, but is not limited to, furnishing and erecting posts, offset blocks, rail, terminal sections, miscellaneous hardware and all other materials; field curving and shop curving of the rail; removing temporary guardrail; excavation; furnishing and installing additional guardrail posts and additional offset blocks; backfilling; fabrication; welding; galvanizing; and furnishing and installing guardrail delineators and end delineation.

Where an anchor plate is required, the cost for anchorage of guardrail posts on box culverts will be made in accordance with Article 104-7, unless otherwise specified in the contract.

Payment will be made under:

Pay Item	**Pay Unit**
Steel Beam Guardrail	Linear Foot
Steel Beam Guardrail, Shop Curved	Linear Foot
Steel Beam Guardrail, Double Faced	Linear Foot
Triple Corrugated Steel Beam Guardrail	Linear Foot
20" Tubular Triple Corrugated Steel Beam Guardrail	Linear Foot
Temporary Steel Beam Guardrail	Linear Foot
Temporary Steel Beam Guardrail, Shop Curved	Linear Foot
Temporary Steel Beam Guardrail, Double Faced	Linear Foot
Temporary Guardrail End Units, Type ____	Each
Temporary Steel Beam Guardrail Terminal Sections	Each
Steel Beam Guardrail Terminal Sections	Each
Triple Corrugated Steel Beam Guardrail Terminal Sections	Each
Guardrail End Units, Type ___	Each
Guardrail Anchor Units, Type ____	Each
Temporary Guardrail Anchor Units, Type ____	Each
W-TR Steel Beam Guardrail Transition Sections	Each
25′ Clear Span Guardrail Sections	Each
Extra Length Guardrail Post (__′ Steel)	Each
Additional Guardrail Posts	Each
Temporary Additional Guardrail Posts	Each

SECTION 863
REMOVE EXISTING GUARDRAIL AND GUIDERAIL

863-1 GENERAL

Dismantle, remove and dispose of existing guardrail, guiderail and anchors of any type at locations shown in the plans or established by the Engineer.

863-2 CONSTRUCTION METHODS

Remove guardrail, guiderail and posts beginning at the trailing end and continuing towards the approach end. Remove the posts immediately after the rail or cable is removed. Complete post removal so that no posts without rail or cable attached are present at the end of any day's operations. Exercise care not to damage adjoining structures or other appurtenances. Fill any void created by post or anchor removal and repair all damages. All guardrail, guiderail and components removed are the property of the Contractor.

863-3 MEASUREMENT AND PAYMENT

Remove Existing Guardrail and *Remove Existing Guiderail* will be measured and paid in linear feet of guardrail or guiderail that has been satisfactorily removed. Measurement will be made to the nearest 1.0 feet from center to center of the outermost post or end shoe center bolt in the length of the guardrail or guiderail being removed. Measurement will be made before removing the guardrail or guiderail.

The work to fill any void or fix all damage created by post or anchor removal is incidental to the work of this section.

Payment will be made under:

Pay Item	Pay Unit
Remove Existing Guardrail	Linear Foot
Remove Existing Guiderail	Linear Foot

SECTION 864
REMOVE AND RESET EXISTING GUARDRAIL AND GUIDERAIL

864-1 GENERAL

Remove and reset existing guardrail, guiderail and anchors of any type at locations shown in the plans and the contract.

864-2 CONSTRUCTION METHODS

Exercise care not to damage adjoining structures or other appurtenances. Fill any void created by post or anchor removal and repair all damage at no cost to the Department. Reset existing guardrail and guiderail in accordance with Articles 862-3 and 865-3. Reset guardrail and guiderail in a condition that is equal to or better than the condition that exists before the guardrail and guiderail is removed. Replace any of the guardrail and guiderail components unnecessarily damaged.

864-3 MEASUREMENT AND PAYMENT

Remove and Reset Existing Guardrail will be measured and paid in linear feet of guardrail and anchors that has been removed, reset and accepted. Measurement will be made after the guardrail has been reset.

Remove and Reset Existing Guiderail will be measured and paid in linear feet of guiderail and anchors that has been removed, reset and accepted. Measurement will be made after the guiderail has been reset.

Such price will include, but is not limited to, removing and resetting the guardrail, guiderail and anchors and for furnishing all equipment, labor and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
Remove and Reset Existing Guardrail	Linear Foot
Remove and Reset Existing Guiderail	Linear Foot

SECTION 865
CABLE GUIDERAIL

865-1 DESCRIPTION

Construct cable guiderail in accordance with the contract and at the locations designated in the plans or as directed by the Engineer. Install additional double faced cable guiderail posts without cable at median hazards as shown in *Roadway Standard Drawings*.

865-2 MATERIALS

Refer to Division 10.

Item	Section
Hardware	1046-4
Portland Cement Concrete, Class A	1000
Posts	1046-3
Precast Concrete Anchors	1077
Rail Elements	1046-2
Select Material, Class VI	1016

Manufacture cable in accordance with AASHTO M 30, Type I, Class A. The cable shall be pre-inspected at the producer's facility before shipment.

Additional guiderail posts shall be double faced guiderail intermediate posts.

865-3 CONSTRUCTION METHODS

Erect the rail elements to produce a smooth continuous rail paralleling the line and grade of the highway surface or as shown in the plans.

Posts may be power driven or set by hand. Protect the top of steel posts by a suitable driving cap if power driven. If set by hand, dig post holes to the depth and at the locations shown in the plans. Thoroughly ram the bottom of the post holes so that the posts will have a stable foundation. Set the posts plumb and accurately space and align. Backfill the post holes in 6 inch layers with suitable material and thoroughly compact by tamping or puddling.

Where rock interferes with the proper installation of the post, excavate a shaft in the rock at least 9 inches wide, parallel to the roadway, by 23 inches long, perpendicular to the roadway, and 24 inches deep. Place the post against the roadside edge of the shaft and fill in behind the post with Class VI select material, up to the top elevation of the rock. Fill the remainder of the hole with earth material. Where timber posts are to be driven in fill slopes 1.5:1 or steeper and the fill height is 15 feet or more, auger a 6 inch diameter pilot hole to the full depth of the post before driving.

When guiderail is being constructed near traffic, conduct operations to constitute the least hazard to the public. Schedule and conduct operations to construct and complete each individual continuous guiderail installation in the least possible time.

Do not begin work on any section of new guiderail until preparations are made to fully complete the installation of the section as a continuous operation. Once work begins on a section, pursue the work to its completion unless inclement weather or other conditions beyond the control of the Contractor interfere with the work. Begin attachment of the cable elements at the approach end of the guiderail and continue in the same direction as the movement of traffic.

865-4 MEASUREMENT AND PAYMENT

Cable Guiderail will be measured and paid in linear feet of guiderail that has been satisfactorily completed and accepted exclusive of that length of guiderail that is within the pay limits of guiderail anchors. Measurement will be made from center to center of the outermost post in the length of guiderail being measured. Such price will include, but is not limited to, furnishing and erecting posts, cable, miscellaneous hardware, concrete, delineators and all incidentals necessary to complete the work.

Double Faced Cable Guiderail will be measured and paid in linear feet of guiderail that has been satisfactorily completed and accepted exclusive of that length of guiderail that is within the pay limits of guiderail anchors. Measurement will be made from center to center of the outermost post in the length of guiderail. Such price will include, but is not limited to, furnishing and erecting posts, cable, miscellaneous hardware, concrete, delineators and all incidentals necessary to complete the work.

Cable Guiderail Anchor Units will be measured and paid in units of each completed and accepted.

Additional Guiderail Posts will be measured and paid in units of each completed and accepted.

No separate measurement will be made of any cable, posts, concrete, hardware or any other components of the completed anchor units that are within the pay limits shown in the plans.

Payment will be made under:

Pay Item	Pay Unit
Cable Guiderail	Linear Foot
Double Faced Cable Guiderail	Linear Foot
Cable Guiderail Anchor Units	Each
Additional Guiderail Posts	Each

SECTION 866
FENCE

866-1 DESCRIPTION

Furnish and erect woven wire, chain link and barbed wire fence with gates in conformity with the details shown in the plans and at locations as shown in the plans.

866-2 MATERIALS

Refer to Division 10.

Item	Section
Barbed Wire	1050-4
Chain Link Fabric	1050-6
Fence Materials	1050-1
Fittings and Accessories	1050-7
Metal Posts and Rails	1050-3
Organic Zinc Repair Paint	1076-7
Timber Posts and Braces	1050-2
Woven Wire	1050-5

Use Class B concrete for anchors. Instead of Class B concrete, pre-mixed commercially bagged dry concrete mix may be used if the concrete meets the minimum strength requirements for Class B concrete when mixed with the quantity of water shown on the instructions printed on the bag.

866-3 CONSTRUCTION METHODS

(A) Clearing and Grubbing

Only clear the ground that is necessary to erect a clear fence line. Clearing includes satisfactory removal and disposal of all trees, brush, stumps, existing fence or other objectionable material. Erect the fence to conform to the general contour of the ground. Place the bottom of the fabric or wire no more than 6 inches above the natural ground, except where the Engineer directs that ditches and depressions are to be spanned by using extra length posts in conjunction with additional barbed wire installed between the bottom of the fence wire or fabric and the ground surface. Grade along the fence line to meet the above requirement such that no obstructions to proper drainage are created.

(B) Setting Posts and Braces

Set and maintain all posts in a vertical position. Line posts may be hand set or set with a post driver. Thoroughly tamp all backfilled material if hand set. If power driven, wood posts may be sharpened to a dull point. Remove and replace posts that are damaged by power driving.

Set posts in concrete anchors to maintain the position and alignment of the post when required in the plans or where dictated by soil conditions. Forms are not required for the concrete. Trowel the top of the concrete to a smooth finish and slope to drain away from the post. The concrete anchors require at least a 3 day curing period before any load is placed on the post.

Instead of setting roll formed steel line posts in concrete, such posts may be driven provided they are not part of a line brace assembly. Drive the posts at least 3 feet into the ground. Provide adequate protection to the post tops to prevent damage from the driving operations. Repair damage to the zinc coating in accordance with Article 1076-7. Set posts in concrete anchors where soil conditions are such that the posts cannot be driven without deformation, or where soils are encountered that does not provide adequate in-ground stability.

Where rock or concrete pavement or slabs are encountered within the required depth where fence posts are to be erected, drill a hole in the rock or concrete of a diameter slightly larger than the largest dimension of the post in the rock or concrete and grout in the post. The depth of post embedment shown in the plans will not be required and the post may be shortened as necessary, provided the post is embedded within the rock or concrete pavement or slab to a minimum depth of 12 inches.

Do not fabricate extra length posts by welding short sections of posts together.

Place line braces at the end of each roll or piece of woven wire.

Do not use pieces of woven wire fabric less than 100 feet in length, unless otherwise directed by the Engineer. When the use of short pieces of woven wire is permitted, furnish and install the additional required brace posts and braces. Approved splicing sleeves may be used instead of providing such brace posts and braces.

(C) Installing Fabric and Wire

(1) Chain Link Fence

Attach chain link fabric to tubular end, gate, corner or brace posts with stretcher bars and stretcher bar bands as shown in the plan. Fasten the fabric to line posts and to top and brace rails with wire fasteners spaced and wound as shown in the plans. Fasten the fabric to the tension wire by hog rings spaced at 24 inch intervals or weave the tension wire through the fabric. Make hog ring ties at fabric joints with the hog ring passing completely around the fabric joint.

Place chain link fabric by securing or fastening on end and applying sufficient tension to remove all slack before making permanent attachments elsewhere. Apply the tension for stretching by mechanical fence stretchers designed for this purpose.

Connect rolls and pieces of chain link fabric to each other by field weaving provided that such weaving is identical in appearance and strength as the machine weaving done at the factory.

Attach barbed wire used in conjunction with chain link fabric, to the post by eyebolt or by a tie wire passing through holes drilled in the metal post to prevent any vertical movement of the barbed wire. Wrap the ends and beginnings of strands around the post twice and securely fasten by winding the end around the wire near the post. Splice barbed wire only at posts.

Install additional barbed wire when shown in the plans or where directed by the Engineer.

(2) Woven Wire Fence

Stretch woven wire fabric taut and securely attach to each post with one or more staples in each line of wire. Use as many staples as required to firmly secure the wire at the location and elevation required by the plans. When woven wire is attached to metal posts, use at least five clips at each post to fasten the individual strands of wire to the post except where wrapping of the strand around the post is required. Stretch with an approved stretcher that will produce equal tension in each line of wire.

At each end or gate post, at the center post in each line brace and at corner posts except as otherwise shown in the plans, cut out all vertical strands of wire and wrap each horizontal strand of wire around the post and securely fasten by winding the end around the strand of wire near the post.

Do not splice fabric between the posts of a brace post assembly. Do not splice between other posts, unless the splicing sleeves are approved by the Engineer.

Pull woven wire taut and securely attach to each post by methods described for woven wire when used in conjunction with woven wire fabric. Do not splice woven wire between posts.

Install additional woven wire as shown in the plans or where directed by the Engineer.

(3) Barbed Wire Fence

Install barbed wire fence in accordance with the plans and as directed.

Pull barbed wire taut and securely attach to each post by methods described for woven wire. Do not splice barbed wire between posts.

866-4 MEASUREMENT AND PAYMENT

Woven Wire Fence, __" Fabric will be measured and paid in linear feet of fence, measured in place from center of each post or gate post to center of end post or gate post exclusive of gate sections, that has been completed and accepted.

Chain Link Fence, __" Fabric will be measured and paid in linear feet, of fence measured in place from center of each post or gate post to center of end post or gate post exclusive of gate sections, that has been completed and accepted.

____ *Strand Barbed Wire Fence with Posts* will be measured and paid in linear feet of fence measured in place from center of each post or gate post to center of end post or gate post exclusive of gate sections that has been completed and accepted. All posts used for the barbed wire fence are included in the price of the barbed wire fence and will not be paid separately.

__" *Timber Fence Posts,* ____ will be measured and paid in units of each for the several sizes and kinds of posts installed on the project, including timber line posts, brace posts, gate posts and posts erected as barriers at driveways and entrances. The actual length of timber posts in linear feet of variable length and extra length posts shall be measured as placed and converted to an equivalent number of standard length posts of the same size for which a pay item has been established. In converting to equivalent numbers of standard length posts, any fractional portion of a post remaining from the division of a total number of linear feet by a standard post length shall be considered as equal to one post. Where the Contractor has elected to use pieces of woven wire shorter than 100 feet in length, as permitted by Subarticle 866-3(B), on the condition that he furnish and install at no additional cost to the Department line braces at the ends of short pieces, timber fence posts shall include the number of line posts made unnecessary by such line braces but shall exclude the posts used in the line braces.

Metal Line Posts for __" Chain Link Fence will be measured and paid in units of each for the several sizes and kinds of posts actually installed on the project. For extra length metal posts, the actual length of post in place in excess of the standard pay length for each post shall be measured in linear feet, and half of such length shall be converted to an equivalent number of standard length posts of the same size for which a pay item has been established. In converting to equivalent numbers of standard length posts, any fractional portion of a post remaining from the division of a total number of linear feet by a standard post length shall be considered as equal to one post.

Metal Terminal Posts for __" Chain Link Fence will be measured and paid in units of each for all end, corner and brace posts installed on the project.

Metal Gate Posts for __" Chain Link Fence, Double Gate will be measured and paid in units of each for gateposts installed on the project.

Metal Gate Posts for __" Chain Link Fence, Single Gate will be measured and paid in units of each for gate posts installed on the project.

Double Gates, __High, __Wide, __ Opening will be measured and paid in units of each for the number of gates actually erected on the project. Double gates will be measured as one gate.

Single Gates, __ High, __Wide, __ Opening will be measured and paid in units of each for the number of gates actually erected on the project.

Additional Barbed Wire will be measured and paid in linear feet of wire installed in the work, complete and in place. Measurement of additional barbed wire will be made along each strand after the installation has been completed. No measurement will be made of any wraps, nor will measurement be made of the upper or lower continuous strand of barbed wire that is erected as part of woven wire fence.

Setting sleeves in retaining wall will not be paid as such work is incidental to the other pay items in this specification.

Work includes, but is not limited to, clearing and grading; and furnishing and installing fence fabric, barbed wire, staples, tie wires, stretcher bars, top rails, tension wire, posts and post braces, concrete, gates, fittings and any other materials, furnishing and installing sleeves in retaining walls and filling sleeves upon setting posts.

When the use of short pieces of woven wire is permitted, furnish and install the additional required brace posts and braces at no additional cost to the Department.

Payment will be made under:

Pay Item	Pay Unit
Woven Wire Fence, __" Fabric	Linear Foot
Chain Link Fence, __" Fabric	Linear Foot
____ Strand Barbed Wire Fence with Posts	Linear Foot
__" Timber Fence Posts, __' Long	Each
Metal Line Posts for __" Chain Link Fence	Each
Metal Terminal Posts for __" Chain Link Fence	Each
Metal Gate Posts for __" Chain Link Fence, Double Gate	Each
Metal Gate Posts for __" Chain Link Fence, Single Gate	Each
Double Gates, __ High, __ Wide, __ Opening	Each
Single Gates, __ High, __ Wide, __ Opening	Each
Additional Barbed Wire	Linear Foot

SECTION 867
FENCE RESET

867-1 DESCRIPTION

Remove and reset existing fences of various types to the locations indicated in the plans or where directed by the Engineer.

867-2 CONSTRUCTION METHODS

Reset the fence in a condition that is equal to or better than before the fence is removed. Replace any of the fence components unnecessarily damaged by the Contractor's forces. Fill any void created by fence removal.

The Contractor will be responsible for damage caused by livestock escaping or entering the existing fenced area through the negligence of his forces.

If the owner of the fence desires to repair, rebuild or renew any parts of the fence and agrees to furnish the materials without cost to the Contractor, then repair, rebuild, renew and reset such fence using the material furnished by the owner at no additional cost to the owner or the Department.

867-3 MEASUREMENT AND PAYMENT

____ *Fence Reset* will be measured and paid in the linear feet of fence that has been acceptably reset. Measurement will be made along the fence after it has been reset from center of end post to center of end post. Such price includes, but is not limited to, removing, hauling and re-erecting the existing fence; and furnishing and installing any fence components unnecessarily damaged by the Contractor's forces.

Payment will be made under:

Pay Item	Pay Unit
____ Fence Reset	Linear Foot

SECTION 869
RELAPPING GUARDRAIL

869-1 DESCRIPTION

Relap either existing or recently installed guardrail in accordance with the contract and where directed by the Engineer.

869-2 CONSTRUCTION METHODS

Where required by the traffic phasing, at locations shown in the plans, or where directed by the Engineer, relap guardrail to conform to the required traffic pattern. Complete all required relapping of guardrail and have it inspected before shifting traffic into a new traffic pattern. All guardrail shall be lapped in the direction of traffic before placing traffic next to the guardrail.

869-3 MEASUREMENT AND PAYMENT

Relapping Guardrail will be measured and paid in linear feet of guardrail that has been satisfactorily relapped and accepted. Measurement will be made from center to center of the outermost post in the length of guardrail being measured. Such price includes, but is not limited to, providing all necessary labor, tools, equipment and materials necessary to acceptably relap the guardrail.

Payment will be made under:

Pay Item	Pay Unit
Relapping Guardrail	Linear Foot

SECTION 873
PREFORMED SCOUR HOLE WITH LEVEL SPREADER APRON

873-1 DESCRIPTION

Construct and maintain preformed scour holes with spreader aprons at the locations shown on the plans and in accordance with the details in the plans. Work includes excavation, shaping and maintaining the hole and apron, furnishing and placing filter fabric, rip rap (class as specified in the contract) and permanent soil reinforcement matting (PSRM) as specified in the contract.

873-2 MATERIALS

Refer to Division

Item	Section
Plain Rip Rap	1042
Filter Fabric	1056

Use PSRM Type 3 in accordance with the contract.

873-3 CONSTRUCTION METHODS

All areas to be protected with the mat shall be brought to final grade and seeded in accordance with Section 1660. The surface of the soil shall be smooth, firm, stable and free of rocks, clods, roots or other obstructions that would prevent the mat from lying in direct contact with the soil surface. Areas where the mat is to be placed will not need to be mulched.

873-4 MEASUREMENT AND PAYMENT

Preformed Scour Holes with Level Spreader Aprons will be measured and paid as the actual number incorporated into the completed and accepted work. Such price and payment will be full compensation for all work covered by this provision.

Payment will be made under:

Pay Item	Pay Unit
Preformed Scour Hole with Level Spreader Aprons	Each

SECTION 876
RIP RAP

876-1 DESCRIPTION

Supply and place rip rap and, if necessary, filtration geotextiles in accordance with the contract and as directed by the Engineer.

876-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextile for Drainage, Type 2	1056
Plain Rip Rap	1042

Provide Type 2 geotextile for filtration geotextiles and plain rip rap classes in accordance with the contract.

876-3 PLAIN RIP RAP

Grade locations for rip rap as shown in the plans. Use filtration geotextiles under rip rap when shown in the plans and as directed by the Engineer. Do not leave geotextiles exposed for more than 7 days before covering with rip rap. Place filtration geotextiles on surfaces free of obstructions, debris and soft pockets.

Overlap adjacent geotextiles at least 18 inches in the downhill and downstream direction to prevent flow from lifting the edge of the top geotextile. Pull filtration geotextiles taut so they are in tension and free of kinks, folds, wrinkles or creases. Hold geotextiles in place as needed with wire staples or anchor pins. Do not displace or damage filtration geotextiles while placing rip rap. Replace any damaged geotextiles to the satisfaction of the Engineer.

For rip rap at pipe outlets, place rip rap immediately after installing pipes. When rip rap is required for channel changes and drainage ditches, place rip rap before diverting water into channels and ditches.

Place rip rap such that the smaller stones are uniformly distributed throughout rip rap. Install rip rap with mechanical methods and if necessary, by hand to form a well-graded, dense and neat layer of rip rap.

876-4 MEASUREMENT AND PAYMENT

Rip Rap, Class ____ will be measured and paid in tons. Plain rip rap will be measured by weighing rip rap in trucks in accordance with Article 106-7.

Geotextile for Drainage will be measured and paid in square yards. Filtration geotextiles will be measured along the ground surface as the square yards of exposed geotextiles before placing rip rap. No measurement will be made for overlapping geotextiles.

The contract unit prices for *Rip Rap, Class* ____ and *Geotextile for Drainage* will be full compensation for providing, transporting and placing rip rap, filtration geotextiles, wire staples and anchor pins.

Payment will be made under:

Pay Item	Pay Unit
Rip Rap, Class ____	Ton
Geotextile for Drainage	Square Yard

DIVISION 9
SIGNING

SECTION 900
GENERAL REQUIREMENTS FOR SIGNING

900-1 DESCRIPTION

Furnish, fabricate and erect complete traffic sign systems in accordance with the contract.

900-2 ACCEPTANCE OF SIGNS

Before final inspection of the signs, clean exposed sign and support surfaces and repair the sign as may be deemed necessary to ensure the safety, effectiveness and neat appearance of the work.

Maintain responsibility for the signs until accepted by the Engineer. Any damaged sign will not be accepted by the Engineer. Any repairs to the signs before final acceptance of the project are to be approved by the Engineer.

Do not perform any repair work without written approval. Make repairs only in the presence of the Engineer.

Handle, transport and store all signs in accordance with the sheeting manufacturer's recommendations. Failure to comply with the manufacturer's recommendations during the handling, transporting and storing of the signs will be cause for rejection.

The Contractor may request early Engineer acceptance of part or all of the highway signs, including sign panels, retroreflective sheeting and associated hardware, before final project acceptance. Sign supports will not be accepted early. To be accepted before final project acceptance, the signs shall be required for traffic control at that phase of project construction.

If the Engineer accepts the signs, the Contractor will be relieved of the responsibility for any damage or theft that may occur to the signs, retroreflective sheeting or associated hardware, with exception of any damage caused by the Contractor or any subcontractor working on the project.

900-3 ALTERNATE DESIGN

Standard designs for Types A, B, C, D, E or F signs will be shown in the contract. Instead of the standard design, the Contractor may submit for approval an alternate design for sign panels differing in component parts and construction details from those shown in the contract. Provide any alternate designs that are in accordance with the MUTCD.

Submit complete details of the alternate sign designs to the Engineer for approval. Include the dimensions, thickness and alloys of the component parts, and typical shop drawings of all fabrication, erection and construction details.

Alternate design for supports and footings will not be permitted.

900-4 COVERING OF SIGNS

Cover signs or portions of signs with opaque material if erected on roads open to traffic and not yet applicable. Keep signs or portions of signs covered until instructed to remove the covering. Provide covering for entire signs by an approved method provided by sheeting manufacturer that will prevent the messages from being read or seen during both day and night conditions and that will cause no harm to the sheeting face.

SECTION 901
SIGN FABRICATION

901-1 DESCRIPTION

Fabricate and furnish signs, including sign face, supporting frames, hardware and package the signs for shipment.

901-2 MATERIALS

Refer to Division 10.

Item	Section
Retroreflective Sheeting	1092-2
Signs and Hardware	1092-1
RFID Tracking Program (A, B, and D Signs)	1030-1, 1030-2, 1030-8

901-3 CONSTRUCTION METHODS

(A) General

Details concerning the fabrication and erection of the signs are shown in the contract. Sign designs not shown in the contract are available from the Engineer.

Fabricate all items within 1/8 inch of design measurements. Scribe each sign, shield, arrow, overlay or blank on the back with the month and year.

Do not begin fabrication of Type A and B signs until S-dimension verification revisions have been approved by the Engineer.

Provide mounting holes in the Z-stringers of the signs in accordance with the details shown in the contract or approved shop drawings. Provide a space between the Z-bar and backing strip not greater than 1/8 inch.

Date the erection of all signs and sign assemblies using printed self-adhesive labels designed for punching the appropriate day, month and year numbers with a hole punch. Place the label on the back of each sign in the lower corner nearest the roadway. The Sign Fabricator will provide a sufficient quantity of the labels for each sign. For Type A, B and D signs, print on the back of each sign the size of that sign (e.g. 144 inches x 48 inches) with black vinyl characters at least 4 inches in height and located in the bottom right corner on the back of the sign. The self-adhesive installation date label shall be located near the vinyl characters and should include a Departmental approved RFID tag/label in accordance with Section 1030.

Ship all multi-panel signs to the project intact, completely assembled and ready to be installed. Fabricate signs taller than 12 feet as two separate signs with a horizontal splice, ready to be spliced and installed. Unless approved by the Engineer, no assembly other than a horizontal splice will be permitted except when a route shield or copy is required to be attached because of the horizontal splice.

(B) Department and Contractor Furnished Signs

Use the contract to determine whether the signs are to be fabricated and furnished by the Contractor or whether the Department will provide them to the Contractor.

For both Department and Contractor Furnished Signs, the Contractor provides all mounting hardware consisting of, but not limited to, shims, backing plates, mounting bolts, washers and nuts.

The sign fabricator will provide vertical Z-bars required for attaching secondary signs to the primary signs.

Confirm in writing at least 4 months in advance, the actual date the Department furnished signs will be required. The signs will be made available to the Contractor for pickup at the

North Carolina Department of Public Safety sign fabrication facility on N.C. 39 near Bunn, North Carolina, unless otherwise indicated in the contract. Provide for all transportation.

The Engineer will inspect and approve the signs before they are packaged and crated for shipment. Take delivery of all signs within 60 days of the date requested or the date they are made available, whichever occurs last, and within 96 hours of receiving the first sign. The Engineer shall approve any exception to the above delivery procedure. At the time the signs are delivered to the project, provide to the Engineer one copy of the sales ticket furnished with the signs.

After taking possession of the signs, the Contractor is responsible for any damage or theft that occurs to signs before final acceptance by the Engineer. Comply with the reflective sheeting manufacturer's recommendations for handling, transporting, erecting and storing of the signs. Acceptably repair or otherwise correct any damage to the signs or refabricate them. When requested by the Contractor, the Department may have the necessary repairs made or the signs refabricated, and deduct the associated cost thereof from monies due the Contractor.

(C) Signs

Construct all signs, supporting frames and assemblies in accordance with the details shown in the contract and Tables 901-1 and 901-2.

TABLE 901-1
SIGN TYPE PARAMETERS

Sign Type	Vertical and Horizontal Dimensions	144"x 48" Aluminum Panels	Horizontal Z-Bars	Aluminum Thickness
A	Vertical or Horizontal > 144" or Vertical and Horizontal > 48"	Multiple	Yes	0.125"
B	Vertical and Horizontal ≤ 144" and Vertical or Horizontal ≤ 48"	Single	Yes	0.125"
D	-	Single	No	See Table 901-2
E	-	Single	No	See Table 901-2
F	-	Single	No	See Table 901-2

(1) Type A Signs

Fabricate Type A signs from multiple aluminum sheet increments of the thickness shown in Table 901-1, with welded studs for attachment to the supporting frame.

Use aluminum sheets with increments of 4 feet in width; except, for sign widths that are not multiples of 4 feet, a maximum of 2 panels may be cut to less than 4 feet. No panel may be cut to less than one foot. Mount aluminum sheet increments vertically and provide with backing strips at the vertical joints, held firmly in place, to keep the abutting sheets in proper alignment. Leave a space of 0.020 inch to 0.032 inch between each panel sheeted with non-prismatic sheeting. Prismatic sheeting is be trimmed at a 45° angle from the edge of each panel.

Fabricate signs with a height of 12 feet or less, without horizontal joints. No more than two horizontal joints will be permitted for signs that are more than 12 feet in height. Locate the joint near the mid-height of the sign. Construct this joint according to the details in accordance with the contract.

(2) Type B Signs

Fabricate Type B signs from a single aluminum sheet of the thickness shown in Table 901-1, with welded studs for attachment to the supporting frame.

(3) Types D, E and F Signs and Milemarkers

Fabricate Types D, E and F signs and milemarkers from single sheets of the thickness shown in Table 901-2, with holes for bolting to the supports.

Construct Types E and F signs in accordance with the *FHWA Standard Highway Signs*. Adequately identify each individual sign to the correct assembly. Following the erection of Type E and F sign assemblies, leave the identification markings on the individual signs until Department personnel have verified compliance with these requirements.

(4) Overlays for Existing Signs

Manufacture all overlays for existing signs of the thickness shown in Table 901-2. Do not make holes for rivets in the overlays during fabrication, but instead field-drill them during the erection process.

(D) Aluminum

(1) Thickness Requirements

TABLE 901-2
ALUMINUM THICKNESS REQUIREMENTS FOR SIGNS

Vertical or Horizontal Dimension	Minimum Thickness
Inches	*Inches*
0-11.9	0.032
12-35.9	0.063
36-47.9	0.080
48 and larger	0.125
Milemarkers	0.080
Overlays	0.063

(2) Preparation of Aluminum Sign Surfaces

Do not handle any metal, except by appropriate handling devices or by workmen wearing clean gloves, between the beginning of the coating operations and the completion of the application of the retroreflective sheeting. Retreat aluminum sign surfaces that come into contact with grease, oils or other contaminants before the application of retroreflective sheeting.

Before applying retroreflective sheeting to the aluminum, treat the aluminum sign surfaces with a chromate conversion coating. Such coating shall be applied according to the manufacturer's instruction and shall conform to ASTM B449, Class 2, and should range in color from silvery iridescent to pale yellow. The coating weight shall be 10 mg/sf to 35 mg/sf on the entire surface area including along the edges of the sign substrate with a median of 25 mg/sf as the optimum coating weight. Ensure the coating does not appear dusty when wiped with a clean, lint-free cloth and does not show excessive buildup at edges. Sand smooth all burrs and scratches before applying retroreflective sheeting. Sheet all sanded aluminum within the same day to prevent the formation of corrosion on the metal. Do not sand or use abrasive materials on sheeted faces. Aluminum products shall be randomly tested.

(E) Supporting Frames

Use supporting frames for Types A and B signs consisting of 2 or more horizontal aluminum Z-stringers with vertical aluminum bar stiffeners in accordance with the details

and dimensions shown in the contract. Use a nylon washer to attach all thru bolts with a play of at least 1/16 of an inch and no more than 1/8 of an inch. Provide stringers with necessary holes and slots for bolting stiffeners, attaching aluminum sheet increments and mounting to supports. Do not field drill holes in any part of the structural assembly, except the field drilling of horizontal Z-bars for attaching new signs to existing supports when necessary.

(F) Welding

Weld studs to aluminum sheets by the capacitor discharge method. If the studs are welded after the retroreflective sheeting has been applied, ensure that burn-through does not damage the retroreflective sheeting.

Shoot a test stud on each Type A and B sign in the lower left corner of the most left panel facing the back of the sign.

(G) Retroreflective Sheeting

Apply retroreflective sheeting to the aluminum sign panels in accordance with the retroreflective sheeting manufacturer's recommendations. For each multi-panel increment sign using glass beaded materials, sheet the entire sign from the same roll.

If a sign panel needs to be replaced after sign fabrication, the replacement panel may be sheeted with retroreflective materials from a different lot or drum number than the remainder of the sign; however, use material that visually color matches and meets Article 1092-2.

Take retroreflectometer readings on all 4 corners of each panel and document the readings on the sign design drawings.

Overlap all splices of any encapsulated or enclosed lens sheeting to allow water to run off without running into the splice. All prismatic sheeting will be butt spliced.

Remove all foreign materials on the sheeted face with compressed air.

Keep a sample of each roll of sheeting and test for retroreflective compliance.

Patch wrinkles in the sheeting around thru bolts by removing the affected sheeting from the metal. Then patch this area with a circular patch encompassing an area 1/4 inch outside the affected area. This patch shall not exceed the standard patching limits shown in Table 901-3.

Ensure that all patches on the sign have a 1 inch minimum width or as recommended by the sheeting manufacturer.

Maintain documentation of the lot, drum, inspector, roll size, date received, date sheeted and metal treater on all signs, slip sheeting, copy, borders, shields, overlays, arrows and panels and retroreflectometer readings.

Obtain and assign to the Department in writing warranties for sign sheeting used in the fabrication of all permanent signs from the sheeting manufacturer. Warrant the signs against defective sheeting per the requirements outlined in the contract.

Define “permanent signs” as Types A, B, C, D, E and F signs, overlays for all sign types and milemarkers, and exclude any signs used only for traffic control while the project is under construction.

The reflective sheeting may be patched to repair incidental damage to the sheeting that might occur during manufacture, in transit or after installation; however, the patches cannot exceed the limits in Table 901-3.

TABLE 901-3
SIGN PATCHING LIMITS

Sign Area	Maximum Number and Size of Patches During Fabrication		Maximum Number and Size of Additional Patches After Field Erection	
Square Feet	*Max. Number per Sign*	*Max. Size in Sq.In.*	*Max. Number per sign*	*Max. Patch Size in Sq.In.*
0 to 15.0	0	0	0	0
15.1 to 50.0 (Single Panel)	1	1	1	1
30.0 to 80.0 (Increment Panel)	2	2	1	2
80.1 and Greater	**A**	3	**A**	3

A. Average not to exceed one patch per panel per sign. Maximum of 3 patches per panel allowed during fabrication with one additional patch per panel allowed after field erection.

(H) Reflectorized Letters, Numerals, Symbols, Border and Shields

(1) General

Use direct-applied retroreflective sheeting, approved digital imaging or demountable retroreflective sheeting letters, numerals, borders, shields and arrows as indicated on the sign designs.

Use designs of letters and numerals that conform to the MUTCD and *FHWA Standard Highway Signs and Markings*. Use border widths, design of route shields and arrows that conform to the MUTCD.

Route shields used on Type A or B signs or overlays shall be demountable or as approved digital imaging.

Space and size all legends and borders in accordance with the contract or approved shop drawings. Any loose, deformed or misplaced legends and borders will be cause for rejection of the entire sign.

(2) Direct Applied

Provide direct-applied reflectorized letters, numerals, arrows and borders that are of the type and color of retroreflective sheeting shown in the contract for each sign. All direct applied copy or border not permanently affixed may be removed and replaced on signs if necessary during manufacture.

(3) Demountable

Attach demountable letters, numerals, borders, shields, arrows and alphabet accessories directly to sign faces with rivets as shown in the contract.

Use letters, numerals, arrows, borders and shields made of adhesive-coated retroreflective sheeting, permanently adhered to a flat aluminum backing, in accordance with the contract.

Use aluminum backing of at least 0.032 inch thick aluminum sheeting of 3004-H38, 5052-H38 or 6061-T6 alloy. Treat with a light, tight, amorphous chromate-type coating in accordance with the recommendations of the retroreflective sheeting manufacturer. Apply the retroreflective sheeting to the properly prepared aluminum using the method and equipment prescribed by the sheeting manufacturer.

Supply each letter, numeral, arrow, border and shield with mounting holes, and secure to the sign surface with non-twist corrosion resistant aluminum rivets. Use letters, numerals, arrows and borders that have rivets on all sides and ends spaced not more than 6 inches on centers, measured along the edges. Make sure that each legend piece has at least one rivet in each corner and at least 2 rivets in each end. Attach route shields as part of Type A or B signs with aluminum rivets spaced not more than 9 inches apart, measured along the edges of the shield.

Use a 1/4 inch diameter nylon washer under the head of all pull through type rivets for all demountable copy and shields.

(4) If approved, use digital printing equipment to image or reverse image on retroreflective sheeting for letters, numerals, borders, shields and arrows on digitally approved retroreflective sheeting for traffic control signs on aluminum or digitally printed traffic sign faces intended to be applied to a sign substrate.

(I) Silk Screening

Apply all legends and borders on Type E and F signs by silk-screening or reverse silk-screening after the sheeting is attached to the panels. Perform all screening as recommended by the manufacturer of the retroreflective sheeting. Use the color of all legends, borders and backgrounds, and their placement on the sign, in accordance with the contract.

Use opaque black ink for nonreflectorized message application, as manufactured or recommended by the manufacturer of the retroreflective sheeting.

Use transparent ink and thinner, for application on signs reflectorized with white retroreflective sheeting, as manufactured or recommended by the manufacturer of the retroreflective sheeting. Use colors that conform to the *FHWA Color Tolerance Charts* and AASHTO M 268 when thoroughly dry.

Test all lots of transparent ink for compliance with the minimum coefficient of retroreflection equal to 70% of the specified minimum retroreflection of the corresponding sheeting color and document the retroreflection value.

Inspect the first 5 signs of each screening and then every fifth sign. When unacceptable signs are found, all signs shall be inspected individually.

Only 3 nonwets per sf, no larger than 1/16 inch in diameter, covering no more than 1/3 of the total area of the sign are allowable. This includes nonwets from either the sheeting or the screen-printing.

Only one tadpole per 6 sf, no longer than 1 1/2 inch and not readily visible under lighted inspection is allowable.

(J) Mounting Hardware

Provide all mounting hardware consisting of, but not limited to, shims, backing plates, mounting bolts, washers and nuts. Provide mounting holes in the Z-stringers of the ground mounted signs in accordance with the details shown in the contract.

(K) Packaging, Shipping and Storing

Protect all signs during shipment and storage. Before shipping, make sure that all signs are free of moisture and that all inks are thoroughly dry. Do not apply adhesive tapes to any sign surface. Keep all packaged signs entirely dry.

Use assembled or partially assembled signs other than flat sheet signs that have sufficient braces securely attached to prevent buckling or warping at all times.

Affix a label outlining the retroreflective sheeting manufacturer's recommendations for handling, transporting and storing all types of signs to each shipping carton or crate. Provide full details of such recommendations with each shipment of signs.

Label each crate or package of signs or panels as to the contents (arrows, shields, etc.), WBS number and sequence of packages if more than one package is for a single sign.

Maintain documentation of the lot, drum, inspector, roll size, date received, date sheeted, metal treater on all signs, slipsheeting, copy, borders, shields, overlays, arrows, panels and retroreflectometer readings.

Individually rack or separate by foam or slip sheeting on A-frame racks all sheeted panels. Do not use spliced, overlapped, ripped or torn slipsheeting or foam.

Store all packed signs standing at a 75° to 90° angle.

Turn all panels and sign faces to the inside of the crates, whenever possible.

When crating a one-panel sign, provide the face side with an extra piece of foam and cardboard taped to the outside of the face side of the package.

Pack panels of 102 inches in length or longer in only 2 per package.

Ensure all signs are debris free on the back side, with no misplaced writing, tape or extraneous sheeting.

Crate to allow a 2 inch space on the inside dimensions larger than the size of the largest package.

Store completed Type A and B signs back to back with at least 12 inches between faces.

When crating 2 panels of different sizes, place the smaller panel with its face to the back of the larger panel and package with an extra piece of foam and cardboard taped to the outside of the larger panel, with its face to the outside of the crate. Provide extra packaging on both outsides of the package for double-faced signs.

Crate packaged panels to allow the passage of a 1/8 inch spacer on the inside of each side of the crate, so that the panels are not overly tight or binding in crate.

Inspect all signs and packaging before shipping to assure compliance with the contract. The Department retains the right to inspect the signs and packaging before shipping.

(L) Transparent Films

Use transparent films instead of silk screening when authorized by the Department. Transparent film is a durable, transparent, acrylic colored film coated with transparent, pressure-sensitive adhesive. When the film is applied over reflective sheeting, the coefficient of retroreflectivity shall meet the color and type of sheeting in Tables 1092-3, 1092-4 or 1092-5. Use Department approved transparent film approved by the manufacturer of the reflective sheeting to ensure the materials meet the manufacturer's warranty and obligation in Subarticle 1092-2(B).

(M) Digital Printing

Use digital Printing instead of silk screening or transparent films when authorized by the Department. Digital print technologies consists of digital reflective sheeting, digital ink systems, and clear overlay film. The manufacturing application process and the materials must be approved by the sheeting manufacturer to ensure it meets the manufacturer's warranty and obligation in Subarticle 1092-2(B). The manufacturer may apply all legends and borders on Type E and F signs using digital printing.

Use opaque black ink for nonreflectorized message application, as manufactured or recommended by the manufacturer of the retroreflective sheeting.

Retroreflective sheeting shall consist of white or colored sheeting having a smooth outer surface and that essentially has the property of a retroreflector over its entire surface. Retroreflective sheeting shall conform to all requirements to the FHWA Color Tolerance Charts and AASHTO M 268 when thoroughly dry Digital printed ink systems used to print traffic signs must meet and comply with daytime and nighttime chromaticity (color standards) as recognized in ASTM D4956.

Digital printed ink systems must meet 70% of the initial retroreflectivity in Table 1092-3 and the coefficient of retroreflectivity for color and type of sheeting in Tables 1092-3, 1092-4 or 1092-5.

All digital inks and digital reflective sheeting shall be listed on the NCDOT APL and tested on AASHTO Product Evaluation & Audit Solutions test deck for 3 years prior to consideration to ensure the digital printed ink system meets the warrantee obligations listed in Subarticle 1092-2(B) for the respective sheeting grade.

Permanent traffic signs printed with digital ink systems will be fabricated with a full sign Protective Overlay Film designed to protect the entire sign from fading and UV degradation. The over laminate will comply with the retroreflective sheeting manufacturer's recommendations to ensure proper adhesion and transparency and will also meet the reflective film durability in Subarticle 1092-2(B).

Temporary signs printed with black ink only will not require a protective overlay film as long as the finished sign is warranted for a minimum outdoor durability of three years by the sheeting manufacturer.

901-4 SIGN QUALITY

Provide signs that present a uniform appearance free from color match problems, non-uniform color, streaks, spots, abrasions, blistering or other defects in the sheeting.

Sheeting may be inspected before application to sign blanks, after installation to sign blanks, after completion of the sign in the sign fabricator's facility and after installation. Clean all installed signs before final field inspection.

The retroreflective sheeting will be unsatisfactory if it has deteriorated due to any cause except defacement resulting from vandalism or damage resulting from impact by a motor vehicle or other object to the extent that:

(A) The sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions, or

(B) The coefficient of retroreflection is less than the minimum specified for that sheeting as shown in Tables 1092-3, 1092-4 or 1092-5 when measured by a Department approved retroreflectometer, or

(C) The screened message and border or reverse screened background has stained, discolored, streaked, faded, turned dark or has developed cracks, scaling, pitting and/or blistering, or

(D) The sign is unsatisfactory with regard to uniform appearance due to cracking, streaking, delamination, blistering, crazing or discoloration of the sheeting, or

(E) The sign is unsatisfactory with regard to remaining uniform in color over the entire reflecting surface both day and night and displaying the same color both in daylight and under lights at night.

(1) For glass bead material, sheeting will be subjected to a visual test with the human eye as the test instrument. Objectionable non-uniformity of color and reflectivity (retroreflection) under light at night is cause for the sign to be tested for retroreflection to determine compliance with the following requirements:

The retroreflection values on any sign shall not vary from each other by more than a ratio of 1.10 (1.20 white) at any 2 points at least 12 inches apart, nor more than 1.30 (1.30 white) at any 2 points anywhere on the sign, nor more than, 1.10 (1.20 white) at any 2 points on the border or between any 2 adjacent letters, numerals or symbols. Failure to meet the above requirements will result in sign rejection. Retroreflection will be tested using a retroreflectometer approved by the Engineer.

(2) For prismatic material, sheeting will be subjected to a visual test with the human eye as the test instrument.

901-5 MEASUREMENT AND PAYMENT

Sign fabrication will be measured and paid as the actual number of square feet of sign face areas of each type, including milemarkers and overlays acceptably fabricated. In measuring this quantity, the sign face areas will be calculated to the nearest 1/100 of a sf, using the dimensions shown in the contract.

The areas of odd-shaped signs (e.g. stop signs and shield-shaped route markers) will be calculated as squares or rectangles using the dimensions shown in the contract. The areas of round, diamond and triangular signs will be calculated for their true shapes using plan dimensions.

Repair or otherwise correct any damage to the signs or refabricate them at no cost to the Department. When requested by the Contractor, the Department may have the necessary repairs made or the signs refabricated, and deduct the associated costs thereof from monies due the Contractor.

Payment will be made under:

Pay Item	Pay Unit
Contractor Furnished, Type ____ Sign	Square Foot

SECTION 902
FOUNDATIONS FOR GROUND MOUNTED SIGNS

902-1 DESCRIPTION

Construct foundations for sign supports including locating, staking, excavating, shoring, backfilling, forming, landscaping and other necessary tasks as required.

902-2 MATERIALS

Refer to Division 10.

Item	Section
Hot Applied Joint Sealer	1028-2
Borrow Material	1018
Organic-Zinc Repair Paint	1080-7
Portland Cement Concrete Production and Delivery	1000
Reinforcing Steel	1070
Select Materials	1016

902-3 CONSTRUCTION METHODS

Establish the proper offset, longitudinal location and foundation elevation of each ground mounted sign support. Provide proper level and orientation of all supports.

Thoroughly compact all backfill in 6 inch layers. Remove all unneeded excavated material from the site.

Perform all excavation necessary for foundation construction to the elevations and dimensions shown in the contract. Place concrete against undisturbed soil.

Construct concrete sign foundations in accordance with Section 825. Construct either reinforced or plain Class A concrete foundations in accordance with the contract. Shape the tops of the foundations to conform to finished ground elevations such that water will not collect against the supports. No construction joints will be permitted.

Form the top 6 inches of foundations by approved methods. Center the supports in the foundations, securely brace and hold in proper position and alignment during placement of the concrete. Provide an ordinary surface finish to the concrete.

902-4 MEASUREMENT AND PAYMENT

Reinforced and *Plain Concrete Sign Foundations* will be measured and paid as the computed number of cubic yards of concrete incorporated into the completed and accepted foundation. Computing the number of cubic yards of concrete will be done from the dimensions shown in the contract or from revised dimensions authorized by the Engineer, calculated to the nearest 1/100 of a cy. Such payment will include, but is not limited to, excavating, shoring, backfilling, forming, landscaping and other necessary tasks as required. No separate measurement and payment will be made for reinforcing steel for *Reinforced Concrete Sign Foundations* as the cost of such shall be included in the price per cubic yard for *Reinforced Concrete Sign Foundations*.

Payment will be made under:

Pay Item	Pay Unit
Reinforced Concrete Sign Foundations	Cubic Yard
Plain Concrete Sign Foundations	Cubic Yard

SECTION 903
GROUND MOUNTED SIGN SUPPORTS

903-1 DESCRIPTION

Furnish, fabricate, clear for sight distance and install ground mounted and barrier mounted signs supports.

The types of supports covered by this section are:

Breakaway steel beam sign supports

Simple steel beam sign supports

3-lb steel U-channel supports

2-lb steel U-channel supports

Barrier sign support assembly

Wood supports

Steel square tube supports

903-2 MATERIALS

Refer to Division 10.

Item	Section
Breakaway or Simple Steel Beam Sign Supports (W- or S-Shapes)	1094-1(A)
Ground Mounted Signs	1094
Hot Applied Joint Sealer	1028-2
Organic-Zinc Repair Paint	1080-7

Item	Section
Signing Materials	1092
Steel Square Tube Supports	1094-1(D)
Steel U-Channel Supports	1094-1(B & C)

903-3 CONSTRUCTION METHODS

(A) Location and Field Verification

The support lengths and dimensions for steel and wood ground mounted supports shown in the contract are estimated for project bid purposes.

The Engineer or contract surveyor will establish the proper offset, longitudinal location; foundation elevation and S-dimension of each ground mounted and barrier mounted sign support. The Signing and Delineation Unit will issue a revision of the Sign Support Chart Sheet following receipt of field-verified S-dimensions.

Order supports for ground mounted signs when the revised support lengths, dimensions and sizes have been determined and the appropriate plan revision is completed.

Provide the proper vertical plumb, level and orientation of all signs and supports.

(B) Clearing for Sign Sight Distance

Clear vegetation in front of signs where necessary to achieve proper sight distance to the sign. The sight distance area includes the triangular region of land extending from the edge of the travel lane 800 feet in advance of the sign to 4 feet beyond the furthest edge of the sign from the travel lane. The Engineer will determine where clearing is required and the amount of clearing at the sign locations. Perform the clearing in accordance with Section 200.

(C) Breakaway Steel Beam and Simple Steel Beam

Fabricate and install the supports in accordance with the contract. Punch, cut or weld supports before galvanizing. Galvanize each component part in accordance with ASTM A123 before assembly. Provide supports that are uniformly straight to within 1/8 inch tolerance for pieces less than 20 feet in length and 1/4 inch tolerance for pieces over 20 feet in length.

Cut the upper and middle sections of breakaway supports from the same member. Bolt the hinge joint in the breakaway supports to ensure true alignment of the 2 sections. After bolting of hinge connections make sure that the 2 sections are in the same position relative to each other, as before being cut. Completely assemble breakaway supports before erection.

Provide supports that are plumb. Do not shim the supports. Take adequate care during erection of supports to prevent damage to the surface finish. Use 2 coats of an approved non-aerosol organic-zinc repair paint in touching up damaged areas on all galvanized materials.

(D) Steel Supports

(1) General

Drive the supports to the required depth, being sure they are plumb. Drive the supports by hand or by mechanical means. Protect the supports with an appropriate driving cap. Concrete foundations are not required. In island applications, cored holes shall be to the soil depth.

Replace any support that is bent, or otherwise damaged in driving.

Do not weld supports in the field. Use 2 coats of an approved non-aerosol organic-zinc repair paint in touching up the tops of U-channel supports that may have been

damaged in driving. Cut ends of supports, frames, cross bracing and damaged areas on these and all other galvanized materials.

Any steel supports cut in the field shall have two coats of an approved non-aerosol organic-zinc repair paint.

Use supports of sufficient length to permit the appropriate sign mounting height. Spliced supports are not permitted on new construction.

(2) U-Channel

Use 3-lb galvanized steel U-channel supports for enhanced milepost signs and Types D, E and F signs. Use 2-lb galvanized steel U-channel supports for milepost signs.

(3) Perforated Square Tubing

Use square tube supports in accordance with the contract.

(E) Barrier Supports

(1) Small

Attach brackets and U-channel supports to the median or shoulder barrier for the erection of Type E or F signs or milemarkers in accordance with the contract.

(2) Large

Attach brackets, anchorage and pipe supports to the median or shoulder barrier for the erection of Type E signs in accordance with the contract.

(F) Wood Supports

Use wood supports in accordance with the contract.

Replace any support that is damaged during erection.

Breakaway wood supports shall be drilled in accordance with the contract. All wood supports larger than 4 inches x 4 inches that have not been drilled shall be behind guardrail.

903-4 MEASUREMENT AND PAYMENT

The supports, specified in these *Standard Specifications*, installed and accepted, will be measured for payment as follows:

Supports, Breakaway Steel Beam and *Supports, Simple Steel Beam* will be measured and paid as the actual number of pounds of structural steel installed and accepted. The computed nominal weights shown in the final revised plans will be used in determining this quantity. Measurement will not be made of the weight of nuts, bolts and washers that are part of the sign support, as they will be incidental to the work.

Supports, 3-lb Steel U-Channel will be measured and paid as the actual number of linear feet of 3-lb steel U-channel supports incorporated into the completed and accepted supports and assemblies. Measurements of length will be made to the nearest 1/10 of a foot.

Supports, 2-lb Steel U-Channel will be measured and paid as the actual number of 2-lb steel U-channel support installed and accepted.

Supports, Barrier (Small) will be measured and paid as the actual number of small barrier supports installed and accepted.

Supports, Barrier (Large) will be measured and paid as the actual number of large barrier supports installed and accepted.

Supports, Wood will be measured and paid as the actual number of linear feet of wood support incorporated into the completed and accepted supports. Measurements of length will be made

to the nearest 1/10 of a linear foot. The computed linear feet of sign supports, as indicated in the final revised plans will be used in determining this quantity.

Supports, Steel Square Tube will be measured and paid as the actual number of linear feet of steel square tube supports incorporated into the completed and accepted supports and assemblies. Measurements of length will be made to the nearest 1/10 of a foot.

Payment will be made under:

Pay Item	Pay Unit
Supports, Breakaway Steel Beam	Pound
Supports, Simple Steel Beam	Pound
Supports, 3-lb Steel U-Channel	Linear Foot
Supports, 2-lb Steel U-Channel	Each
Supports, Barrier (Small)	Each
Supports, Barrier (Large)	Each
Supports, Steel Square Tube	Linear Foot
Supports, Wood	Linear Foot

SECTION 904
SIGN ERECTION

904-1 DESCRIPTION

Erect existing and proposed ground mounted and overhead signs to existing and proposed supports and furnish mounting hardware. Relocate existing signs in accordance with the contract and Specifications.

The types of signs covered by this section are as follows:

Type A signs
Type B signs
Type D signs
Type E signs
Type F signs
Milemarkers
Overlay signs
Reposition signs
Logo Trailblazer
Logo to panel
Relocation signs

904-2 MATERIALS

Refer to Division 10.

Item	Section
Signing Materials	1092
Organic-Zinc Repair Paint	1080-7

904-3 CONSTRUCTION METHODS

(A) General

Provide new mounting bolts, washers, hex nuts, backing plates and all hardware for signs to be mounted on existing or proposed supports. Do not weld, cut or fabricate in any manner in the field, except for as allowed under Section 903 and for the drilling of holes for attaching demountable legends and borders that cannot be attached in the shop. Field drill Z-bars for attaching signs to supports as required.

Use 2 coats of an approved non-aerosol organic-zinc repair paint in touching up field-drilled holes and damaged areas on all galvanized materials as covered under Section 903.

Make sure that the horizontal edges of signs are level and that the faces of signs are vertical.

Refer to Sections 900 and 901 for requirements of care and handling of signs, final clean up and covering of signs.

(B) Type A and B

(1) General

Attach the signs to supports in accordance with the contract or the approved shop drawings. Make sure that the face of the sign is flat. Any appreciable buckling or warping of the sign face will be cause for rejection of the entire sign.

(2) Ground Mounted

Erect ground mounted Type A and B secondary signs by the required method of attachment shown in the contract. Affix these signs by bolting the horizontal Z-stringers directly to the supports or by bolting vertical Z-bars to the horizontal Z-stringers of the primary sign.

(3) Overheads

For new overhead supports, erect overhead secondary signs in accordance with the approved shop drawings.

For existing overhead supports, design and furnish all new structural members and mounting hardware necessary to erect the new signs. Prepare and submit to the Engineer for approval complete shop drawings and design computations for the bracing and accessory hardware required to attach the sign to the existing overhead sign support. Prepare the design in accordance with *AASHTO Structural Supports for Highway Signs, Luminaires and Traffic Signals,* and the Interim Specifications as shown on the plans. Upon request, the Engineer will provide the Contractor with copies of the shop drawings for existing overhead sign supports.

Attach a new sign above a designated existing overhead sign in accordance with the contract. Furnish all new structural members and mounting hardware necessary to erect the new sign.

(C) Type D, E, F and Milemarkers

Attach the signs to U-channel or perforated square tube supports

(D) Overlay (Ground Mounted and Overhead)

Attach overlays to designated existing ground mounted or overhead signs as required by the contract.

Remove and dispose of all conflicting demountable legends, borders and overlays before attaching new overlays. Employ any method of removal necessary, provided it does not damage the existing sign or the attached overlay. Perform such minor repairs to existing signs as necessary before the attachment of overlays to ensure a finished sign face that is completely flat.

Field-drill 5/32 inch holes in both the overlay and the existing sign simultaneously, according to the rivet spacing requirements shown in the contract. Attach the proposed overlays with 1/8 inch diameter aluminum rivets of the “pull-through” type. Exercise sufficient care in attaching the overlays to ensure that the finished sign face is completely flat and without any ripples and/or buckles.

(E) Reposition Overhead Signs

Reposition existing signs on existing overhead sign supports as required by the contract. Reposition associated lighting systems and secondary signs along with the signs.

When required, drill new holes in the existing vertical attachment members, in order to maintain a minimum clearance of 17 feet to the roadway surface at the new location on the structure. No other field drilling will be allowed.

Adjust and relocate conduit and junction boxes as required.

(F) Logo Trailblazer

All logos will be made available for pick up at the Division Traffic Services' sign shop. Erect logos on U-channel or perforated square tube supports in accordance with Type F sign details shown in the contract.

(G) Logo to Panel

All logo panels and logo mileage panels will be made available for pick up at the Division Traffic Services' sign shop. Attach logo panels to the mainline signs with ten 1/8 inch diameter rivets of the pull through type. Attach logo panels to the ramp signs with four 1/8 inch diameter rivets of the pull through type. Attach mileage panels to ramp signs with six 1/8 inch diameter rivets of the pull through type. Drill 5/32 inch holes in the background signs to match those in the logo panels and logo mileage panels for attaching these signs to the background signs. The mileage panel shall be installed 1/2 inch below the logo panel with 3 rivets at the top and 3 rivets at the bottom spaced evenly apart. Place logo as shown on the contract.

(H) Relocation (Ground Mounted) Signs

Maintain signs in good serviceable condition throughout the duration of the project. Repair any areas or materials within the project limits disturbed or damaged in performance of the work required under this section as directed by the Engineer at no cost to the Department.

Remove existing signs from their existing locations and relocate to their new location in accordance with the contract. Repair or replace signs damaged in relocating at no cost to the Department. Refer to Section 907 for disposal of sign components.

Erect signs and supports according to requirements of Sections 903 and 904. Immediately relocate all warning and regulatory signs to new locations. Relocate all other signs to new locations in no more than 12 hours.

904-4 MEASUREMENT AND PAYMENT

Sign Erections (Ground Mounted and Overhead) will be measured and paid as the actual number of ground mounted and overhead signs erected and accepted. Each type F sign assembly will be measured as one sign.

Sign Erection, Relocate Type ____ (Ground Mounted) will be measured and paid as the actual number of signs acceptably relocated. Secondary signs will be incidental work in conjunction with the primary sign. Sign assemblies consisting of more than one sign panel will be considered one sign.

Sign Erection, Logo Mileage Panel to Sign will be measured and paid for as actual number of Mileage Panels erected and accepted. Payment for *Sign Erection, Logo Mileage Panel to Sign* shall be incidental to *Sign Erection, Logo to Panel* erection unless only replacing the logo mileage panel.

Payment will be made under:

Pay Item	Pay Unit
Sign Erection, Type ____ (Overhead)	Each
Sign Erection, Type ____ (Ground Mounted)	Each
Sign Erection, Type ____	Each
Sign Erection, Milemarkers	Each
Sign Erection, Overlay (Overhead)	Each
Sign Erection, Overlay (Ground Mounted)	Each
Sign Erection, Reposition Overhead	Each
Sign Erection, Logo to Panel	Each
Sign Erection, Logo Trailblazer	Each
Sign Erection, Logo Mileage Panel to Sign	Each
Sign Erection, Relocate Type (Ground Mounted)	Each

SECTION 906
OVERHEAD SIGN STRUCTURE

906-1 DESCRIPTION

Design, fabricate, furnish and erect various types of overhead sign assemblies. Fabricate supporting structures using tubular members of either aluminum or steel. The types of overhead sign assemblies included in this specification are span structures, cantilever structures and sign structures attached to bridges.

906-2 MATERIALS

Refer to Division 10.

Item	Section
Structural Steel	1072
Overhead Sign Structures	1096
Signing Materials	1092
Organic-Zinc Repair Paint	1080-7
Direct Tension Indicators	440 and 1072-5

906-3 CONSTRUCTION METHODS

(A) General

Fabricate overhead sign assemblies in accordance with the details shown in the approved working drawings and the requirements of these specifications.

No welding, cutting or drilling will be permitted in the field, unless approved by the Engineer.

Drill bolt holes and slots to finished size. Holes may also be punched to finish size, provided the diameter of the punched holes is at least twice the thickness of the metal being punched. Flame cutting of bolt holes and slots is not permitted.

Erect sign panels in accordance with the requirement for Type A or B signs as indicated in the plans. Field drill two holes per connection in the Z bars for attaching signs to overhead structures. Provide two U-bolts at each U-bolt connection such as each truss chord to sign hanger and each truss chord to walkway support or light support. Provide two U-bolts at each U-bolt connection where ends of truss chords are supported. The minimum diameter of all U-bolts is 1/2 inch.

For all U-bolt connections of hanger beams to overhead assembly truss chords, provide all U-bolts with a flat washer and double nuts at each end of the U-bolts. All double nuts that are on any U-bolt shall be the same thickness and weight. When assembled, the double nuts shall be brought tight against each other by the use of two wrenches.

Use two coats of an approved non-aerosol organic-zinc repair paint to touch up minor scars on all galvanized materials.

For high strength bolted connections, use direct tension indicators in accordance with Article 440-8. When galvanized high strength bolts are required, use bolts, nuts and washers meeting Subarticle 1072-5(F).

(B) Shop Drawings

Design the overhead sign supports, including foundations, prior to fabrication. Submit design calculations and working drawings of the designs to the Engineer for review and acceptance.

Have a professional engineer registered in the State of North Carolina, perform the computations and render a set of sealed, signed and dated drawings detailing the construction of each structure.

Submit to the Engineer for review and acceptance complete design and fabrication details for each overhead sign assembly, including foundations and brackets for supporting the signs and maintenance walkways, if applicable, electrical control boxes, and lighting luminaires. Base design upon the revised structure line drawings, wind load area and the winds speed shown in the plans, and in accordance with the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals,* and the Interim Specifications as shown on the plans.

Submit electronic (.pdf) copies of completely detailed working drawings and the design calculations including all design assumptions for each overhead sign assembly to the Engineer for approval prior to fabrication. Working drawings shall include complete design and fabrication details, including foundations, provisions for attaching signs, maintenance walkways, when applicable, lighting luminaires to supporting structures, applicable material specifications, and any other information necessary for procuring and replacing any part of the complete overhead sign assembly.

Allow 40 days for initial working drawing review after the Engineer receives them. If revisions to working drawings are required, an additional 40 days shall be required for review and approval of the final working drawings.

Approval of working drawings by the Engineer shall not relieve the Contractor of responsibility for the correctness of the drawings, or for the fit of all shop and field connections and anchors.

(C) Design and Fabrication

(1) The following criteria govern the design of overhead sign assemblies:

Design shall be in accordance with the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals,* and the Interim Specifications as shown on the plans.

There are several design criteria that are specified. They include:

(a) Overhead cantilever sign structures shall include galloping loads (exclude four-chord horizontal trusses)

(b) The Yearly Mean Velocity, V_{mean}, in North Carolina shall be assumed to be 11.6 mph.

(c) The Fatigue Importance Category used in the design, for each type of structure, shall be for:

(i) Cantilevered structures with span greater than 50 feet – Fatigue Importance Category I.

(ii) Cantilevered structures with span less than or equal to 50 feet – Fatigue Importance Category II.

(iii) Non-Cantilevered structures – Fatigue Importance Category II.

(2) The following interpretations or criteria shall be used in the design of overhead sign assemblies:

(a) For design of supporting upright posts or columns, the effective length factor for columns "K", as provided for in Appendix B, Section B.5 of the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals,* and the Interim Specifications as shown on the plans*,* shall be taken as the following, unless otherwise approved by the Engineer:

(i) Case 1: For a single upright post of cantilever or span type overhead sign structure, the effective column length factor, "K", shall be taken as 2.0.

(ii) Case 2: For twin post truss-type upright post with the post connected to one chord of a horizontal truss, the effective column length factor for that column shall be taken as 2.0.

(iii) Case 3: For twin post truss-type upright post with the post connected to two truss chords of a horizontal tri-chord or box truss, the effective column length factor for that column shall be taken as 1.65.

(b) For twin post truss-type uprights, the unbraced length of the post shall be from the chord to post connection to the top of base plate.

(c) For twin post truss-type uprights, when the post is subject to axial compression, bending moment, shear, and torsion, the post shall satisfy the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals,* and the Interim Specifications as shown on the plans. Apply axial compression, bending, and shear equations: Equations 5.12.2.1-1, 5.12.2.1-2 and 5.12.2.1-5 as found in the sixth edition. To reduce the effects of secondary bending, in lieu of Equation 5.12.2.1-2, the following equation may be used:

$$\frac{f_a}{F_a} + \frac{f_b}{\left(1 - \frac{0.6 f_a}{F_{\acute{e}}}\right) F_b} + \left(\frac{f_v}{F_v}\right)^2 \leq 1.0$$

Where f_a = Computed axial compression stress at base of post

(d) The base plate thickness for all uprights and poles shall be a minimum of 2 inches but not less than that determined by the following criteria and design:

(i) Case 1: Circular or rectangular solid base plates with the upright pole welded to the top surface of the base plate with full penetration butt weld, and where no stiffeners are provided. A base plate with a small center hole, which is less than 1/5 of the upright diameter, and located concentrically with the upright pole, may be considered as a solid base plate.

The magnitude of bending moment in the base plate, induced by the anchoring force of each anchor bolt shall be calculated as

M = $(PxD_1)/2$.

(ii) Case 2: Circular or rectangular base plate with the upright pole socketed into and attached to the base plate with two lines of fillet weld, and where no stiffeners are provided, or any base plate with a center hole that is larger in diameter than 1/5 of the upright diameter. The magnitude of bending moment induced by the anchoring force of each anchor bolt shall be calculated as

M = $P \times D_2$

Where:

M = Bending moment at the critical section of the base plate induced by one anchor bolt
P = Anchoring force of each bolt
D_1 = Horizontal distance between the center of the anchor bolt and the outer face of the upright, or the difference between the radius of the bolt circle and the radius of the upright
D_2 = Horizontal distance between the face of the upright and the face of the anchor bolt nut

(e) The critical section shall be located at the face of the anchor bolt and perpendicular to the radius of the bolt circle. The overlapped part of two adjacent critical sections shall be considered ineffective.

(f) The thickness of Case 1 base plate shall not be less than the calculated based on formula for Case 2.

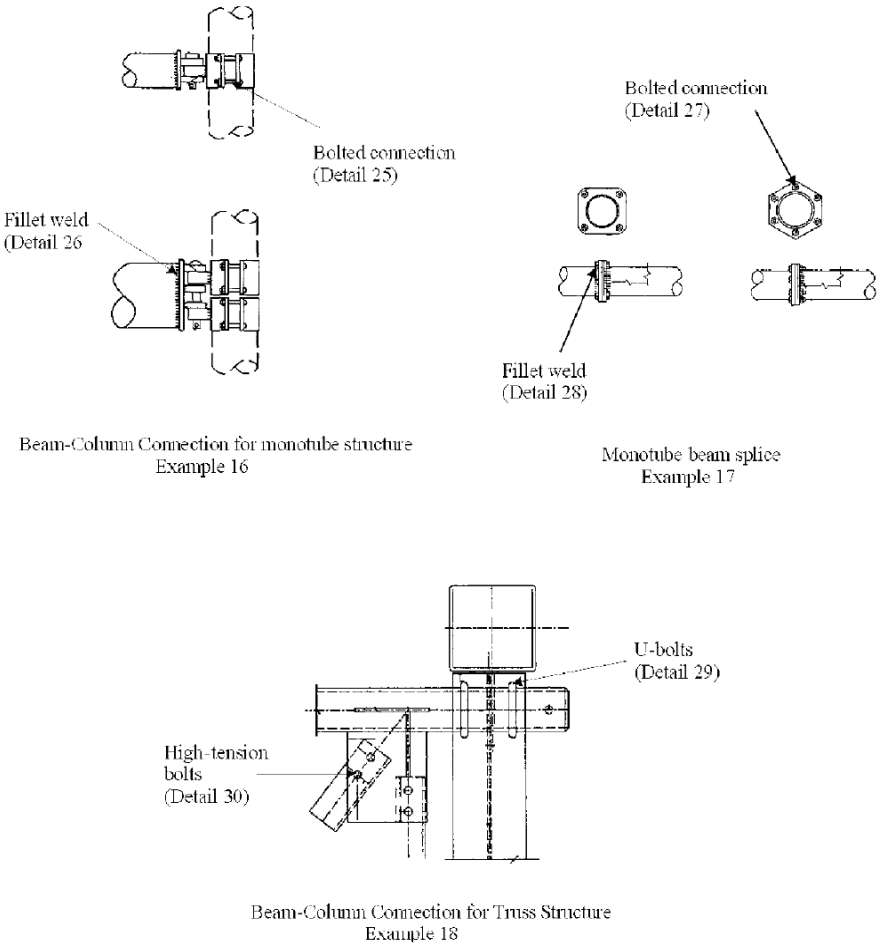
(g) Uprights, foundations, and trusses that support overhead signs shall be designed in accordance with the contract for the effects of torsion. Torsion shall be considered from dead load eccentricity of these attachments, as well as for the attachments such as supporting brackets, lights, etc., that add to the torsion in the assembly. Truss vertical and horizontal truss diagonals in particular and any other assembly members shall be appropriately sized for these loads.

(h) Uprights, foundations, and trusses that support overhead mounted signs shall be designed for the proposed sign wind area as noted in the contract drawings. Truss vertical and horizontal truss diagonals in particular and any other assembly members shall be appropriately sized for these loads.

For non-cantilevered monotube sign support structures, Table 906-1 and Figure 906-1 are considered as a required addition to the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals,* and the Interim Specifications and shown on the plans*:*

TABLE 906-1
NON-CANTILEVERED MONOTUBE SIGN SUPPORT STRUCTURES

Construction	Detail	Stress Category	Application	Example
Mechanically Fastened Connections	25. Bolts in tension	D	Beam column connection for monotube structures	16
Fillet-Welded Connections	26. Fillet weld with one side normal to the applied stress	E’	Beam column connection for monotube structures	16
Mechanically Fastened Connections	27. High-Strength bolts in tension	D	Monotube or truss-chord splice	17
Fillet-Welded Connections	28. Fillet weld with one side normal to the applied stress	E’	Monotube or truss-chord splice	17
Mechanically Fastened Connections	29. U-bolts tied to the transverse truss column to keep the chords in place	D	Horizontal truss connection with the vertical truss	18
Mechanically Fastened Connections	30. Net section of full-tightened, high-tension bolts in shear	B	Truss-bolted joint	18



From NCHRP Report 494 dated 2003

Figure 906-1. Details shown in Table 906-1.

Fabricate all overhead sign assemblies, including but not limited to foundations, in accordance with the details shown on the approved shop drawings and with the requirements of these Specifications.

Fabricate the span and cantilever supporting structures using tubular members of either aluminum or steel, using only one type of material throughout the project. Sign support structures that are to be attached to bridges shall be fabricated using other structural shapes.

Horizontal components of the supporting structures for overhead signs may be of a truss design or a design using singular (monotube) horizontal members to support the sign panels.

Truss or singular member centerline must coincide with the centerline of sign design area shown on the structure line drawing.

Provide permanent camber in addition to dead load camber in accordance with the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals,* and the Interim Specifications as shown on the plans. Indicate on the shop drawings the amount of camber provided and the method employed in the fabrication of the support to obtain the camber.

Use cantilever sign structures that meet the following design criteria:

(A) Do not exceed an L/150 vertical dead load deflection at the end of the arm due to distortions in the arm and vertical support, where L is the length of the arm from the center of the vertical support to the outer edge of the sign.

(B) Do not exceed an L/40 horizontal deflection at the end of the arm due to distortions in the arm and vertical support, as a result of design wind load.

Fabricate attachment assemblies for mounting signs in a manner that allows easy removal of sign panels for repair.

906-4 MEASUREMENT AND PAYMENT

Supports, Overhead Sign Structure ____ will be paid for at the contract lump sum for each structure. Such price will be full compensation for design, fabrication, construction, transportation, erection of the complete overhead sign structure, supporting structure hardware, lighting support brackets, preparing and furnishing shop drawings, and attaching the signs to the overhead assembly. *Supports, Overhead Sign Structure* ____ does not include the cost for foundations as this item will be paid for elsewhere in the contract.

Payment will be made under:

Pay Item	Pay Unit
Supports, Overhead Sign Structure _____	Lump Sum

SECTION 907
DISPOSAL AND STOCKPILING OF SIGNING COMPONENTS

907-1 DESCRIPTION

Properly dispose of or stockpile signing components.

907-2 CONSTRUCTION METHODS

(A) General

Repair any areas or materials within the project limits disturbed or damaged in performance of the work required under this section as directed by the Engineer.

(B) Removal

Do not remove existing signing components until required replacements have been erected and are available for use by traffic or are available for immediate replacement.

Remove signing components by methods that will not damage other portions of the project or facility. Repair any damage by methods satisfactory to the Engineer.

Cut and remove electrical conduit to at least 18 inches below finished ground elevation. Plug or seal the ends of the cut conduit by methods approved by the Engineer.

Remove foundations, including any reinforced steel or anchor bolts, to a minimum depth of 2 feet below the finished ground elevation unless otherwise indicated by the contract.

Promptly backfill and compact areas disturbed by removal of foundations with suitable materials and match the finished ground elevation. Seed disturbed areas in accordance with Section 1661.

(C) Disposal

All materials to be removed and disposed of will become the property of the Contractor. Promptly transport the materials from the project after they have been removed unless otherwise permitted by the Engineer.

Promptly dispose of the concrete, reinforcing steel and anchor bolts from the project.

(D) Stockpile

Before stockpiling, remove signs from supports. The Department maintains ownership of all materials to be stockpiled. Transport and stockpile designated items to locations approved by the Engineer. Sort and stockpile all materials neatly in stacks or storage bins. Repair or replace materials damaged in removal or while in storage.

907-3 MEASUREMENT AND PAYMENT

Disposal of ____ and *Stockpile* ____ will be measured and paid as the actual number of signing components acceptably disposed or stockpiled. Removal is incidental to stockpiling and disposal. Secondary signs will be incidental work in conjunction with the primary sign. Sign assemblies consisting of more than one sign panel will be considered one sign. Overhead sign systems include signs, supports, walkways and all electrical components. Sign systems include signs, supports and foundations. Supports include any foundations.

Repair or replacement of any materials or areas within the project limits disturbed or damaged in performance of the work required under this section will be at no cost to the Department.

Payment will be made under:

Pay Item	Pay Unit
Disposal of Sign System, Overhead	Each
Disposal of Sign System, Steel Beam	Each
Disposal of Sign System, U-Channel	Each
Disposal of Sign System, Wood	Each
Disposal of Sign, A and B, (Ground Mounted)	Each
Disposal of Sign, A or B, (Overhead)	Each
Disposal of Sign, D, E or F	Each
Disposal of Sign, Milemarker	Each
Disposal of Sign, Overlay (Overhead)	Each
Disposal of Sign, Overlay (Ground Mounted)	Each
Disposal of Support, Overhead Structure	Each
Disposal of Support, Steel Beam	Each
Disposal of Support, U-Channel	Each
Disposal of Support, Wood	Each
Disposal of Lighting System	Each
Disposal of Lighting Fixtures	Each
Disposal of Walkway	Each
Stockpile Sign System, Overhead	Each
Stockpile Sign System, Steel Beam	Each
Stockpile Sign System, U-Channel	Each
Stockpile Sign System, Wood	Each
Stockpile Sign, A or B, (Overhead)	Each
Stockpile Sign, A and B, (Ground Mounted)	Each
Stockpile Sign, D, E or F	Each
Stockpile Sign, Milemarker	Each
Stockpile Support, Overhead Structure	Each
Stockpile Support, Steel Beam	Each
Stockpile Support, U-Channel	Each
Stockpile Support, Wood	Each
Stockpile Lighting System	Each
Stockpile Lighting Fixtures	Each
Stockpile Walkway	Each

DIVISION 10
MATERIALS

SECTION 1000
PORTLAND CEMENT CONCRETE PRODUCTION AND DELIVERY

1000-1 DESCRIPTION

This section addresses Portland cement concrete to be used for pavement, structures and precast and incidental construction. Produce Portland cement concrete composed of Portland cement, fine and coarse aggregates, and water. Include supplementary cementitious material (SCM) and chemical admixtures as required or needed. SCMs consist of ground granulated blast furnace slag, fly ash or silica fume and may be substituted for a portion of the Portland cement. Type (Portland-Limestone Cement) IL, (Portland-Pozzolan Cement) IP, (Portland-Slag Cement) IS or (Ternary Blended Cement) IT blended cement may be used instead of Portland cement (see Section 1024 for details). Cement, fine and coarse aggregate, and SCMs shall be approved by the Department prior to use. Only use admixtures that are currently on the NCDOT APL.

All Portland cement concrete mixtures shall be designed by a NCDOT Certified Concrete Mix Design Technician or an engineer licensed by the State of North Carolina.

For approved mixture designs requiring a major change, submit a new mix design accompanied by the applicable test results indicating the mix conforms to the design requirements for the indicated class of concrete. Define a major change as:

(A) A source change in coarse aggregate or fine aggregate.

(B) A change in cement type (e.g. from Type I/II to Type IL).

(C) A change in SCM class or type change (e.g. Class F fly ash to Class C fly ash)

(D) A quantitative change in coarse aggregate, fine aggregate, or pozzolan greater than 5% (by weight).

(E) A quantitative change in water (applies to increase only) or cement (applies to decrease only).

For approved mix designs requiring a minor change, submit a Materials and Tests Form 312M. Define a minor change as:

(A) A change in source of the same type of cement or SCM.

(B) A change in source or brand of admixtures.

When concrete for any one pour is furnished by multiple concrete plants, use the same mix design for all concrete, including sources and quantities of ingredients.

Use materials which do not produce a mottled appearance through rusting or other staining of the finished concrete surface.

1000-2 MATERIALS

Refer to Division 10.

Item	Section
Air Entraining Agent	1024-3
Calcium Nitrite Corrosion Inhibitor	1024-3
Chemical Admixtures	1024-3
Coarse Aggregate	1014-2
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6
Portland Cement	1024-1
Silica Fume	1024-7
Type IL Blended Cement	1024-1
Type IP Blended Cement	1024-1
Type IS Blended Cement	1024-1
Type IT Blended Cement	1024-1
Water	1024-4

1000-3 PORTLAND CEMENT CONCRETE FOR STRUCTURES AND INCIDENTAL CONSTRUCTION

(A) Composition and Design

Provide the class of concrete required by the contract. Higher strength classes of concrete may be permissible as approved by the Engineer.

Submit proposed concrete mix designs for each class of concrete to be used in the work. Mix proportions shall meet the design requirements provided in Table 1000-1 and the applicable portions of this section. Laboratory trial batches shall be created to confirm the proposed mix design meets the requirements of the plastic and hardened concrete.

Submit mix designs in terms of saturated surface dry weights on *Materials and Tests Form 312U* at least 35 days before proposed use. Adjust batch proportions to compensate for surface moisture contained in the aggregates at the time of batching. Changes in the saturated surface dry mix proportions will not be permitted unless revised mix designs have been submitted to the Engineer and approved.

Accompany *Materials and Tests Form 312U* with a listing of laboratory test results of aggregate gradation, air content, slump and compressive strength from a certified laboratory. List the compressive strength of at least three 6 inch x 12 inch or 4 inch x 8 inch cylinders at the age of 7 and 28 days.

Perform laboratory tests in accordance with the following test procedures:

Property	Test Method
Aggregate Gradation	AASHTO T 27
Air Content	AASHTO T 152
Slump	AASHTO T 119
Compressive Strength	AASHTO T 22 and R100

The Engineer will review the mix design for compliance with the specifications and notify the Contractor as to its acceptability. Do not use a mix until written notice has been received. Acceptance of the mix design does not relieve the Contractor of his responsibility to furnish a product that meets the contract.

(B) Air Entrainment

Entrain air in the concrete unless otherwise indicated in the plans or in the Specifications. Add an air entraining agent at the time of mixing to produce an air content in the freshly mixed concrete of 6.0% ± 1.5% when tested at the job site. Determine the air content in accordance with AASHTO T 121, T152 or T196. Measurement of air content may also be performed by the Chace Indicator, in which case sufficient tests will be made in accordance with AASHTO T 121, T152 or T196 to establish correlation with the Chace Indicator. Concrete for structures will not be rejected based on tests made with the Chace Indicator. Concrete for incidental construction may be rejected based on an average of 3 or more tests made with the Chace Indicator.

Air entraining agent may be added at the job site when permitted by the Engineer.

(C) Strength of Concrete

The compressive strength of the concrete will be considered the average compressive strength test results of two 6 inch x 12 inch cylinders, or two 4 inch x 8 inch cylinders if the aggregate size is not larger than size 57 or 57M. Make cylinders in accordance with AASHTO R 100 from the concrete delivered to the work. Make cylinders at such frequencies as the Engineer may determine and cure them in accordance with AASHTO R 100 as modified by the Department. Copies of these modified test procedures are available upon request from the Materials and Tests Unit.

When the average compressive strength of the concrete test cylinders is less than the minimum strength specified for the class of concrete and the Engineer determines it is within reasonably close conformity with strength requirements, concrete strength will be considered acceptable. When the Engineer determines average cylinder strength is below the specification, the in-place concrete will be investigated. Based on these investigation results, the concrete will be accepted with no reduction in payment, accepted at a reduced unit price or rejected as set forth in Article 105-3.

(D) Temperature Requirements

The concrete temperature at the time of placement shall be not less than 50°F and no more than 95°F except where other temperatures are required by Articles 420-4, 420-7, 420-14 and 420-15.

Do not place concrete without permission when the air temperature measured at the location of the concrete operation in the shade away from artificial heat is below 35°F.

When such permission is granted, uniformly heat the aggregates and/or water to a temperature not higher than 150°F. Heated concrete shall be between 55°F and 80°F at the time of placement.

TABLE 1000-1
DESIGN REQUIREMENTS FOR CONCRETE

Class of Concrete	Min. Compressive Strength at 28 days	Maximum Water-Cementitious Ratio	Maximum Slump		Min. Cementitious Content	Coarse Aggregate Sizes
			Vibrated	Non-Vibrated		
Units	*psi*		*inch*	*inch*	*lb/cy*	
AA	4500	0.426	1.5 slip form 3.5 [A]	---	639	57, 67, or 78M
Drilled Pier [B]	4500	0.450	---	5 – 7 dry 7 - 9 wet	640	78M
Sand Light-weight	4500	0.420	4.0 [A]	---	715	Lightweight (see Table 1014-1)
A [B,C]	3000	0.532	3.5 [A]	4.0	564	57, 67, or 78M
B[B]	2500	0.567	1.5 machine placed 2.5 [A] hand placed	4.0	508	57, 67, or 78M

A. A slump of 6 inches is allowed only by use of an approved admixture meeting Article 1024-3. In no case shall the water-cement ratio on the approved design be exceeded.

B. Drilled Pier mixes are non-air entrained. Class A and Class B mixes may be non-air entrained if specified by the contract or special provision.

C. Per Article 450-2, Class A concrete used for drilled-in piles shall have a slump of 6-8 inches and is achieved using an approved water reducer. Do not exceed the water-cement ratio on the approved design.

(E) Elapsed Time for Placing Concrete

Regulate the delivery so the maximum interval between the placing of batches at the work site does not exceed 20 minutes. Place concrete before exceeding the times in Table 1000-2. Measure the elapsed time as the time between adding the mixing water to the mix and placing the concrete.

TABLE 1000-2 ELAPSED TIME FOR PLACING CONCRETE		
Air or Concrete Temperature Whichever is Higher	Maximum Elapsed Time	
	No Retarding Admixture Used	Retarding Admixture Used
90°F or above	30 minutes	1 hr. 15 minutes
80°F through 89°F	45 minutes	1 hr. 30 minutes
79°F or below[A]	60 minutes	1 hr. 45 minutes
70°F through 79°F[B]	60 minutes	1 hr. 45 minutes
69°F or below[B]	1 hr. 30 minutes	2 hr. 15 minutes

A. Applicable to Class AA, A and Drilled Pier concrete.
B. Applicable to Class B concrete.

(F) Use of Set Retarding Admixtures

Use an approved set retarding admixture in all concrete placed in the superstructure of bridges such that the concrete will remain workable until the entire operation of placing and finishing, including corrective measures, if necessary, has been completed. The Engineer may waive the use of set retarding admixture when conditions clearly indicate that it is not needed.

Other structural concrete may contain an approved set retarding admixture when permitted by the Engineer.

Use a set retarding admixture on the NCDOT APL following the manufacturer's recommended dosage rate.

(G) Use of Water Reducing Admixtures

By permission of the Engineer, the Contractor may use an approved water reducing admixture to facilitate placing and finishing.

Use a water reducing admixture on the NCDOT APL following the manufacturer's recommended dosage rate. Concrete containing water reducing admixtures that exhibits segregation and/or excessive bleeding will be rejected. Utilizing an admixture to modify slump does not relinquish the contractor's responsibility to ensure the final product quality and overall configuration meets design specifications. Caution should be taken when placing these mixes on steep grades to prevent unintended changes to the set slope.

(H) Use of Calcium Chloride

Calcium chloride may be used as a set accelerating agent where permitted by the Engineer. Use one lb. of calcium chloride per 100 lbs. of cement except where lesser amounts are directed by the Engineer. Do not use calcium chloride where steel reinforcement, metal conduit or other metals will be in contact with the concrete. Do not use calcium chloride in concrete that has a temperature higher than 70°F, or when the air temperature is greater than 70°F. Provide cold weather protection for concrete containing calcium chloride in the same manner as is provided for concrete without calcium chloride.

Use calcium chloride in liquid form. Dissolve solid calcium chloride using one lb. or less of calcium chloride per one quart of water and mix well to form a liquid solution. To avoid incompatibility with other additives, add the calcium chloride to the batch after all other ingredients have been put into the mixer.

(I) Use of Supplementary Cementitious Materials (SCMs)

SCMs may be substituted for cement in the mix design at a rate of 1.0 lb. of SCM to each pound of cement replaced, up to the maximum amount shown in Table 1024-1. Concrete mixes using SCMs shall not exceed the maximum allowable water/cementitious material

ratio for the designated concrete class. Use Table 1000-1 to determine the maximum allowable water-cementitious material ratio for the classes of concrete listed.

(J) Use of Calcium Nitrite Corrosion Inhibitor

Units with calcium nitrite in a quantity less than specified are subject to rejection. Furnish concrete powder drilled from representative cylinders to the Engineer, in a quantity to be specified, to verify the concentrations of calcium nitrite in hardened concrete. Concrete that fails to contain calcium nitrite at the required concentrations as tested is subject to rejection. Use air-entraining, water-reducing and/or set-controlling admixtures compatible with calcium nitrite solutions. Strictly adhere to the manufacturer's written recommendations regarding the use of admixtures, including storage, transportation and method of mixing. If preferred, use calcium nitrite, which acts as an accelerator, in conjunction with a retarder to control the set of concrete, as per the manufacturer's recommendation. Add an approved calcium nitrite corrosion inhibitor (30% solids) to the concrete mix at the batch plant for the bridge elements identified by the plan notes. Use the inhibitor at a minimum rate of 3.0 gal/cy. Ensure that the hardened concrete contains at least 5.8 lbs/cy nitrite (NO_2) when tested in accordance with Materials and Tests Method Chem. C-20.0. The preceding paragraph does not apply to concrete used in prestressed concrete members. Concrete used in prestressed concrete members shall be tested in accordance with Subarticle 1078-4(G).

1000-4 PORTLAND CEMENT CONCRETE FOR PAVEMENT

(A) Composition and Design

Submit a concrete paving mix design in terms of saturated surface dry weights on *Materials and Tests Form 312U* to the Engineer for approval at least 35 days before proposed use. Mix proportions shall meet the design requirements provided in Table 1000-3 and the applicable portions of this section.

TABLE 1000-3
DESIGN REQUIREMENTS FOR CONCRETE PAVEMENT

Class of Concrete	Min. Compressive Strength at 28 days	Min. Flexural Strength at 28 days	Maximum Water/ Cementitious Ratio	Max. Slump	Min. Cementitious Content	Air Content	Coarse Aggregate Sizes
Units	*psi*	*psi*	*lb/lb*	*inch*	*lb/cy*	%	
Pavement	4500	650	0.559	1.5 slip form 3.0 hand placed	526	5.0% ± 1.5%	57, 67, or 78M
Very High Early Strength for Pavement Repair	4500	650 400 at 4 hours[A]	0.500	1.5 slip form 3.0 hand placed	600	5.0% ± 1.5%	57, 67, or 78M

A. Use of a high alkali cement or reactive aggregate is prohibited unless the supplier can achieve the required flexural strength in 4 hours while substituting the minimum supplementary cementitious material (SCM) amount specified in Section 1024-1 for mitigating ASR.

Include in the mix design the source of aggregates, cement, SCM, water and admixtures; the gradation and specific gravity of the aggregates; the fineness modulus of the fine aggregate; and the dry rodded unit weight and size of the coarse aggregate. Submit test

results showing that the mix design conforms to the criteria, including the 1, 3, 7, 14 and 28-day strengths of the average of two 6 inch x 6 inch x 20 inch beams and the average of two 6 inch x 12 inch cylinders for each age made and tested in accordance with AASHTO R 39, T22 and T97 from a certified laboratory. Design the mix to produce an average strength sufficient to indicate that a minimum strength of 650 psi in flexure and 4,500 psi in compression will be achieved in the field within 28 days.

Where concrete with a higher slump for hand methods of placing and finishing is necessary, submit an adjusted mix design for approval to provide a maximum slump of 3 inches and to maintain the water/cementitious material ratio established by the original mix design. The water/cementitious ratio refers to the ratio of the weight of water (lb) in concrete to the combined weight of cement and SCMs in the concrete. For mixes that use only cement (e.g. no SCMs), the water/cementitious ratio refers to the ratio of the weight of water (lb) to the weight of cement (lb) in the concrete.

(B) Air Entrainment

Entrain air in the concrete by the use of an approved air entraining agent dispensed with the mixing water, unless prohibited.

Provide an air content of 5.0% ± 1.5% in the freshly mixed concrete. The air content will be determined in accordance with AASHTO T 121, T152 or T196. At the option of the Engineer, the air content may be measured by the Chace Indicator, in which case sufficient tests will be made to establish correlation with the test methods of AASHTO T 121, T152 or T196. Concrete will not be rejected based on tests from the Chace Indicator.

(C) Slump

Provide concrete with a maximum slump of 1.5 inches where placed by a fully mechanized paving train and no more than 3 inches where placed by hand methods.

The sample taken for determination of slump will be obtained immediately after the concrete has been discharged onto the road.

(D) Set Retarding Admixture and Water Reducing Admixture

With permission, the Contractor may use an approved set retarding admixture, an approved water reducing admixture or both to facilitate placing and finishing. Use a quantity of set retarding admixture or water reducing admixture within the range shown on the current list of approved admixtures maintained by the Materials and Tests Unit.

(E) Use of Supplementary Cementitious Materials (SCMs)

SCMs may be substituted for cement in the mix design at a rate of 1.0 lb. of SCM to each pound of cement replaced, up to the maximum amount shown in Table 1024-1. Concrete mixes using SCMs shall not exceed the maximum allowable water-cementitious material ratio for the designated concrete class. Use Table 1000-3 to determine the maximum allowable water-cementitious material ratio for the classes of concrete listed.

(F) Contractor's Responsibility for Process Control

Before or at the preconstruction conference, submit a plan detailing the process control and the type and frequency of testing and inspection necessary to produce concrete that meets the specifications. During all batching and delivery operations assign a Certified Concrete Batch Technician on site whose sole duty is to supervise the production and control of the concrete. This duty includes the following:

(1) Tests and inspections necessary to maintain the stockpiles of aggregates in an unsegregated and uncontaminated condition.

(2) Calibration of admixture dispensing systems, weighing systems and water gauges.

(3) Tests and adjustments of mix proportions for moisture content of aggregates.

(4) Mixer performance tests before reducing mixing time of central mix plant to less than 90 seconds and at other times when deemed necessary by the Engineer.

(5) Verifying the actual mixing time of the concrete after all materials are introduced into the mixer at the beginning of paving operations and at least once each month.

(6) Testing all vibrators.

(7) Tests necessary to document the slump and air content of the mix produced. Determine air content at least twice each day.

(8) Tests for depth of the pavement in the plastic state.

(9) Furnishing data to verify that the approved theoretical cement content has been met at intervals not to exceed 50,000 sy of pavement.

(10) Signing all plant reports, batch tickets and delivery tickets.

The Department certifies technicians who satisfactorily complete examinations prepared and administered by the Department.

Perform all test procedures in compliance with the appropriate articles of Section 1000.

Tests may be witnessed by the Engineer. Document the results of all tests and inspections and make a copy available to the Engineer upon request. Take prompt action to correct conditions that have resulted in or could result in the submission of materials, products, or completed construction that do not conform to the specifications.

(G) Contractor Not Relieved of Responsibility for End Result

The Contractor will not be relieved of his obligation to produce a uniform pavement meeting specifications by reason of:

(1) The acceptance or approval by the Engineer of the concrete mix design or any adjustments;

(2) Compliance with the concrete mix design and compliance with the testing requirements and other process control requirements by the Contractor; or

(3) The failure of the Engineer to perform any tests in the process control, nor the performance of any tests in the process control that indicate compliance with the specifications.

1000-5 VERY HIGH EARLY STRENGTH CONCRETE FOR CONCRETE PAVEMENT REPAIR

Mix proportions shall meet the design requirements provided in Table 1000-3 and the applicable portions of this section. Use cement, fine aggregate, coarse aggregate, admixtures and SCMs that have been approved by the Department. SCMs shall be used according to Section 1024.

Accompany *Materials and Tests Form 312U* with 4 hour flexural strength results of at least 6 beams made and tested in accordance with AASHTO R 39 and T97. In addition, submit 4 hour compressive strength results of at least six 4 inch by 8 inch or 6 inch by 12 inch cylinders and maturity test results of the mix. With permission of the Engineer, compressive strength testing and maturity testing may be used in lieu of or concurrent with flexural strength testing to determine the acceptability of the concrete in the field.

1000-6 HIGH EARLY STRENGTH PORTLAND CEMENT CONCRETE

Use high early strength Portland cement concrete when required by contract. When not required, it may be used at the Contractor’s option with approval of the Engineer.

For all classes of concrete, high early strength concrete may be produced by using Type III Portland cement. To produce high early strength concrete with regular cement, use a higher class of concrete as follows:

For Class A and Class B, use Class AA with a cement content of at least 677 lbs/cy. Other classes that lend themselves to high early strength with regular cement will be reviewed by the Engineer on a case-by-case basis.

1000-7 FLOWABLE FILL

Flowable fill consists of Portland cement, water, supplementary cementitious materials and/or fine aggregate and, optionally, concrete admixtures.

Submit the proposed mix design on *Materials and Tests Form 312U* at least 35 days before use.

State on *Materials and Tests Form 312U* the intended use of the material (excavatable or non-excavatable). Excavatable flowable fill shall have a maximum strength of 150 psi at 56 days of age. Non-excavatable flowable fill shall have a minimum strength of 125 psi at 28 days of age. Accompany *Materials and Tests Form 312U* with a listing of compressive strength of at least three 4 inch x 8 inch cylinders at the age of 28 or 56 days, depending on whether the mix is to be excavated or not. Air cure the cylinders during the entire period before testing. The Engineer will advise the Contractor in writing of the acceptability of the mix design.

1000-8 LATEX MODIFIED CONCRETE (LMC)

(A) Materials

Refer to Division 10.

Item	Section
Coarse Aggregate, standard size No. 78M	1014-2
Fine Aggregate	1014-1
Portland Cement	1024-1
Type IL Blended Cement	1024-1
Type IP Blended Cement	1024-1
Type IS Blended Cement	1024-1
Type IT Blended Cement	1024-1
Water	1024-4

Use a formulated latex admixture that is a non-hazardous, film forming and polymeric emulsion in water and is homogeneous and uniform in composition. Add all stabilizers at the point of manufacture. The use of Type III high early strength cement in LMC is only permitted as allowed by the contract.

Use a latex modifier conforming to Table 1000-4.

TABLE 1000-4 PROPERTIES OF LATEX MODIFIER FOR CONCRETE	
Property	**Requirement**
Polymer Type	Styrene Butadiene: 68 ± 4% Styrene 32 ± 4% Butadiene
Average Polymer Particle Size	1500 to 2500 Angstroms
Emulsion Stabilizers	Anionic and non-ionic surfactants
Percent Solids	46.5% to 49.0%
Weight per gallon at 75°F	8.40 to 8.60 lb
pH	9.5 to 11.0
Shelf Life	2 Years
Color	White

Provide a Type 5 material certification for each load of latex emulsion admixture in accordance with Article 106-3. Test admixture samples to verify compliance with the requirements before use. Allow 7 days for sampling and testing after delivery to the project.

Do not allow the temperature of latex emulsion admixture to fall below 35°F at any time or exceed 85°F after delivery to the project.

For latex emulsion that has been in storage, use a transfer pump and lines to recirculate it before using and sampling.

For LMC, use a workable mixture that meets Table 1000-5.

Measure the slump 4 to 5 minutes after discharge from the mixer.

Submit the LMC mix design, including laboratory compressive strength data for a minimum of six (6) 4-inch by 8-inch cylinders at seven (7) days for normal setting concrete to the Engineer for review. Include test results for the slump and air content of the laboratory mix. Perform tests in accordance with AASHTO T 22, T119 and T152.

TABLE 1000-5 PROPERTIES OF LATEX MODIFIED CONCRETE	
Property	**Requirement**
Cement Content, lb/cy	658 min.
Latex Emulsion Admixture, gal/cy	24.5 min.
Air Content of Plastic Mix, %	3.5 - 6.5
Slump, inches	3 - 6
% Fine Aggregate as percent of total aggregate by weight	50 - 55
7 day Compressive Strength, psi	3,000 min.
Water-Cement Ratio by weight	0.40 max.

(B) Equipment

Before beginning any work, obtain approval for all equipment to be used for deck preparation, mixing, placing, finishing and curing the latex modified concrete.

Use sandblasting equipment capable of removing all clay, salt deposits, oil and grease deposits and all other foreign matter. Provide traps or separators to remove oil and water from the compressed air. Use traps or separators of adequate size and drain them periodically during operations. For proportioning and mixing, use self-contained, mobile and continuously mixing equipment that meets the following requirements:

(1) Use a self-propelled mixer that is capable of carrying sufficient unmixed dry, bulk cement, sand, coarse aggregate, latex modifier and water to produce at least 6 cy of concrete on site.

(2) Use a mixer that is capable of positive measurement of cement introduced into the mix. Use a recording meter that is visible at all times and equipped with a ticket printout to indicate the quantity of cement.

(3) Calibrate the mixers to accurately proportion the specified mix. Before placing latex modified concrete, perform calibration and yield tests under the Engineer's supervision in accordance with the Department's written instructions. Copies of these written instructions are available from the Materials and Tests Unit. Perform the calibration and yield tests using the material to be used on the project. Recalibrate the mixer after any major maintenance operation on the mixer, anytime the source of materials changes or as directed by the Engineer. Furnish all materials and equipment necessary to perform the calibrations and yield tests.

(4) Use a mixer that controls the flow of water and latex emulsion into the mix. Measure the flow rate of water and the latex emulsion with a calibrated flowmeter coordinated with both the cement and aggregate feeding mechanisms and the mixer. Adjust the flow rate, as necessary, to control the slump and ensure that the water-cement ratios are met. In addition to flowmeters, use mixers with accumulative water and latex meters capable of indicating the number of gallons, to the nearest 0.1 gallon, introduced into the mixer. Filter water and latex with a suitable mesh filter before it flows through the accumulative water and latex meters.

(5) Calibrate the mixer to automatically proportion and blend all components of the indicated composition on a continuous or intermittent basis as the finishing operation requires. Provide a mixer that discharges mixed material through a conventional chute and is capable of spraying water over the placement width as it moves ahead to ensure that the surface to be overlaid is wet before receiving the modified material.

(6) Mount a tachometer on the unit to indicate the drive shaft speed.

(7) Use adequate hand tools for placing and leveling concrete down to approximately the correct level for striking off with the screed.

(8) Use a finishing machine that meets the approval of the Engineer and the requirements of the contract. Use a self-propelled finishing machine capable of forward and reverse movement under positive control. Use a machine with at least 2 finishing devices, one that is a vibrating screed and the other either a vibrating screed, oscillating screed, or one or more rotating cylindrical drums 48 inches long or less and operating between 1,500 and 2,500 vpm. Make certain the finishing machine can finish the surface to within 1 foot of the edges of the area being placed. Raise all screeds when the finishing machine is moving backwards over the screeded surface.

(9) Use screeds with a vibration frequency that is variable between 3,000 and 6,000 vpm with positive controls. Use screeds with a metal covered bottom face not less than 4 inches wide. Provide screeds with positive control of the vertical position.

(10) Use supporting rails for travelling of the finishing machine rigid enough to eliminate deflection from the weight of the machine.

(C) Proportioning and Mixing of Modified Compositions

Use mobile continuous mixers that accurately proportion all materials for the specified mixture. Operate the proportioning equipment at the manufacturer's recommended speed verified with the tachometer during calibration and normal operations.

Yield checks and other checks are permitted.

(D) Contractor's Responsibility for Process Control

Before or at the preconstruction conference, submit a plan detailing the process control and the type and frequency of testing and inspection necessary to produce concrete that meets the specifications. During all batching and delivery operations assign a Certified Concrete

Batch Technician on site whose sole duty is to supervise the production and control of the concrete. This duty includes the following:

(1) Tests and inspections necessary to maintain the stockpiles of aggregates in an unsegregated and uncontaminated condition.

(2) Calibration of admixture dispensing systems, weighing systems and water gauges.

(3) Tests and adjustments of mix proportions for moisture content of aggregates.

(4) Mixer performance tests before reducing mixing time of central mix plant to less than 90 seconds and at other times when deemed necessary by the Engineer.

(5) Verifying the actual mixing time of the concrete after all materials are introduced into the mixer at the beginning of paving operations and at least once each month.

(6) Testing all vibrators.

(7) Tests necessary to document the slump and air content of the mix produced. Determine air content at least twice each day.

(8) Tests for depth of the pavement in the plastic state.

(9) Furnishing data to verify that the approved theoretical cement content has been met at intervals not to exceed 50,000 sy of pavement.

(10) Signing all plant reports, batch tickets and delivery tickets.

The Department certifies technicians who satisfactorily complete examinations prepared and administered by the Division of Highways.

Perform all test procedures in compliance with the appropriate articles of Section 1000.

Tests may be witnessed by the Engineer. Document the results of all tests and inspections and make a copy available to the Engineer upon request. Take prompt action to correct conditions that have resulted in or could result in the submission of materials, products, or completed construction that do not conform to these specifications.

1000-9 MEASURING MATERIALS

(A) Weighing Cement

Measure cement by weight on scales separate from those used for other materials and in a hopper that is entirely free and independent of the hoppers used for weighing the aggregates. When the quantity of cement in a batch exceeds 30% of the full capacity of the scale, ensure the quantity of cement as indicated by the scale is within ± 1% of the required weight. For smaller batches, ensure the quantity of cement as indicated by the scale be not less than the required amount or more than 4% in excess. Equip all beam type scales with a tare beam.

(B) Weighing Aggregates

Measure aggregates by weight. Base batch weights on saturated surface dry materials which is the required weight plus the total weight of surface moisture contained in the aggregate. Ensure the individual aggregates, as weighed, are within ± 2% of the required weights.

(C) Water

Measure water by volume or by weight. Ensure the quantity of water measured is within ± 1% of the required amount.

(D) Admixture Dispensing Systems

Provide a separate dispensing system with separate fill and discharge lines for each type of admixture to be used, except that admixtures may be measured and introduced into the mix

manually if approval has been obtained. Ensure each system is capable of measuring, displaying and discharging the required amount of admixture into the mix. Keep dispensing systems clean and in good operating condition. Use a dispensing system that is either:

(1) Manually operated, self-contained; or

(2) Semi-automatic or automatic, self-contained; or

(3) Interfaced to operate automatically with the concrete batching control panel.

Have the admixture dispenser dispense the required quantity of admixture for each concrete batch within an accuracy of ± 3%. Check the accuracy of the dispenser as provided below. Check the accuracy at the point of discharge, or through a bypass valve suitable for obtaining a calibrated sample of admixture and at the volumes normally used for one half mixer capacity and for full mixer capacity. Determine the accuracy at the time of installation and check daily during the early part of each day's operation.

Include in each system a graduated measuring unit into which the admixture is batched to permit a quick visual check of accuracy before its discharge. Ensure the measuring unit is clearly graduated and be of sufficient size to hold the maximum anticipated dose for one batch. Clearly mark the measuring unit for the type of admixture to be used.

Control the discharge sequence so an admixture will not be brought into contact with raw cement or another admixture before being diluted through contact with the mixing water in the mixer. Where 2 types of admixtures are being used, do not discharge them into the mix simultaneously. Add the air entraining agent with the first addition of water and add any other chemical admixture with the final addition of water, unless otherwise permitted.

Construct the discharge lines to completely empty after each cycle. Locate the admixture dispensing systems so the batching plant operator will have a visual verification of the actual quantity of admixture batched.

Use air entraining admixtures in accordance with the manufacturer's recommendations and in such quantity to provide the specified air content in freshly mixed concrete. Use a quantity of set retarding admixture and of water reducing admixture per 100 lbs. of cement that is within the range recommended on the current list of approved admixtures issued by the Materials and Tests Unit.

1000-10 BATCHING PLANT

(A) General

Plants located on the Department rights of way shall conform to Article 107-3.

Have ready mixed concrete plants inspected and approved by the Department before they are used to produce concrete, either paving, structural or incidental, for the project. Plants shall meet all the applicable requirements of these *Standard Specifications*, and in addition, ensure each ready mix plant provides at least three acceptable truck mixers or truck agitators available for use. Use trucks that have an identifying number. Plants approved by the Department will be placed on a list of approved plants available to the Contractor. All plants will be subject to reinspection at intervals selected by the Engineer. Reapproval after each inspection will be contingent on continuing compliance with the *Standard Specifications*.

(B) Bins and Hoppers

Provide bins with separate compartments for fine aggregates and for each required size of coarse aggregate in the batching plant. Design each compartment to discharge efficiently and freely into the weighing hopper. Provide control so, as the quantity desired is being approached, the material may be added slowly and shut off with precision. Construct weighing hoppers to eliminate accumulation of tare materials and to discharge fully unless

otherwise permitted. Provide a port or other opening for removing an overload of any one of the several materials from the hopper.

(C) Scales

Use either the beam type, load cell type or the springless dial type scales for weighing aggregates and cement. Ensure the minimum graduation on beam or dial is not more than 0.1% of the total capacity of the scale. Methods of weighing, other than beam or springless dial scales, may be approved by the Engineer provided they meet the required weighing tolerances. Ensure the scales are accurate within 0.5% under operating conditions. Make available ten 50 lb. test weights at the plant for checking accuracy. Use test weights which meet the U.S. Bureau of Standards requirements for calibrating and testing equipment. Keep all exposed fulcrums, clevises and similar working parts of scales clean. When beam type scales are used, make provisions for indicating to the operator that the required load in the weighing hopper is being approached. Ensure the device indicates at least the last 50 lbs. of load and design it to give a positive indication of overload of the scales. During charging of the hopper, have all indicating devices in full view of the operator and provide convenient access to all controls. Ensure the indicating devices are in the immediate vicinity of the operator and easily readable by the operator.

(D) Water Measuring Devices

Use devices for measurement of the water which are readily adjustable and are capable of being set to deliver the required amount and cut off the flow automatically when this amount has been discharged. Under all operating conditions the device shall have accuracy within 1% of the quantity of water required for the batch. Arrange the device so variable pressures in the water supply line will not affect the measurements. Use measuring tanks of adequate capacity to furnish the maximum mixing water required and equip them with outside taps and valves to provide for checking their calibration unless other means are provided for readily and accurately determining the amounts in the tank.

1000-11 MIXERS AND AGITATORS

(A) General

Mixers are defined as equipment to mix concrete and may be stationary or truck mounted. Agitators are defined as equipment used to haul central mixed concrete and may be truck mixers or truck agitators. Provide a metal plate or plates attached to each mixer and agitator in a prominent place on which the manufacturer has plainly marked the mixing speed of the drum or paddles and the maximum capacity of the drum or container in terms of volume of mixed concrete. On truck mixers and agitators, show the manufacturer's recommended agitating and mixing speed of rotation of the mixing drum or blades. Equip stationary mixers with an acceptable timing device that will not permit the batch to be discharged until the specified mixing time has elapsed. Equip truck mixers with counters to verify the number of revolutions of the drum or blades. Actuate the counters at the initial time the drums have reached mixing speed.

Examine mixers and agitators periodically for changes in condition due to accumulation of hard concrete or mortar, wear of blades or any other condition which decreases mixing efficiency. Mixers are unacceptable when the radial height or other dimension of the blade has worn below 90% of the original dimension. This radial height excludes any lips on the blade and is the height of the blade running perpendicular to the shell of the drum. Where such conditions are found, do not use the units until they are corrected.

Also examine mixers and agitators periodically for general mechanical condition, including water measuring and discharge apparatus, identifying number on trucks, condition of the blades, speed of rotation of the drum and condition of the drum.

(B) Mixer Capacity

Do not load truck mixers with concrete with more than 63% of the gross volume of the drum. Use mixers capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity. Use stationary mixers, when loaded at the manufacturers guaranteed mixing capacity and the concrete mixed for the prescribed mixing time, capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and discharging the concrete with satisfactory uniformity.

Use at least 20% of the rated mixing capacity as the minimum quantity of concrete permitted to be mixed or agitated in any mixer.

(C) Agitator Capacity

Load the agitator to not exceed 80% of the gross drum volume and have it be capable of maintaining the concrete in a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

(D) Consistency Tests

The Engineer may, from time to time, make slump tests to measure consistency of the concrete. Take individual samples at approximately the 1/5th point, the midpoint and the 4/5th point of the load, using AASHTO T 119. Such tests will be made within 20 minutes of discharge of that portion of the load. If the results vary by more than 1 inch in slump, do not use the mixer or agitator unless the condition is corrected.

1000-12 MIXING AND DELIVERY

(A) General

Mix and deliver concrete to the site of the work by one of the following methods, except where other methods are approved by the Engineer. Maintain responsibility for controlling the materials and operations as to produce uniform concrete meeting specifications requirements.

When concrete is being produced for structures and incidental construction in accordance with Article 1000-3, have present during all batching operations a Certified Concrete Batch Technician employed by the Contractor or concrete supplier. During batching and delivery, the sole duty of this employee is to supervise the production and control of the concrete. Perform moisture tests, adjust mix proportions of aggregates for free moisture, complete and sign Batch Tickets (*Materials and Tests Form 903*) or approved delivery tickets and assure quality control of the batching. Delivery tickets will be permitted instead of batch tickets (*Materials and Tests Form 903*) provided they have been reviewed and approved by the Materials and Tests Unit. The Department certifies technicians who satisfactorily complete examinations prepared and administered by the Department.

(1) Central Mixed Concrete

Concrete that is mixed completely in a stationary mixer and the mixed concrete transported to the point of delivery in a truck agitator or in a truck mixer operating at agitating speed or in non-agitating equipment approved by the Engineer. Perform mixing within the capacity and at the mixing speeds recommended by the manufacturer.

(2) Transit Mixed Concrete

Concrete that is mixed completely in a truck mixer while at the batching plant, in transit, or at the work site.

(3) Shrink Mixed Concrete

Concrete that is mixed partially in a stationary mixer at a central mixing plant and completed as transit mixed concrete. Place all ingredients for a batch in the stationary mixer, partially mix before any concrete is discharged to the truck mixer and do not exceed the rated capacity of the equipment for the batch size. The mixing time at the stationary mixer may be reduced to the minimum necessary to intermingle the ingredients, and the mixing may be completed in the truck mixer. Use the number of mixing revolutions in the truck mixer as specified for transit mixed concrete or reduce as indicated by mixer performance tests.

(B) Mixing Time for Central Mixed Concrete

Mixing time begins when all solid materials are in the mixing compartment and ends when any part of the concrete begins to discharge. In charging the mixer, water will enter in advance of cement and aggregate. Ensure all the water is substantially in the drum before 1/3 of the specified mixing time has elapsed. Count transfer time in multiple drum mixers as part of the mixing time.

Where mixer performance tests are not made, use a minimum mixing time of 90 seconds, providing that blending of materials during charging is achieved to the satisfaction of the Engineer. The minimum mixing time for an individual mixer is that which, as shown by mixer performance tests, will produce concrete in accordance with Table 1000-6, except that the mixing time shall not be less than 50 seconds under any circumstances. Maximum mixing time excluding discharge time is 150 seconds.

Sampling and testing for mixer performance tests will be done as provided below. Charge the mixer to its rated capacity with the materials and proportions to be used in the work and mixed at the recommended mixing speed to the target time. Stop mixing and begin discharging. Two samples of sufficient size to make the required tests will be taken after discharge of approximately 15% and 85% of the load.

TABLE 1000-6
REQUIREMENTS FOR UNIFORMITY OF CONCRETE

Property	Requirement	Test Method
Difference in Test Samples Air Content, percent by volume of concrete	1.0%	AASHTO T 152
Slump	1.0"	AASHTO T 119
Coarse aggregate content, portion by weight of each sample retained on the No. 4 sieve	6.0%	AASHTO M 157
Weight	1.0 lb	AASHTO T 121
Average Compressive Strength at 7 days, percent of average	10.0%[A]	AASHTO T 22 AASHTO R 100

A. Tentative approval may be granted pending 7 day compressive strength tests.

Each of the two samples of concrete will be separately tested for the properties listed in Table 1000-6. Tests will be conducted in accordance with the test procedures specified in Table 1000-6 or procedures established by the Materials and Tests Unit.

The mixer performance test described above will be performed on at least two batches of concrete. For the performance test to be acceptable, have all tests in each batch tested meet the requirements listed above.

The Engineer may recheck mixer performance at any time when, in his opinion, satisfactory mixing is not being accomplished.

Where satisfactory mixing cannot be accomplished in 90 seconds, the Engineer may increase the mixing time or require that the mixer be repaired or replaced before any further mixing can be done.

(C) Truck Mixers and Truck Agitators

When a truck mixer is used for complete mixing, mix each batch of concrete for at least 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as mixing speed, unless otherwise directed by the Engineer. Unless the mixer is equipped with a counter which will distinguish between mixing and agitating speeds, perform the minimum required number of revolutions of the drum at mixing speed as directed by the Engineer, either at the batching plant before the mixer leaves for the work site and/or at the work site before the concrete is discharged. Perform any additional mixing at the speed designated by the manufacturer of the equipment as agitating speed. Put all materials including mixing water in the drum before actuating the revolution counter for determining the number of revolutions of the drum.

When a truck mixer or truck agitator is used to transport concrete that has been completely mixed in a stationary mixer, perform mixing during transport at agitating speed.

Provide concrete, when discharged from truck mixers or truck agitators, of the consistency and workability required for the work. Control the rate of discharge of the plastic concrete from the mixer drum by the speed or rotation of the drum in the discharge direction with the discharge gate fully open. If additional mixing water is necessary to produce the slump necessary for proper placement, add it only with permission and rotate the truck mixer drum at least 25 revolutions at mixing speed before discharge of any concrete. Additional mixing water will be allowed only if the maximum specified water content per cubic yard is not exceeded.

(D) Delivery

Use a ticket system for recording the transportation of batches from the proportioning plant to the site of the work. Use tickets furnished by the Engineer and fill it out in accordance with instructions issued by the Engineer. Issue the tickets to the truck operator at the proportioning plant for each load and have them signed by the plant inspector, which will signify that the concrete in the truck has been inspected before departure. Ensure each ticket shows the time batching was completed and if transit mixed, the number of revolutions at mixing speed, if any, at the plant. Deliver the tickets to the inspector at the site of the work. Do not use loads which do not carry such tickets and loads which do not arrive in satisfactory condition within the time limits specified in the work.

1000-13 VOLUMETRIC MIXED CONCRETE

Upon written request by the contractor, the Department may approve the use of concrete proportioned by volume. The volumetric producer must submit and have approved a process control plan and product quality control plan by the Materials and Tests Unit. If concrete is proportioned by volume, the other requirements of these specifications with the following modifications will apply. Unless otherwise approved by the Department, use of concrete proportioned by volume shall be limited to Class B concrete and no more than 30 cy per unit per day.

(A) Materials

Use materials that meet the requirements for the respective items except that they will be measured by a calibrated volume-weight relationship.

Storage facilities for all material shall be designed to permit the Department to make necessary inspections before the batching operations. The facilities shall permit identification of approved material at all times and shall be designed to avoid mixing with, or contaminating by, unapproved material. Coarse and fine aggregate shall be furnished and handled so variations in the moisture content affecting the uniform consistency of the concrete is avoided.

Moisture content of the coarse and fine aggregate will be made available onsite for the Engineer's review for each load. The frequency of moisture testing will be dependent on

certain variables such as weather, season and source; however, moisture tests should be performed at least once at the beginning of the work day for each source material. Additional daily moisture tests for the coarse and fine aggregate shall be performed if requested by the Engineer.

Unused materials should be emptied from hopper daily. Concrete should not be mixed with materials left in the hopper overnight.

(B) Equipment

Provide volumetric mixers with rating plates indicating that the performance of the mixer is in accordance with the Volumetric Mixer Manufacturer Bureau or equivalent. Mixers must comply with ASTM C685. Unless otherwise specified, all mixing operations must be in strict accordance with the manufacturer's recommended procedures. Such procedures shall be provided to the Department for review upon request.

The volumetric mixer shall be capable of carrying sufficient unmixed dry bulk cement, supplementary cementitious material (if required), fine aggregate, coarse aggregate, admixtures and water, in separate compartments and accurately proportioning the specified mix. Each batching or mixing unit (or both) shall carry in a prominent place a metal plate or plates on which are plainly marked the gross volume of the unit in terms of mixed concrete, discharge speed and the weight-calibrated constant of the machine in terms of a revolution counter or other output indicator.

The concrete mixing device shall be an auger-type continuous mixer used in conjunction with volumetric proportioning. The mixer shall produce concrete, uniform in color and appearance, with homogeneous distribution of the material throughout the mixture. Mixing time necessary to produce uniform concrete shall be established by the contractor and shall comply with other requirements of these specifications. Only equipment found acceptable in every respect and capable of producing uniform results will be permitted.

Each volumetric mixer shall be equipped with an onboard ticketing system that will electronically produce a record of all material used and their respective weights and the total volume of concrete placed. Alternate methods of recordation may be used if approved by the Engineer. Tickets shall identify at least the following information:

(1) Contractor Name
(2) Contractor Phone Number
(3) NCDOT Project No. and TIP No.
(4) Date
(5) Truck No.
(6) Ticket No.
(7) Time Start/End of Pour
(8) Mix ID and Description (Strength)
(9) Aggregate Moisture Before Mixing

(C) Proportioning Devices

Volume proportioning devices, such as counters, calibrated gate openings or flow meters, shall be easily accessible for controlling and determining the quantities of the ingredients discharged. All indicating devices that affect the accuracy of proportioning and mixing of concrete shall be in full view of and near enough to be read by the operator and Engineer while concrete is being produced. In operation, the entire measuring and dispensing mechanism shall produce the specified proportions of each ingredient.

Provide positive control of the flow of water and admixtures into the mixing chamber with a volumetric mixer. Indicate water flow by a flow meter and be readily adjustable to provide for slump control and/or minor variations in aggregate moisture. Provide a mixer capable of continuously circulating or mechanically agitating the admixtures.

Dispense liquid admixtures through a controlled, calibrated flow meter. A positive means to observe the continuous flow of material shall be provided. If an admixture requires diluting, the admixture shall be diluted and thoroughly mixed before introducing the admixture into the dispenser. When admixtures are diluted, the ratio of dilution and the mixing shall be approved by and performed in the presence of the Department.

The volumetric mixer shall be capable of measurement of cement, supplementary cementitious material (if required), liquids and aggregate being introduced into the mix.

(D) Calibration

Volume-weight relationships will be based on calibration. The proportioning devices shall be calibrated by the contractor before the start of each NCDOT job and subsequently at intervals recommended by the equipment manufacturer. Calibrations will be performed in the presence of the Department and subject to approval from the Department. Calibration of the cement and aggregate proportioning devices shall be accomplished by weighing (determining the mass of) each component. Calibration of the admixture and water proportioning devices shall be accomplished by weight (mass) or volume. Tolerances in proportioning the individual components will be as follows:

TABLE 1000-7
VOLUMETRIC MIXED CONCRETE CALIBRATION TOLERANCES

Item	Tolerance
Cement, Weight (Mass) percent	0 to +4
Fine Aggregate, Weight (Mass) percent	± 2
Coarse Aggregate, Weight (Mass) percent	± 2
Admixtures, Weight (Mass) or Volume percent	± 3
Water, Weight (Mass) or Volume percent	± 1

Each volumetric mixer must be accompanied at all times by completed calibration worksheets and they shall be made available to the Department upon request.

(E) Verification of Yield

Verification of the proportioning devices may be required at any time by the Department. Verification shall be accomplished by proportioning the rock and sand based on the cement meter count for each concrete mobile mixer. Once the count (revolutions) for 94 lbs. of cement has been determined then delivery of the correct amount of rock and sand can be verified.

(F) Uniformity

When concrete is produced, have present during all batching operations a Certified Concrete Batch Technician. During batching and placement, the sole duty of this employee is to supervise the production and control of the concrete, perform moisture tests, adjust mix proportions of aggregates for free moisture, complete and sign approved delivery tickets and assure quality control of the batching.

Two samples of sufficient size to make the required tests will be taken after discharge of approximately 15% and 85% of the load. Each of the two samples of concrete will be separately tested for the properties listed in Table 1000-7. Tests will be conducted in accordance with the test procedures specified in Table 1000-7 or procedures established by the Materials and Tests Unit. The Engineer may recheck mixer performance at any time when, in his opinion, satisfactory mixing is not being accomplished.

SECTION 1002
SHOTCRETE PRODUCTION AND DELIVERY

1002-1 DESCRIPTION

This section addresses shotcrete to be used for temporary support of excavations and other applications in accordance with the contract. Produce shotcrete by either the dry-mix or wet-mix process composed of Portland cement, fine and/or coarse aggregates, water and at the Contractor's option, SCMs. Include chemical admixtures as required or needed for shotcrete produced by the wet-mix process. SCMs may be substituted for a portion of the Portland cement. Type IL, IS, IP or IT blended cement may be used instead of Portland cement.

Mixes for all shotcrete shall be designed by a Certified Concrete Mix Design Technician or an engineer licensed by the State of North Carolina. Dry-mix shotcrete shall be on the NCDOT APL. Shotcrete shall be applied by a nozzelman certified as an ACI Shotcrete Nozzelman in accordance with *ACI Certification Publication CP-60*. Nozzlemen shall be certified in either dry-mix or wet-mix shotcrete based on the process to be used for the work.

1002-2 MATERIALS

Refer to Division 10.

Item	Section
Chemical Admixtures	1024-3
Coarse Aggregate	1014-2
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6
Portland Cement	1024-1
Silica Fume	1024-7
Type IL Blended Cement	1024-1
Type IP Blended Cement	1024-1
Type IS Blended Cement	1024-1
Type IT Blended Cement	1024-1
Water	1024-4

1002-3 SHOTCRETE FOR TEMPORARY SUPPORT OF EXCAVATIONS

(A) Composition and Design

Submit proposed shotcrete mix designs for each shotcrete mix to be used in the work. Mix proportions shall be determined by a testing laboratory approved by the Department. Submit shotcrete mix designs in terms of saturated surface dry weights on *Materials and Tests Form 312U* at least 35 days before proposed use. Adjust batch proportions to compensate for surface moisture contained in the aggregates at the time of batching. Changes in the saturated surface dry mix proportions will not be permitted unless revised shotcrete mix designs have been submitted to the Engineer and approved.

The Engineer will review the shotcrete mix design for compliance with the contract and notify the Contractor as to its acceptability contingent upon compressive strength test results for cores from preconstruction test panels. Do not use a shotcrete mix until written notice has been received. Acceptance of the shotcrete mix design does not relieve the Contractor of his responsibility to furnish a product that meets this contract.

(B) Chemical Admixtures

Use a quantity of chemical admixture within the range shown on the current list of approved admixtures issued by the Materials and Tests Unit.

(C) Strength of Shotcrete

Provide shotcrete with a compressive strength at 3 and 28 days of at least 2,000 psi and 4,000 psi, respectively. The compressive strength of the shotcrete will be considered the average compressive strength test results of 3 cores from the same test panel at each age.

(D) Preconstruction Test Panels

Before beginning construction, provide one preconstruction test panel for each shotcrete mix design and nozzlemen using the same equipment that will be used for the work. Use 3 feet x 3 feet forms at least 3.5 inches thick for preconstruction test panels.

Batch, deliver, mix and apply shotcrete in accordance with Subarticles 1002-3(E) and 1002-3(F) and the contract. Make preconstruction test panels in the presence of the Engineer with forms in a vertical position and from the same shooting position anticipated for construction. Do not disturb test panels for the first 24 hours after shotcreting.

(E) Mixing and Delivery

Produce shotcrete of required strength, consistency, quality and uniformity with minimum rebound. Do not use rebound or previously expanded material in the shotcrete mix. Thoroughly mix materials in sufficient quantity to place shotcrete continuously. Regulate the delivery so the maximum interval between the shooting of batches at the work site does not exceed 20 minutes. Comply with Articles 1000-10 through 1000-13 to the extent applicable for shotcrete instead of concrete.

(F) Shooting Requirements

Use equipment capable of handling and shooting shotcrete at a steady uninterrupted flow. Use air supply systems that supply clean, dry air free of contamination and capable of maintaining sufficient nozzle velocity at all times. Apply shotcrete with the same equipment and methods as used for the preconstruction test panels.

The shotcrete temperature at the time of shooting shall be not less than 50°F or no more than 90°F. Do not apply shotcrete during heavy rains or runoff or high winds so the nozzle stream separates during shooting. Do not apply shotcrete if surface to receive shotcrete is frozen or the air temperature measured at the location of the shotcreting operation in the shade away from artificial heat is below 40°F. Apply shotcrete before the time between adding the mixing water to the shotcrete mix and shooting the shotcrete exceeds 60 minutes.

(G) Production Test Panels

Provide one production test panel for every 33 cy of shotcrete with at least one test panel for each day shotcreting occurs. Use 18 inch x 18 inch forms at least 3.5 inches thick for production test panels. Make production test panels with forms in a vertical position from the same shooting position and at the same time as shotcreting is done. Do not disturb test panels for the first 24 hours after shotcreting.

(H) Handling and Storing Test Panels

Notify the Area Materials Engineer when preconstruction or production test panels are made within 24 hours of shooting the panels. Field cure and protect test panels from damage in accordance with ASTM C1140. The Contractor shall core the panels in the presence of the Engineer. The Department will transport the cores to a Materials and Tests Regional Laboratory for testing.

SECTION 1003
GROUT PRODUCTION AND DELIVERY

1003-1 DESCRIPTION

This section addresses cement grout to be used for structures, foundations, retaining walls, concrete barriers, embankments, pavements and other applications in accordance with the contract. Produce non-metallic grout composed of Portland cement and water and at the Contractor's option or as required, aggregate and supplementary cementitious materials. Include chemical admixtures as required or needed. Provide sand cement or neat cement grout as required. Define "neat cement grout" as grout without aggregate.

The types of grout with their typical uses are as shown below:

Type 1 – A cement grout with only a 3 day strength requirement and a fluid consistency that is typically used for filling subsurface voids.

Type 2 – A nonshrink grout with strength, height change and flow conforming to ASTM C1107 that is typically used for foundations and rock anchors.

Type 3 – A nonshrink grout with high early strength and freeze-thaw durability requirements that is typically used in pile blockouts, grout pockets, shear keys, dowel holes and recesses for concrete barriers and structures.

Type 4 – A neat cement grout with low strength, a fluid consistency and high fly ash content that is typically used for slab jacking.

Type 5 – A neat cement grout that is typically used for soil nails and ground anchors.

Type 6 – A low slump, low mobility cement grout with minimal strength that is typically used for compaction grouting.

1003-2 MATERIALS

Refer to Division 10.

Item	Section
Chemical Admixtures	1024-3
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6
Portland Cement	1024-1
Silica Fume	1024-7
Water	1024-4

Do not use grout that contains soluble chlorides or more than 1% soluble sulfate.

At the Contractor's option, use an approved packaged grout instead of the materials above except for water. Use packaged grouts that are on the NCDOT APL.

Use admixtures for grout that are on the NCDOT APL or other admixtures in accordance with Subarticle 1024-3(E) except do not use concrete additives or unclassified or other admixtures in Type 4 or 6 grout. Use Class F fly ash for Type 4 grout and Type II Portland cement for Type 6 grout.

Use well graded rounded aggregate with a gradation, liquid limit (LL) and plasticity index (PI) that meet Table 1003-1 for Type 6 grout. Fly ash may be substituted for a portion of the fines in the aggregate. Do not use any other supplementary cementitious materials in Type 6 grout.

TABLE 1003-1 AGGREGATE REQUIREMENTS FOR TYPE 6 GROUT			
Gradation		Maximum Liquid Limit	Maximum Plasticity Index
Sieve Designation per AASHTO M 92	Percentage Passing (% by weight)		
3/8"	100	N/A	N/A
No. 4	70 – 95		
No. 8	50 – 90		
No. 16	30 – 80		
No. 30	25 – 70		
No. 50	20 – 50		
No. 100	15 – 40		
No. 200	10 – 30	25	10

1003-3 COMPOSITION AND DESIGN

When using approved packaged grout, a grout mix design submittal is not required. Otherwise, submit proposed grout mix designs for each grout mix to be used in the work, except for Type 5 grout, which has a prescribed mix design specified in Article 1003-4. Mixes for all grout shall be designed by a Certified Concrete Mix Design Technician or an engineer licensed by the State of North Carolina. Mix proportions shall be determined by a testing laboratory approved by the Department. Base grout mix designs on laboratory trial batches that meet Table 1003-2 and this section. With permission, the Contractor may use a quantity of chemical admixture within the range shown on the current list of approved admixtures maintained by the Materials and Tests Unit.

Submit grout mix designs in terms of saturated surface dry weights on *Materials and Tests Form 312U* at least 35 days before proposed use. Adjust batch proportions to compensate for surface moisture contained in the aggregates at the time of batching. Changes in the saturated surface dry mix proportions will not be permitted unless revised grout mix designs have been submitted to the Engineer and approved.

Accompany *Materials and Tests Form 312U* with a listing of laboratory test results of compressive strength, density and flow or slump and if applicable, aggregate gradation, height change and durability from a certified laboratory. List the compressive strength of at least three 2 inch cubes at the age of 3 and 14 or 28 days per Table 1003-2 for Type 1 through 4 grouts. List the compressive strength of at least three 6 inch x 12 inch cylinders at the age of 3 and 28 days for Type 6 grout.

The Engineer will review the grout mix design for compliance with the contract and notify the Contractor as to its acceptability. Do not use a grout mix until written notice has been received. Acceptance of the grout mix design or use of approved packaged grouts does not relieve the Contractor of his responsibility to furnish a product that meets the contract.

Perform laboratory tests in accordance with the following test procedures:

Property	Test Method
Aggregate Gradation[A]	AASHTO T 27
Compressive Strength	AASHTO T 106
Density (Unit Weight)	AASHTO T 121, AASHTO T 133[B], ANSI/API RP[C] 13B-1[B] (Section 4, Mud Balance)
Durability	AASHTO T 161[D]
Flow	ASTM C939 (Flow Cone)
Height Change	ASTM C1090[E]
Slump	AASHTO T 119 (Except do not rod grout)

A. Applicable to grout with aggregate.
B. Applicable to Neat Cement Grout.
C. American National Standards Institute/American Petroleum Institute Recommended Practice.
D. Procedure A (Rapid Freezing and Thawing in Water) required
E. Moist room storage required.

1003-4 GROUT REQUIREMENTS

Provide grout types in accordance with the contract. Use grouts with properties that meet Table 1003-2. For Type 1 through 5 grouts, the compressive strength of the grout will be considered the average compressive strength test results of three 2 inch cubes at the oldest age per Table 1003-2. Make cubes that meet AASHTO T 106 from the grout delivered for the work or mixed on-site. Make cubes at such frequencies as the Engineer may determine and cure them in accordance with AASHTO T 106.

For Type 5 grout, use neat cement grout that only contains cement and water with a water cement ratio of 0.4 to 0.5, which is approximately 5.5 gallons of water per 94 lbs. of Portland cement.

For Type 6 grout, the compressive strength of the grout will be considered the average compressive strength test results of three 6 inch x 12 inch cylinders at the age of 28 days. Make cylinders in accordance with AASHTO R 100 except do not rod grout. Make cylinders at such frequencies as the Engineer may determine and cure them in accordance with AASHTO R 100.

TABLE 1003-2
GROUT REQUIREMENTS

Type of Grout	Minimum Compressive Strength at			Height Change at 28 days	Flow[A]/Slump[B]	Minimum Durability Factor
	3 days	14 days[C]	28 days			
1	3,000 psi	-	-	-	10 – 30 sec	-
2	Table 1[D]				Fluid Consistency[D]	-
3	5,000 psi[E]	5,000 psi	-	0 – 0.2%	Per Accepted Grout Mix Design or Approved Packaged Grout[F]	80
4[G]	600 psi	-	1,500 psi	-	10 – 26 sec	-
5	1,500 psi	-	4,000 psi	-	Per Standard Mix Design specified in Article 1003-4	-
6	100 psi	-	250 psi	-	< 2"	-

A. Applicable to Type 1 through 4 grouts.
B. Applicable to Type 6 grout.
C. Not applicable to Type 2 grout
D. ASTM C1107.
E. Minimum compressive strength at 3 days is only required to approve Type 3 grout mix designs or evaluate Type 3 packaged grouts for the NCDOT APL.
F. Add mixing water to Type 3 packaged grout at the manufacturer's recommended rate to produce grout with the designed consistency and required 3 day strength.
G. Use Type 4 grout with proportions by volume of 1 part cement and 3 parts fly ash.

1003-5 TEMPERATURE REQUIREMENTS

When using an approved packaged grout, follow the manufacturer's instructions for grout and air temperature at the time of placement. Otherwise, the grout temperature at the time of placement shall be not less than 50°F nor more than 90°F. Do not place grout when the air temperature measured at the location of the grouting operation in the shade away from artificial heat is below 40°F.

1003-6 ELAPSED TIME FOR PLACING GROUT

Agitate grout continuously before placement. Regulate the delivery so the maximum interval between the placing of batches at the work site does not exceed 20 minutes. Place grout before exceeding the times in Table 1003-3. Measure the elapsed time as the time between adding the mixing water to the grout mix and placing the grout.

TABLE 1003-3
ELAPSED TIME FOR PLACING GROUT
(with continuous agitation)

Air or Grout Temperature, Whichever is Higher	Maximum Elapsed Time	
	No Retarding Admixture Used	Retarding Admixture Used
90°F or above	30 minutes	1 hr. 15 minutes
80°F through 89°F	45 minutes	1 hr. 30 minutes
79°F or below	60 minutes	1 hr. 45 minutes

1003-7 MIXING AND DELIVERY

Use grout free of any lumps and undispersed cement. When using an approved packaged grout, mix grout in accordance with the manufacturer's instructions. Otherwise, comply with Articles 1000-9 through 1000-13 to the extent applicable for grout instead of concrete.

SECTION 1005
GENERAL REQUIREMENTS FOR AGGREGATE

1005-1 GENERAL

Obtain aggregates from sources participating in the Department's Aggregate QC/QA Program as described in Section 1006. Obtain aggregates from pre-approved sources, or have the source approved through the Department's Aggregate QC/QA Program before use. Approval of such sources is based not only on the quality of the aggregate, but also on satisfactory production facilities and procedures. A list of approved aggregate sources participating in the Department's Aggregate QC/QA Program in North Carolina and adjoining states is available from the Materials and Tests Unit. Use of aggregates is allowed in the work provided they have been properly stockpiled in units of not less than 300 tons, tests of representative samples of these aggregates indicate satisfactory compliance with the specifications and the source meets all the requirements of the Aggregate QC/QA Program.

Separate aggregate containing rock of more than one identifiable rock type or particles of visibly different degrees of weathering in amounts of 10% or more into each individual type. Aggregate is acceptable only if each type does not exceed the percentage of wear specified for a particular use.

Blended aggregates from different sources are allowed if all aggregates meet the Specifications for soundness or resistance to abrasion.

1005-2 HANDLING AND STORING AGGREGATES

Handle and stockpile aggregates in such a manner to minimize segregation.

Provide sites for aggregate stockpiles that are cleared, grubbed and cleaned with a firm, smooth and well drained ground surface. Maintain a cover of at least 3 inches of aggregate over the ground surface to avoid the inclusion of soil or foreign material. Operate trucks or other equipment on a stockpile in an acceptable manner.

Space, or separate with suitable walls or partitions, stockpiles of different types or sizes of aggregates to prevent the mixing of the aggregates. Do not allow the stockpile to become contaminated with foreign matter or degrade excessively. Failure of aggregate samples to meet all gradation requirements due to excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile and is cause for discontinuance of such stockpiling procedure.

Stockpiled aggregates should be essentially free of clay or shale particles, and should contain dust that is primarily rock dust produced through normal handling of the aggregate.

Sampling stockpiles for conformance shall be conducted as described in the Aggregate QC/QA Program manual.

1005-3 GRADATION

Grade all standard sizes of aggregate to meet Tables 1005-1 or 1005-2.

1005-4 TESTING

Aggregates will be tested in accordance with the test methods below except where other test procedures are required by other articles covering a particular application.

Property	Test Method
Gradation	AASHTO T 27 and T11, AASHTO T 88 as Modified for Base Course and Stabilizer
Liquid Limit	AASHTO T 89 as Modified
Plasticity Index	AASHTO T 90
Resistance to Abrasion (Percentage of Wear)	AASHTO T 96
Soundness	AASHTO T 104 Using Sodium Sulfate

1 Copies of modified test procedures are available from the Materials and Tests Unit.

TABLE 1005-1
AGGREGATE GRADATION - COARSE AGGREGATE

Percentage of Total by Weight Passing													
Std. Size #	**2"**	**1 1/2"**	**1"**	**3/4"**	**1/2"**	**3/8"**	**#4**	**#8**	**#10**	**#16**	**#40**	**#200**	**Remarks**
4	100	90-100	20-55	0-15	-	0-5	-	-	-	-	-	A	Asphalt Plant Mix
467M	100	95-100	-	35-70	-	0-30	0-5	-	-	-	-	A	Asphalt Plant Mix
5	-	100	90-100	20-55	0-10	0-5	-	-	-	-	-	A	AST, Sediment Control Stone
57	-	100	95-100	-	25-60	-	0-10	0-5	-	-	-	A	AST, Str. Conc., Shoulder Drain, Sediment Control Stone
57M	-	100	95-100	-	25-45	-	0-10	0-5	-	-	-	A	AST, Concrete Pavement
6M	-	-	100	90-100	20-55	0-20	0-8	-	-	-	-	A	AST
67	-	-	100	90-100	-	20-55	0-10	0-5	-	-	-	A	AST, Str. Concrete, Asphalt Plant Mix
78M	-	-	-	100	98-100	75-100	20-45	0-15	-	-	-	A	AST, Str. Conc., Weep Hole Drains, , Asphalt Plant Mix
14M	-	-	-	-	100	98-100	35-70	5-20	-	0-8	-	A	Asphalt Plant Mix, AST, Weep Hole Drains, Str. Concrete
9M	-	-	-	-	100	98-100	85-100	10-40	-	0-10	-	A	AST
ABC	-	100	75-97	-	55-80	-	35-55	-	25-45	-	14-30	4-12[B]	Aggregate Base Course, Aggregate Stabilization
ABC(M)	-	100	75-100	-	45-79	-	20-40	-	0-25		-	0-12[B]	Maintenance Stabilization
Light-weight[C]	-	-	-	-	100	80-100	5-40	0-20	-	0-10	-	0-2.5	AST

A. See Subarticle 1005-4(A). **B.** See Subarticle 1005-4(B). **C.** For Lightweight Aggregate used in Structural Concrete, see Subarticle 1014-2(E)(6)

(A) When aggregates are used for Portland cement concrete, asphalt treatment and asphalt plant mix, the requirements pertaining to material passing the No. 200 sieve are as follows:

(1) When tested in a stockpile at the quarry site, the amount of material passing the No. 200 sieve shall be no greater than 1.0%.

(2) When tested at the job site before use, the amount of material passing the No. 200 sieve shall:

(a) Be no greater than 1.5% for aggregate used in Portland cement concrete or asphalt surface treatment.

(b) Be no greater than 2.0% for aggregate used in asphalt plant mix.

(3) If a stockpile at the job site is found to contain in excess of the specified amount of material passing the No. 200 sieve before use, the Engineer may approve its use provided:

(a) For aggregate used in Portland cement concrete, the total percentage by weight passing the No. 200 sieve in the combined coarse and fine aggregate in the mix does not exceed 3.5%, and provided no increase in water-cement ratio is required by the use of this aggregate.

(b) For aggregate used in asphalt plant mix, the total percentage by weight of minus No. 200 material in the plant mix being produced, as determined by the extraction test, can be maintained within the limits allowed by the job mix formula.

(B) For ABC and ABC(M), in addition to the gradation requirements, the material passing the No. 40 sieve shall not have a LL in excess of 30 nor a PI in excess of 4. If PI exceeds 4 and is no more than 6, soil mortar limits apply. If PI exceeds 6, material shall be rejected. The gradation requirements for material passing the No. 10 sieve (soil mortar) will be as required in Section 1010.

TABLE 1005-2
AGGREGATE GRADATION FINE AGGREGATE

Std. Size #	Percentage of Total by Weight Passing								Remarks
	3/8"	#4	#8	#16	#30	#50	#100	#200	
1S	100	90-100		40-85		0-20		0-3	Blotting Sand, Asphalt Retreatment
2S	100	95-100	80-100	45-95	25-75	5-30	0-10	0-3	Concrete, Shotcrete, Grout, Subsurface Drainage, Blotting Sand
2MS		95-100	80-100	45-95	25-75	5-35	0-20	0-8[A]	Concrete, Shotcrete, Grout, Subsurface Drainage
4S		100	95-100			15-45	0-10	0-5	Mortar

A. When tested at the job site before use, the amount of material passing the No. 200 sieve shall not be greater than 10%.

SECTION 1006
AGGREGATE QUALITY CONTROL/QUALITY ASSURANCE

The Aggregate QC/QA Program is designed to allow aggregate producers the responsibility for controlling the quality of material they produce and to utilize the quality control information they provide in the acceptance process by the Department. It requires aggregate producers to perform quality control sampling, testing and record keeping on aggregates they ship for use by the Department. It requires the Department to perform quality assurance sampling, testing and record keeping confirming the performance of the producers' control plan. The program and participation requirements are described in the *Aggregate QC/QA Program Manual*.

Participation in this program does not relieve the producer of the responsibility of complying with all requirements of the *Standard Specifications*.

SECTION 1008
AGGREGATE FOR STABILIZATION

1008-1 AGGREGATE STABILIZATION

(A) General

Aggregates consist of crushed stone, crushed gravel, uncrushed gravel or other similar material having hard, strong, durable particles free of adherent coatings.

Supply aggregates from approved sources participating in the Department's Aggregate QC/QA Program in accordance with Sections 1005 and 1006. Sources will not be approved unless the material has satisfactory soundness and satisfactory resistance to abrasion. Satisfactory soundness will be a loss in weight of not greater than 15% when subject to 5 alternations of the soundness test. Satisfactory resistance to abrasion will be a percentage of wear of not greater than 55%.

(B) Sampling and Acceptance

Sampling and acceptance for the determination of gradation, LL and PI will be performed as described in the *Aggregate QC/QA Program Manual* and the *Aggregate Sampling Manual* using the versions in effect at the time material is shipped.

SECTION 1010
AGGREGATE FOR NON-ASPHALT TYPE BASES

1010-1 AGGREGATE BASE COURSE

(A) General Requirements

Aggregate base course material consists of crushed stone, crushed gravel, uncrushed gravel or other similar material having hard, strong, durable particles free of adherent coatings.

Provide aggregates from approved sources participating in the Department's Aggregate QC/QA Program in accordance with Sections 1005 and 1006. Sources will not be approved unless the material has satisfactory soundness and resistance to abrasion. Satisfactory soundness will be a weighted average loss of not greater than 15% when subjected to five alternations of the soundness test. Satisfactory resistance to abrasion will be a percentage of wear of not greater than 55%.

(B) Sampling and Acceptance

Sampling and acceptance for the determination of gradation, LL and PI will be performed as described in the *Aggregate QC/QA Program Manual* and the *Aggregate Sampling Manual* using the versions in effect at the time material is shipped.

1010-2 AGGREGATE FOR PLANT MIXED CEMENT TREATED BASE COURSE

Provide aggregate meeting Article 1010-1, except as modified herein. Sources of aggregate will not be approved unless the material has a percentage of wear of not greater than 65%.

SECTION 1012
AGGREGATE FOR ASPHALT PAVEMENTS AND SURFACE TREATMENTS

1012-1 AGGREGATE FOR ASPHALT PLANT MIXES

(A) General

Design the asphalt plant mix with coarse and fine aggregate that meet Section 1005, except as noted herein. Size, uniformly grade and combine the aggregate fractions in such proportions that the resulting mixture meets the grading and physical requirements of these specifications for the specified mix type. Materials that will not produce a mixture within the design criteria required by these specifications will be rejected, unless otherwise approved by the Engineer.

The consensus property criteria in Table 1012-1 apply to the design aggregate blend. Source property criteria apply to individual aggregate sources.

For all dense-graded surface course mixes, that are the top or final layer, limit the amount of coarse aggregate or fine aggregate produced from crystalline limestone, crystalline-dolomitic limestone or marble to no more than 50% of the total amount of coarse aggregate or fine aggregate in the asphalt mixture. For open-graded asphalt friction course and ultra-thin bonded wearing course, do not use aggregates produced from crystalline limestone, crystalline-dolomitic limestone or marble.

(B) Coarse Aggregate

(1) General

Use coarse aggregate consisting of crushed stone, crushed gravel, a mixture of uncrushed gravel with either crushed stone or crushed gravel or other inert material having similar characteristics. Provide coarse aggregate composed of clean, tough, durable fragments free from an excess of flat or elongated pieces and free of organic matter and deleterious substances.

Use coarse aggregate from sources participating in the Department's Aggregate QC/QA Program as described in Section 1006. A list of sources participating in the Department's Aggregate QC/QA Program in North Carolina and adjoining states is available from the Materials and Tests Unit in Raleigh.

(2) Gradation

Use standard size coarse aggregate meeting Table 1005-1 and these *Standard Specifications* unless otherwise approved by the Engineer.

(3) Coarse Aggregate Angularity (Fractured Faces)

Use coarse aggregate meeting Table 1012-1 for coarse aggregate angularity (fractured faces) when tested in accordance with ASTM D5821.

(4) Flat and Elongated Pieces

Use coarse aggregate meeting Table 1012-1 for flat and elongated pieces when tested in accordance with ASTM D4791 on the No. 4 sieve and larger with a 5:1 aspect ratio (maximum to minimum) for all pavement types, except there is no requirement for Types S4.75A and S9.5B.

(5) Soundness

The maximum weighted average soundness loss of individual coarse aggregate sources when subjected to 5 cycles using sodium sulfate when tested in accordance with AASHTO T 104 is 15%.

TABLE 1012-1
AGGREGATE CONSENSUS PROPERTIES[A]

Mix Type	Coarse Aggregate Angularity[B]	Fine Aggregate Angularity % Minimum	Sand Equivalent % Minimum	Flat and Elongated 5 : 1 Ratio % Maximum
Test Method	*ASTM D5821*	*AASHTO T 304*	*AASHTO T 176*	*ASTM D4791*
S4.75A; S9.5B	75 / -	40	40	-
S9.5C; I19.0C; B25.0C	95 / 90	45	45	10
S9.5D	100 / 100	45	50	10
OGFC	100 / 100	45	45	10
UBWC	100 / 85	45	45	10

A. Requirements apply to the design aggregate blend.
B. 95/90 denotes that 95% of the coarse aggregate has one fractured face and 90% has 2 or more fractured faces.

(6) Toughness (Resistance to Abrasion)

The maximum allowable percentage of loss of each individual coarse aggregate source for all plant mix types except open-graded asphalt friction course, shall be 55% when tested in accordance with AASHTO T 96. The maximum percentage loss for aggregate used in OGFC shall be 45%. The percentage loss for aggregate used in UBWC shall be no more than 35%.

(7) Deleterious Materials

The maximum allowable percentage by weight of clay lumps and friable particles in individual aggregate sources shall be 1% when tested in accordance with AASHTO T 112.

(8) Durability (Micro-Deval test)

The maximum allowable abrasion loss for aggregate used in UBWC shall be 18% when tested in accordance with AASHTO T 327.

(C) Fine Aggregate

(1) General

Use fine aggregate that is consistently graded from coarse to fine and consists of natural sand, stone screenings, or a blend of natural sand and stone screenings. Use aggregate composed of rough surfaced and angular grains of quartz or other hard durable rock.

Use fine aggregate from sources participating in the Department's Aggregate QC/QA Program as described in Section 1006. A list of sources participating in the Department's QC/QA Program in North Carolina and adjoining states is available from the Department's Materials and Tests Unit in Raleigh. If a natural sand source is owned by the same owner as the asphalt plant where the material is used, participation in the Aggregate QC/QA Program is not required.

Furnish sand from approved sources. Do not use sources contaminated by industrial waste. A sufficient number of samples of fine aggregate, but in no case less than three, will be taken to indicate any variation within any stockpile or source of supply.

Do not use fine aggregate containing sticks, roots, trash, visible lumps of clay, or other unsatisfactory material unless all undesirable material is removed to the satisfaction of the Engineer before the aggregate is used in the asphalt mixture.

Use natural sand that is non-plastic when tested in accordance with AASHTO T 90.

Produce stone screenings from stone that has a maximum percentage of wear of 55% when tested in accordance with AASHTO T 96 using test grading A.

(2) Gradation

Use stone screenings that are consistently graded with not more than 20% by weight passing the No. 200 sieve when tested by dry sieving in accordance with AASHTO T 27. Use natural sand that is consistently graded.

(3) Clay Content (Sand Equivalent)

Use a fine aggregate blend that has a minimum sand equivalent percentage as indicated in Table 1012-1 when tested in accordance with AASHTO T 176.

(4) Soundness

The maximum weighted average soundness loss of individual fine aggregate sources when subjected to 5 cycles using sodium sulfate shall be 15% when tested in accordance with AASHTO T 104.

Natural sand that contains grains of questionable hardness will be subjected to 5 cycles of the soundness test. The weighted average loss shall be not more than 15%. The soundness test will be performed before establishing the mix design.

(5) Deleterious Materials

The maximum percentage by weight of clay lumps and friable particles in individual fine aggregate sources shall be 1% when tested in accordance with AASHTO T 112.

(6) Fine Aggregate Angularity

Use a fine aggregate blend that has a minimum fine aggregate angularity as indicated in Table 1012-1 when tested in accordance with AASHTO T 304, Method A.

(D) Mineral Filler

Use mineral filler consisting of limestone dust, dolomite dust, Portland cement, or other inert mineral matter that conforms to AASHTO M 17.

(E) Reclaimed Asphalt Shingles (RAS)

For use in asphalt mix, Reclaimed Asphalt Shingles (RAS) can be either manufacturer-waste shingles or post-consumer shingles that have been processed into a product that meets the requirements of this section.

Manufacturer-waste RAS (MRAS) are processed shingle materials discarded from the manufacturing of new asphalt shingles. It may include asphalt shingles or shingle tabs that have been rejected by the shingle manufacturer.

Post-consumer RAS (PRAS) are processed shingle materials recovered from mixed roofing material scrap removed from existing structures. Tear-off shingle scrap must be sorted and other roofing debris, including nails, plastic, metal, wood, coal tar epoxy, rubber materials, or other undesirable components, shall be removed. This sorting of the scrap must be done prior to grinding of the PRAS for use in asphalt production.

Sample and test PRAS for asbestos and provide results demonstrating that the bulk samples contain less than one percent of asbestos containing material in accordance with Federal, State of North Carolina, and Local regulations. Use NC-accredited Asbestos Inspectors or Roofing Supervisors to sample the PRAS to meet the above criteria. Maintain records on-site indicating shingle source(s), asbestos operation plan approved by Division of Public Health's Health Hazards Control Unit, and all asbestos analytical reports. All documentation will be subject to review by the Department.

Process RAS by ambient grinding or granulating methods such that 100% of the particles will pass the 9.50 mm (3/8 inch) sieve when tested in accordance with AASHTO T27. Perform sieve analysis on processed asphalt shingles prior to ignition or solvent extraction testing.

RAS shall contain no more than 0.5% by total cumulative weight of deleterious materials. These materials include, but are not limited to, excessive dirt, debris, concrete, metals, glass, paper, rubber, wood, plastic, soil, brick, tars, or other contaminating substances.

Blend RAS with fine aggregate, meeting the requirements of this Section, if needed to keep the processed material workable. Any stockpile containing RAS will be considered a RAS stockpile and will be limited in mixtures as prescribed in Article 610-3.

MRAS and PRAS shall not be blended together for the production of hot mix asphalt.

(1) Mix Design RAS

Incorporate RAS from stockpiles that have been tested for uniformity of gradation and binder content prior to use in an asphalt mix design.

(2) Mix Production RAS

New Source RAS is defined as acceptable material which was not included in the stockpile when samples were taken for mix design purposes. Process new source RAS so that all materials will meet the gradation requirements prior to introduction into the plant mixer unit.

After a stockpile of processed RAS has been sampled and mix designs made from these samples, do not add new source RAS to the original stockpile without prior field testing to ensure gradation and binder uniformity. Sample and test new source RAS before blending with the existing stockpile.

Store new source RAS in a separate stockpile until the material can be sampled and tested for comparison with the original recycled mix design data. New source RAS may also be placed against the existing stockpile in a linear manner provided it is sampled for mix design conformity prior to its use in the recycled mix. Store RAS materials in such a manner as to prevent contamination.

Field approval of new source RAS will be based on Table 1012-2 and volumetric mix properties on the mix with the new source RAS included. Provided these tolerances are met, volumetric properties of the new mix will then be performed. If all volumetric mix properties meet the mix design criteria for that mix type, the new source RAS may continue to be used.

If the gradation, binder content, or any of the volumetric mix properties are not within the allowable tolerances of Table 1012-2, do not use the new source RAS unless approved by the Engineer. The Contractor may elect to either not use the stockpile, to request an adjustment to the JMF, or to redesign the mix.

TABLE 1012-2 NEW SOURCE RAS BINDER AND GRADATION TOLERANCES (Apply Tolerances to Mix Design Data)	
P_b %	**± 2.5**
Sieve Size, mm	*Tolerance*
4.75	± 5
2.36	± 4
1.18	± 4
0.300	± 4
0.150	± 4
0.075	± 2.0

(F) Reclaimed Asphalt Pavement (RAP)

(1) RAP Classifications

During production incorporate RAP from stockpiles or other sources tested for uniformity of gradation and binder content before use in an asphalt mix. Ensure that no deleterious material is allowed in any stockpile. When multiple stockpiles of recycled material are used during production, erect and maintain signs satisfactory to the Engineer properly identifying each stockpile. Use RAP that meets all requirements specified for the following classifications.

(a) Millings

Existing RAP that is removed from its original location by a milling process as specified in Section 607. Millings shall have a uniform gradation and binder content and all materials must pass a 1 1/2 inch sieve before introduction into the plant mixer unit.

(b) Processed RAP

RAP that is processed by crushing, screening and/or blending to produce a uniform gradation and binder content. Processed RAP shall have a uniform gradation and binder content and will pass a 1 inch sieve before introduction into the plant mixer unit.

(c) Fractionated RAP

RAP that is processed by crushing, screening and/or blending into one or two stockpiles. When only one fractionated RAP stockpile is used, the stockpile shall only contain material passing the 5/8 inch sieve. If a second coarse fraction is used, the coarse stockpile shall only contain material passing the 1 inch sieve and retained on the 5/8 inch sieve. The Engineer may allow the Contractor to use an alternate screen to fractionate the RAP. The maximum percentages of fractionated RAP may be comprised of coarse, fine, or the combination of both. Use a separate cold feed bin for each stockpile of fractionated RAP introduced into the plant mixer unit.

Perform gradation and asphalt content tests at a rate of one per 1,000 tons of RAP, with at least five tests per stockpile to determine the asphalt content and gradation. Assure that no deleterious material is allowed to contaminate any stockpile. The Engineer may reject by visual inspection any stockpiles that are not kept clean, separated and free of foreign materials.

For the Fractionated RAP to be considered for approval, the gradation and asphalt content shall be uniform. Individual test results, when compared to the target, will be accepted if within the tolerances listed in Table 1012-3.

TABLE 1012-3 FRACTIONATED RAP GRADATION AND BINDER TOLERANCES[A] (Apply Tolerances to Mix Design Data)	
P_b %	**± 0.3%**
Sieve Size, mm	*Tolerance*
25.0	± 5%
19.0	± 5%
12.5	± 5%
9.50	± 5%
4.75	± 5%
2.36	± 4%
1.18	± 4%
0.300	± 4%
0.150	± 4%
0.075	± 1.5%

A. If more than 20% of the individual sieves are out of the gradation tolerances, or if more than 20% of the asphalt binder content test results fall outside the appropriate tolerances, the RAP shall not be used in asphalt mix unless the RAP representing the failing tests is removed from the stockpile.

Do not add additional material to any fractionated RAP stockpile, unless otherwise approved by the Engineer.

Maintain a record system for all fractionated RAP stockpiles at the plant site. Include at a minimum the following: Stockpile identification and a sketch of all stockpile areas at the plant site; all RAP test results (including asphalt content, gradation and asphalt binder characteristics).

(2) RAP Management During Production

New source RAP is any acceptable material that was not included in the stockpile or other source when samples were taken for mix design purposes.

After a stockpile of millings, processed RAP or fractionated RAP has been sampled and mix designs made from these samples, do not add new source RAP to the original stockpile without prior field testing to insure gradation and binder uniformity. Sample and test new source RAP to ensure it meets one of the RAP Classifications in Subarticle 1012-1(F)(1) before blending with the existing stockpile.

Store new source RAP in a separate stockpile until the material can be sampled and tested for comparison with the original recycled mix design data. New source RAP may also be placed against the existing stockpile in a linear manner provided it is sampled for mix design conformity before its use in the recycled mix.

Unprocessed RAP is asphalt material that was not milled and/or has not been processed to obtain a uniform gradation and binder content and is not representative of the RAP used during the applicable mix design. Unprocessed RAP shall not be incorporated into any JMFs before processing. Different sources of unprocessed RAP may be stockpiled together provided it is generally free of contamination and will be processed before use in a recycled mix. RAP contamination in the form of excessive dirt, debris, clean stone, concrete, etc. will not be allowed. Incidental amounts of dirt, concrete and clean stone may be acceptable. Unprocessed RAP may be processed and then classified as a new source RAP as described above.

Field approval of new source RAP will be based on Table 1012-4 and volumetric mix properties in the mix with the new source RAP included. Provided the Table 1012-3 tolerances are met, volumetric properties of the new mix will then be performed. If all volumetric mix properties meet the mix design criteria for that mix type, the new source RAP may continue to be used.

If the gradation, binder content, or any of the volumetric mix properties are not within the allowable tolerances of Table 1012-4, do not use the new source RAP unless approved by the Engineer. The Contractor may elect to either not use the stockpile, to request an adjustment to the JMF, or to redesign the mix.

TABLE 1012-4
NEW SOURCE RAP GRADATION AND BINDER TOLERANCES
(Apply Tolerances To Mix Design Data)

	0 - 20% RAP			20 - 30 % RAP			> 30 % RAP		
Pb, %	± 0.7%			± 0.4%			± 0.3%		
Sieve Size, mm	Mix Type			Mix Type			Mix Type		
	Base	Inter.	Surf.	Base	Inter.	Surf.	Base	Inter.	Surf.
25.0	±10	-	-	±7	-	-	±5	-	-
19.0	±10	±10	-	±7	±7	-	±5	±5	-
12.5	-	±10	±6	-	±7	±3	-	±5	±2
9.50	-	-	±8	-	-	±5	-	-	±4
4.75	±10	-	±10	±7	-	±7	±5	-	±5
2.36	±8	±8	±8	±5	±5	±5	±4	±4	±4
1.18	±8	±8	±8	±5	±5	±5	±4	±4	±4
0.300	±8	±8	±8	±5	±5	±5	±4	±4	±4
0.150	-	-	±8	-	-	±5	-	-	±4
0.075	±4	±4	±4	±2	±2	±2	±1.5	±1.5	±1.5

1012-2 AGGREGATES FOR ASPHALT SURFACE TREATMENT

(A) General

Use coarse aggregate consisting of crushed stone, crushed gravel, or other inert material having similar characteristics. Adequately wash coarse aggregate so it is free from clay, loam, dust and other adherent materials.

Adequately clean all fine aggregate so it is free from sticks, roots, visible lumps of clay or other unsatisfactory material before use.

(B) Gradation

Use coarse aggregate for mat and seal coat and AST as required by Section 660, unless otherwise required by the contract. Use aggregate meeting the applicable gradation requirements of Table 1005-1.

Remix aggregate that has become segregated until it meets the applicable gradation requirements.

(C) Fractured Faces

Use coarse aggregate that contains at least 75% by weight of crushed pieces having 2 or more fractured faces and at least 90% by weight of crushed pieces having one or more fractured faces on that portion retained on the No. 4 sieve.

(D) Soundness

The maximum weighted average loss of either coarse or fine aggregate when subjected to 5 cycles using sodium sulfate when tested in accordance with AASHTO T 104 is 15%.

(E) Toughness (Resistance to Abrasion)

The maximum percentage loss of coarse aggregate for asphalt surface treatment when tested in accordance with AASHTO T 96 is 55%.

(F) Blending of Aggregates

Blending of two or more aggregates will not be permitted regardless of the origin of the aggregates if any one of the aggregates fails to meet the requirements for soundness or resistance to abrasion.

1012-3 BLOTTING SAND

Blotting sand is fine aggregate consisting of natural sand, commercial sand, manufactured sand, coarse screenings, or other inert material having similar characteristics. Subarticles 1012-2(D) and 1012-2(F) will be applicable to blotting sand. Adequately clean the fine aggregate so it is free from sticks, roots, visible lumps of clay or other unsatisfactory material before use.

1012-4 LIGHTWEIGHT AGGREGATE

Lightweight aggregates used in asphalt surface treatments shall be produced by the rotary kiln process and shall come from an approved Department source meeting applicable requirements of Section 1005 and 1006. The aggregate shall meet Table 1012-5 and AASHTO M 195 with the exception of any other references to concrete samples or concrete strength.

TABLE 1012-5
LIGHTWEIGHT AGGREGATE PHYSICAL PROPERTIES

Property	Specification (maximum limit)	Test Method
Sodium Sulfate Soundness	5%	AASHTO T 104
Los Angeles Abrasion	45%	AASHTO T 96 (B grading)
Percent Absorption	10%	AASHTO T 19
Micro-Deval	18%	AASHTO T 327

SECTION 1014
AGGREGATE FOR PORTLAND CEMENT CONCRETE

1014-1 FINE AGGREGATE

(A) General

Use fine aggregate from sources participating in the Department's Aggregate QC/QA Program as described in Section 1006. A list of sources participating in the Department's QC/QA Program in North Carolina and adjoining states is available from the Materials and Tests Unit.

Use fine aggregate consisting of natural sand or manufactured sand having clean, durable, hard, uncoated particles, or other inert materials having similar characteristics. Produce manufactured sand from fractured stone material. Use fine aggregate free from dirt, wood, paper, burlap and all other foreign material.

To permit excess water to drain and the moisture content to become uniform, stockpile the aggregates either at the producer's plant or at the batch plant site for at least 24 hours before use in the concrete. Build open stockpiles of fine aggregate at the batch plant on concrete surfaces. Do not add new material to the stockpile during the 24 hour period. When the aggregates have a low and uniform moisture content and the consistency of the concrete can be satisfactorily controlled without stockpiling the aggregates for 24 hours, the minimum stockpiling period may be reduced or waived entirely by the Engineer.

The Department's list of approved sources of fine aggregate shows the target fineness modulus of each aggregate as established by the producer. Do not use fine aggregate with a fineness modulus that varies more than 0.2 from the target value until the concrete mix proportions are adjusted.

(B) Soundness

When subjected to 5 cycles of the soundness test, the weighted average loss shall not be more than 15%.

(C) Deleterious Substances

Determine the percentage of deleterious substances (clay lumps and friable particles) in accordance with AASHTO T 112. The amount of deleterious substances shall not exceed 2.0% by weight for natural sand or 1.0% by weight for manufactured sand.

(D) Organic Impurities

The color of each source of fine aggregate will be determined annually in accordance with AASHTO T 21. Should the fine aggregate show a darker color than samples previously approved from the same source, withhold its use until tests have been made to determine the quality of the sand.

(E) Mortar Strength

Mortar made with the fine aggregate shall have a compressive strength at the age of 3 and 7 days using Type III Portland cement, or 7 and 28 days using Type I or II Portland cement, of not less than 95% of that developed by a comparison mortar. Make the comparison mortar with the same cement, graded Ottawa sand with a fineness modulus of 2.40 ± 0.05, and the same water-cement ratio and consistency as the test mortar. Test the mortar strength in accordance with AASHTO T 106.

Fine aggregate that fails the mortar strength may be used with the approval of the Engineer, provided that when it is tested in concrete cylinders the compressive strength of the concrete at 14 days is equal to or greater than the strength of cylinders made with an identical mix using an acceptable sand.

(F) Gradation

Natural sand shall meet the gradation for standard size No. 2S fine aggregate. Manufactured sand shall meet the gradation for standard size No. 2MS fine aggregate.

(G) Blending Fine Aggregate

Blending fine aggregates to obtain the required gradation will be permitted if test results of each aggregate meet the durability requirements and test results of the combination indicate acceptable quality. Blend aggregates by weighing them separately at the time of batching or by other means acceptable to the Engineer.

When natural sand is blended with natural sand, the blend shall meet the gradation for No. 2S fine aggregate. When manufactured sand is blended with natural sand or with manufactured sand, the blend shall meet the gradation for No. 2MS fine aggregate and neither component shall exceed the gradation limits on the No. 200 sieve shown in Table 1005-2.

1014-2 COARSE AGGREGATE

(A) General

Use coarse aggregate from sources participating in the Department's Aggregate QC/QA Program as described in Section 1006. A list of these sources in North Carolina and adjoining states is available from the Materials and Tests Unit in Raleigh.

Use coarse aggregate that consists of crushed stone, crushed or uncrushed gravel, crushed air-cooled blast furnace slag or other inert materials that have similar characteristics. Wash all coarse aggregate for Portland cement concrete to remove clay, loam, dust and similar adherent materials unless otherwise permitted by the Engineer in writing. Keep coarse aggregate free from dirt, wood, paper, burlap and all other foreign material.

To permit excess water to drain and the moisture content to become uniform, stockpile the aggregates either at the producer's plant or at the batch plant site for at least 24 hours before use in the concrete. Build open stockpiles of coarse aggregate at the batch plant on concrete surfaces. Do not add new material to the stockpile during the 24 hour period. Where the aggregates have low and uniform moisture content and the consistency of the concrete can be satisfactorily controlled without stockpiling the aggregates for 24 hours, the minimum stockpiling period may be reduced or waived entirely by the Engineer.

Do not mix coarse aggregate from different sources or use it in alternate batches except where permitted by the Engineer in writing. Blending of coarse aggregates to obtain the required gradation will be permitted if the different sizes are from the same source. Blend coarse aggregates by weighing them separately at the time of batching or by other means acceptable to the Engineer.

(B) Soundness

When subjected to 5 cycles of the soundness test, the weighted average loss shall not exceed 15%. For concrete with a 28 day design compressive strength greater than 6,000 psi, the loss shall not exceed 8%.

(C) Deleterious Substances

Determine the percentage of deleterious substances (clay lumps and friable particles) in accordance with AASHTO T 112. The amount of deleterious substances shall not exceed 3% by weight.

(D) Resistance to Abrasion

The percentage of wear of crushed stone or gravel shall not exceed 55%. For concrete with a 28 day design strength greater than 6,000 psi, the wear shall not exceed 40%.

(E) Aggregate Sizes

(1) General

Use standard size No. 57, No. 67, or No. 78M coarse aggregate in Portland cement concrete unless otherwise indicated.

(2) Latex Modified Concrete

Use standard size No. 78M coarse aggregate in latex modified concrete.

(3) Prestressed and Precast Concrete

Use standard size No. 67 or No. 78M coarse aggregate in prestressed and precast concrete.

(4) Use of More Than One Size

All concrete used in a single component of any structure shall be made with the same size aggregate.

(5) Portland Cement Concrete Pavement

Use standard size No. 57, No. 57M, No. 67 or No. 78M coarse aggregate in concrete for Portland cement concrete pavement unless otherwise specified by the Engineer.

(6) Sand Lightweight Concrete

Use the following gradation for the lightweight coarse aggregate.

TABLE 1014-1 GRADATION FOR LIGHTWEIGHT COARSE AGGREGATE	
Sieve Size	**Passing Square Opening Sieves (Percent by Weight)**
1"	100
3/4"	90 - 100
3/8"	10 - 50
No. 4	0 - 15

(7) Drilled Pier Concrete

Use standard size No. 78M coarse aggregate in Drilled Pier concrete.

SECTION 1016
SELECT MATERIALS

1016-1 DESCRIPTION

Select material is suitable material classified by gradation and performance characteristics as shown in this section.

1016-2 USES

Use select material called for in the contract. With written approval and without additional compensation, a higher class of material may be substituted than stated in the contract.

1016-3 CLASSIFICATIONS

CLASS I

Class I select material is silty or clayey soil material meeting AASHTO M 145 for soil classification A-4. Soil materials which meet AASHTO M 145 for soil classifications A-2, A-5, A-6 and A-7 are acceptable provided such materials do not have a LL greater than 50, nor a PI of less than 7 or greater than 20.

CLASS II

Type 1 Select Material

Type 1 select material is a fine aggregate material consisting of crushed stone screenings (washed or unwashed) meeting the gradation in Table 1016-1.

TABLE 1016-1 GRADATION FOR CLASS II, TYPE 1 SELECT MATERIAL	
Sieve	**Percent Passing**
3/8"	100
No. 4	80 - 100
No. 10	65 - 95
No. 40	25 - 55
No. 200	0 - 20
LL	≤ 30
PI	≤ 6

Type 2 Select Material

Type 2 select material is a granular soil material meeting AASHTO M 145 for soil classifications A-2-4 with a maximum PI of 6 and A-4 soil containing 45% maximum passing a No. 200 sieve and a maximum PI of 6.

When a type is not specified, either type may be used, but no additional compensation will be made.

CLASS III

Type 1 Select Material

Type 1 select material is a natural or manufactured fine aggregate material meeting the requirements of standard size 2S or 2MS as described in Sections 1005 and 1006.

Type 2 Select Material

Type 2 select material is a granular soil material meeting AASHTO M 145 for soil classification A-1 or A-3.

Type 3 Select Material

Type 3 select material is a natural or manufactured fine aggregate material meeting the gradation in Table 1016-2.

TABLE 1016-2
GRADATION FOR CLASS III, TYPE 3 SELECT MATERIAL

Sieve	Percent Passing
3/8"	100
No. 4	95 - 100
No. 8	65 - 100
No. 16	35 - 95
No. 30	15 - 75
No. 50	5 - 50
No. 100	0 - 25
No. 200	0 - 8

Type 3 select material shall meet the requirements described in Sections 1005 and 1006. When a type is not specified, Type 1, Type 2 or Type 3 may be used, but no additional compensation will be made.

CLASS IV

Select material is a coarse aggregate material meeting the requirements of standard size ABC as described in Sections 1005, 1006 and 1010. When material is produced from aggregates from crushed concrete, Section 1043 requirements shall be applied.

CLASS V

Select material is a coarse aggregate material meeting the requirements of standard size 78M as described in Sections 1005 and 1006.

CLASS VI

Select material is a coarse aggregate material meeting the requirements of standard size 57 as described in Sections 1005 and 1006.

CLASS VII

Select material is clean, unweathered durable, blasted rock material. While no specific gradation is required, the below criteria will be used to evaluate the materials for visual acceptance by the Engineer.

(A) At least 50% of the rock has a diameter of from 1.5 feet to 3 feet,

(B) 30% of the rock ranges in size from 2 inches to 1.5 feet in diameter, and

(C) Not more than 20% of the rock is less than 2 inches in diameter. No rippable rock will be permitted.

SECTION 1018
BORROW MATERIAL

1018-1 GENERAL

Borrow material is used for embankments, backfill or other intended uses. Material that contains roots, root mats, stumps or other unsatisfactory material will not be acceptable.

1018-2 APPROVAL OF BORROW MATERIAL

The approval of borrow material is subject to Section 230.

(A) Statewide Criteria for Acceptance of Borrow Material

See exceptions in Subarticle 1018-2(B).

Use only natural earth materials as borrow material. Any other materials are subject to rejection.

TABLE 1018-1 PIEDMONT AND WESTERN AREA CRITERIA FOR ACCEPTANCE OF BORROW MATERIAL	
Soil with PI of 25 or less	Acceptable
Soil with PI of 26 through 35	Acceptable, but not to be used in top 3 ft of embankment or backfill
Soil with PI of more than 35	Not Acceptable

(B) Exceptions to Statewide Criteria for Acceptance of Borrow Material

(1) Soils in the Coastal Plain (area described below) will be accepted by the Engineer in accordance with the Table 1018-2.

TABLE 1018-2 COASTAL AREA CRITERIA FOR ACCEPTANCE OF BORROW MATERIAL	
Soil with PI of 15 or less	Acceptable
Soil with PI of 16 through 20	Acceptable, but not to be used in top 3 ft of embankment or backfill
Soil with PI of more than 20	Not Acceptable

Areas where Table 1018-2 is applicable are as follows:

Division 1	Entire Division except Northampton (West of I-95)
Division 2	Entire Division
Division 3	Entire Division
Division 4	Edgecombe, Wayne, Johnston (East of US 301), Wilson (East of I-95), Nash (East of I-95), Halifax (East of I-95)
Division 6	Bladen, Columbus, Robeson, Cumberland, Harnett (South of NC 27)
Division 8	Scotland, Hoke, Moore (Southeast of US 15-501, NC 73, NC 211), Richmond (East of US 220 North and US 1 South)

Table 1018-2 shall be applicable to the flood plains of the Roanoke, Tar, Neuse, Cape Fear and Lumber Rivers and their tributaries that are outside the above described areas.

(2) Waste or by-products from industrial processes or mining operations are not acceptable except by specific written approval.

(3) When tested, soils having a pH of less than 5.5 or an organic content more than 4.0% may be rejected by the Engineer.

(4) When material is to be used for placing embankments or backfilling of undercut areas that are excessively wet, the material shall consist of Class II, III or IV select material.

SECTION 1019
SHOULDER AND SLOPE MATERIAL

1019-1 GENERAL

Use shoulder and slope material to construct shoulders and plate slopes with materials capable of supporting vegetation. Material that contains roots, root mats, stumps or other unsatisfactory material will not be acceptable.

1019-2 SHOULDER AND SLOPE BORROW

Use borrow sources in accordance with Section 230.

Use soil consisting of loose, friable, sandy material with a PI greater than 6 and less than 25 and a pH ranging from 5.5 to 7.0. Remove stones and other foreign material 2 inches or larger in diameter.

Soil consisting of a pH ranging from 4.0 to 5.4 may be accepted by the Engineer if the following limestone application is used. Substitute listed limestone application rates when performing seeding and mulching operations. Standard lime application rate is 4000 lbs. per acre. Soil type should be identified during the soil analysis. Soils with a pH below 4.0 should not be used. Soils with a pH above 7.0 require acidic amendments to be added. Contact the Engineer for recommendations to lower pH below 7.0.

TABLE 1019-1
LIMESTONE APPLICATION RATE (lbs / acre) TO RAISE pH

pH Test Result	Sandy Soils	Silt Loam Soils	Clay Loam Soils
4.0 to 4.4	4000 + 1000	4000 + 4000	4000 + 6000
4.5 to 4.9	4000 + 500	4000 + 3000	4000 + 5000
5.0 to 5.4	4000	4000 + 2000	4000 + 4000

1019-3 AGGREGATE SHOULDER BORROW

Use aggregate shoulder borrow (ASB) that meets the following gradation in Table 1019-2.

TABLE 1019-2
GRADATION OF AGGREGATE SHOULDER BORROW

Sieve	Percentage Passing
1 1/2"	100
1/2"	55-95
#4	35-74

SECTION 1020
ASPHALT MATERIALS AND ADDITIVES

1020-1 DELIVERY AND ACCEPTANCE OF ASPHALT MATERIALS

Asphalt materials are accepted at the source of shipment subject to the conditions herein.

All asphalt transport tankers, including rail and truck tankers, shall have a sampling valve in accordance with *Asphalt QMS Manual*, AASHTO R66, ASTM D140 or a comparable device acceptable to the Engineer.

Each transport tanker delivering asphalt materials to the project or rail siding shall keep a running log showing the date, destination and type and grade of material hauled on each trip. Print, stamp, or write in ink information appearing in the log and have available for examination upon request.

Furnish with each shipment 2 copies of a delivery ticket. Ensure both copies accompany the shipment and are delivered to the Engineer or his representative at the destination. The delivery ticket must contain all necessary information to identify the material and meet the state requirements of the Department of Agriculture and Consumer Services or other appropriate state agency that the asphalt terminal is in, the Department's *Performance Graded Asphalt Binder QC/QA Program* and the Department's *Asphalt Emulsion QC/QA Program*.

When anti-strip additive is introduced into the asphalt binder, ensure the delivery ticket notes the brand, grade and percentage or quantity at which the additive was introduced.

Furnish a statement of certification from the supplier and a separate statement of certification from the transporter. Sign each certification by an authorized representative of the supplier or transporter. Stamp, write or print these certifications on the delivery ticket in accordance with the appropriate QC/QA Program (Department's *Performance Graded Asphalt Binder QC/QA Program* or the Department's *Asphalt Emulsion QC/QA Program*), or attach to the delivery ticket.

Failure to sign the certifications by either the supplier or transporter will be cause to withhold use of the material until a sample can be taken and tested, except where an alternative testing and invoicing procedure has been pre-approved by the Engineer.

The Engineer reserves the right to sample and test any shipment regardless of whether the above conditions have been met and to reject any material not meeting the specifications.

1020-2 ASPHALT BINDER

Use performance graded asphalt binder meeting AASHTO M 320 Table 1 and the Department's *Performance Graded Asphalt Binder QC/QA Program*. See Article 610-3 for the specified grades.

Submit a Quality Control Plan for asphalt binder production in conformance with AASHTO R 26 and the Department's *Performance Graded Asphalt Binder QC/QA Program* to the Asphalt Workgroup in the Materials and Tests Unit. The Department's *Performance Graded Asphalt Binder QC/QA Program* shall be implemented in accordance with Article 1020-6.

Where modification of the asphalt binder is required to meet the specified grade, accomplish the modification using a styrene butadiene styrene (SBS), styrene butadiene rubber (SBR), styrene butadiene (SB) polymer or other modifiers approved by the Engineer to modify asphalt to meet the grade specified before delivery to the asphalt plant. Other polymers shall be pre-approved and listed by the Materials and Tests Unit. Air blown asphalt will not be permitted.

1020-3 ASPHALT EMULSION

Use asphalt emulsion that meets the requirements in the Department's *Asphalt Emulsion QC/QA Program*. The program includes requirements for latex modified, polymer modified, and non-tracking tack emulsified asphalt products and producers. New emulsified asphalt products will need to go through the new products approval process.

Submit a QC Plan for asphalt emulsion that meets the Department's *Asphalt Emulsion QC/QA Program* to the Materials and Tests Unit.

1020-4 POLYMER MODIFIED EMULSION MEMBRANE

Use polymer modified emulsion membrane consisting of styrene butadiene block copolymer modified asphalt emulsion to form a water impermeable seal and bond the new hot mix to the existing surface. Complete polymer modification of base asphalt before emulsification. Conform to Table 1020-1.

TABLE 1020-1 EMULSION AND RESIDUE TESTING			
Property	**Requirement**		**Test Method**
EMULSION:	**Min.**	**Max.**	
Saybolt Viscosity @ 77°F, SFS	20	100	AASHTO T 59
Sieve Test, %		0.1	AASHTO T 59
24-Hour Storage Stability, %[A]		1	AASHTO T 59
Residue from Distillation, %[B]	63		AASHTO T 59
Oil portion from distillation ml of oil per 100 g emulsion		2.0	
Demulsibility	60		AASHTO T 59
RESIDUE:			
Solubility in TCE, %	97.5		AASHTO T 44
Elastic Recovery	60		AASHTO T 301
Penetration @ 77°F, 100 g, 5 sec, d_{mm}	60	150	AASHTO T 49

A. After standing undisturbed for 24 hours, the surface shall show no white, milky colored substance, but shall be a smooth homogeneous color throughout.

B. AASHTO T-59 with modifications to include a 400°F ± 10°F maximum temperature to be held for 15 minutes.

1020-5 PRIME COAT MATERIALS

Supply prime coat materials from pre-approved sources that are on the NCDOT APL. Verification samples taken at the point of application (destination) are subject to the following conditions:

(A) All prime coat materials shall be delivered to the project ready for use.

(B) Sampling will be made at the point of application as directed by the Engineer. The Department reserves the right to sample all materials used for prime coat applications, either at the destination or at the point of origin, and to withhold acceptance of material until analysis of such samples have been made. When a material meets specification requirements, but has a history of unsatisfactory service performance, its use for construction or maintenance purposes may be restricted by the Engineer.

(C) The sand penetration results for a material used as a prime coat are penetration depth of at least 12 mm and penetration time of not more than 90 seconds. Copies of the *Sand Penetration Test Procedure* are available upon request from the Materials and Tests Unit.

(D) Materials used as a prime coat shall have a minimum rating of fair on the coating ability and water resistance test in accordance with AASHTO T 59.

(E) For materials stored longer than one day at the destination point (Contractors'/Divisions' tanks), submit to the Engineer a certified laboratory report on the performance of the material for storage stability test in accordance with AASHTO T 59.

(F) The diluted materials shall be tested for asphalt residue percent in accordance with AASHTO T 59, and shall have a minimum asphalt residue percent of 15%.

1020-6 PERFORMANCE GRADED ASPHALT BINDER AND ASPHALT EMULSION QUALITY CONTROL/QUALITY ASSURANCE

The *Performance Graded Asphalt Binder and Asphalt Emulsion QC/QA Programs* are designed to give asphalt binder and asphalt emulsion producers/suppliers (henceforth Producer

designates producer/supplier) more responsibility for controlling the quality of material they produce and to use the quality control information they provide in the acceptance process by the Department. It requires asphalt binder and asphalt emulsion producers to perform quality control sampling, testing and record keeping on materials they ship for use by the Department. It documents that the Department will perform quality assurance sampling, testing and record keeping confirming the performance of the producers' control plan. In addition, the producer is required to participate in independent assurance comparative sample activities. The program is described in the *Performance Graded Asphalt Binder and Asphalt Emulsion QC/QA Program Manuals*. An electronic copy of the program manuals may be obtained by accessing the Materials and Tests website.

The types of samples and the lot sizes required by the Producers and the Department are described in detail in the *Performance Graded Asphalt Binder and Asphalt Emulsion QC/QA Program Manuals*.

Acceptance or rejection of material will be based on the total program. Therefore, a comparison of the quality control, quality assurance and other sample data may be used by the Department for acceptance or rejection of a lot of material.

Participation in this program does not relieve the producer of the responsibility of complying with all requirements of the specifications.

1020-7 WATERPROOFING AND DAMPPROOFING MATERIALS

(A) Asphalt Primer

Asphalt primer shall meet ASTM D41.

(B) Asphalt Binder

Asphalt Binder shall meet Article 1020-2, Grade PG 64-22.

(C) Tar

Tar shall meet ASTM D490.

(D) Woven Cotton Fabric

Bitumen-saturated woven cotton fabric for waterproofing shall meet ASTM D173.

1020-8 ANTI-STRIP ADDITIVES

Anti-strip additives may either be hydrated lime or a chemical additive or a combination of both and must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan. Use an anti-strip additive capable of preventing the separation of the asphalt binder from the aggregate and achieving the required tensile strength ratio (TSR) on the asphalt mix when tested in accordance with AASHTO T 283 as modified by the Department.

Use hydrated lime conforming to AASHTO M 303. Add hydrated lime used of anti-strip purposes at a rate of not less than 1.0% by weight of the total dry aggregate.

Add chemical anti-strip additives to the asphalt binder before introduction into the mix. Do not use any chemical additive or particular concentration of chemical additive found to be harmful to the asphalt material or which causes the performance grading of the original asphalt binder to be out of specifications for the grade required.

1020-9 SILICONE

Silicone additives shall be pre-approved by the Materials and Tests Unit.

1020-10 FIBER STABILIZING ADDITIVES

Use fiber stabilizing additives that are capable of stabilizing the asphalt film surrounding the aggregate particles to reduce drain-down of the asphalt binder. A fiber stabilizer such as mineral fiber or cellulose may be used. The selected fiber shall meet the properties described

below. Dosage rates given are typical ranges but the actual dosage rate used will be approved by the Engineer.

(A) Mineral Fibers

Mineral fibers shall be made from virgin basalt, diabase or slag treated with a cationic sizing agent to enhance disbursement of the fiber as well as increase adhesion of the fiber surface to the asphalt binder. Mineral fibers shall be in accordance with Table 1020-2. Add the fiber at a dosage rate between 0.2% and 0.4% by weight of total mix, as approved by the Engineer.

TABLE 1020-2
MINERAL FIBER PROPERTIES

Property	Requirement	Test Method
Average Fiber length	0.25" maximum	-
Average Fiber thickness	0.0002" maximum	-
Shot Content Passing No. 60 sieve	90 - 100%	ASTM C612
Shot Content Passing No. 230 sieve	65 - 100%	ASTM C612
Degradation	30% maximum	GDT-124/McNett Fractionation

(B) Cellulose Fibers

Add cellulose fibers at a dosage rate between 0.2% and 0.4% by weight of total mix as approved by the Engineer. Fiber properties shall be in accordance with the following table.

TABLE 1020-3
CELLULOSE FIBER PROPERTIES

Property	Requirement
Average Fiber Length	0.25" maximum
Alpine Sieve Method Passing No. 100 Sieve	60 - 80%
Ro-Tap Sieve Method Passing No. 20 Sieve	80 - 95%
Ro-Tap Sieve Method Passing No. 40 Sieve	45 - 85%
Ro-Tap Sieve Method Passing No. 100 Sieve	5 - 40%
Ash Content	18% ± 5% non-volatiles
pH	7.5 ± 1
Oil Absorption	5.0 ± 1 (times fiber weight)
Moisture Content	5.0 maximum

(C) Cellulose Pellets

Cellulose pellets consist of a 50/50 blend of cellulose fiber and asphalt binder. Use cellulose that complies with Subarticle 1020-10(B) and the following table. Add the cellulose pellets at a dosage rate between 0.4% and 0.8% by weight of total mix, as approved by the Engineer.

TABLE 1020-4
CELLULOSE PELLET PROPERTIES

Property	Requirement
Pellet Size	1/4 cu.in. maximum
Asphalt	25 - 80 pen.

SECTION 1024
MATERIALS FOR PORTLAND CEMENT CONCRETE

1024-1 PORTLAND CEMENT

Supply Portland cement that meets AASHTO M 85 for Type I, II or III except that the maximum fineness requirements of AASHTO M 85 do not apply to cement used in precast concrete products. Throughout these specifications Types I and II cement are referred to as regular Portland cement and Type III as high early strength Portland cement.

Certain combinations of cement and aggregate exhibit an adverse alkali-silica reaction. The alkalinity of any cement, expressed as sodium-oxide equivalent, shall not exceed 1.0%. For mix designs that contain non-reactive aggregates and cement with an alkali content less than 0.6%, straight cement or a combination of cement and SCM may be used. The SCM quantity shall not exceed the amount shown in Table 1024-1. For mixes that contain cement with an alkali content between 0.6% and 1.0% and for mixes that contain a reactive aggregate documented by the Department, use a SCM in the amount shown in Table 1024-1.

Obtain the list of reactive aggregates documented by the Department at the Materials and Tests Unit website.

TABLE 1024-1
SUPPLEMENTARY CEMENTITIOUS MATERIAL FOR USE IN PORTLAND CEMENT CONCRETE

SCM	Substitution Rate (1 lb. SCM per 1 lb. Cement)
Class F Fly Ash	20% - 30%
Ground Granulated Blast Furnace Slag	35%-50%
Microsilica	4%-8%

Blended cements meeting AASHTO M 240 may be used with permission of the Engineer. Blended cements consist of either binary blends (e.g. a mixture of hydraulic cement with one other component) or ternary blends (e.g. a mixture of hydraulic cement and two other components). The components permitted for blending with cement are slag, pozzolans, or limestone. The term pozzolan can reference natural pozzolans (e.g. metakaolins), fly ash, or silica fume. The binary blended cements are Type IS (Portland-slag cement), Type IP (Portland-pozzolan cement), and Type IL (Portland-limestone cement). The ternary blended cement is Type IT and represents blends of Portland cement with varying amounts of any two different additives, which are pozzolans, slags or limestone. See AASHTO M 240 for details on the various blend ratios for Type IT blended cement.

Type IP or IS blended cement is allowed for the cement-and-fly-ash or cement-and-slag portion of the mix. Type IT may be allowed for the cement-and- supplementary cementitious portion of the mix with the permission of the Engineer. Do not substitute fly ash or slag for a portion of Type IP, IS or IT cement.

Use white cement that meets ASTM C150, except that the ferric oxide content is limited to 0.5%.

Use Type IP blended cement that meets AASHTO M 240, except that the pozzolanic content is limited to between 20 and 30% by weight and the constituents shall be interground.

Use Type IS blended cement that meets AASHTO M 240 except that the slag content is limited to between 35% and 50% by weight and the constituents are interground.

Use Type IT blended cement that meets AASHTO M 240. The Engineer will evaluate the blend of constituents for acceptance in Department work.

Use Type IL blended cement that meets AASHTO M 240, except the constituents shall be interground. SCMs can replace a portion of Type IL blended cement and shall be replaced as outlined in Subarticle 1000-3(I) for Portland cement.

Do not use air-entraining Portland cement. Do not mix different types of cement, different brands of cement, or the same brand from different mills nor use them alternately except when authorized in writing by the Engineer.

Protect cement from contamination or damage during handling and storage. Do not use cement that is damaged, partially set, lumpy or caked.

All cement is sampled and tested by the Department as it arrives on the project or at the batching plant at such frequency as established by the Department.

1024-2 AGGREGATE

Provide aggregate that meets Section 1014.

1024-3 ADMIXTURES

(A) Basis of Acceptance

Admixtures from an approved source are accepted without further testing. Only use admixtures that are on the NCDOT APL. Products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT APL.

(B) Approved Admixture

An approved admixture complies with this subarticle in order to be added to the NCDOT APL.

The manufacturer shall submit to the Product Evaluation Program an application and certified reports of tests that show that the admixture meets the applicable specifications. Tests shall be performed by AASHTO's designated AASHTO Product Evaluation & Audit Solutions laboratory for concrete admixture testing. Admixtures that contain chloride other than calcium chloride as provided herein are not permitted. The manufacturer is required to state in writing that no chloride was added during the manufacture of the admixture.

After an admixture is accepted, the manufacturer is required to submit to the Product Evaluation Program on or before February 1 of each year a notarized certification that shows that the material is of the same composition as originally accepted and has not been changed or altered. If an admixture is changed or altered, approval of the source in accordance with the above requirements is necessary before using the admixture.

The Engineer has the option to perform tests deemed desirable to verify the manufacturer's certification. Failure of the admixture in such tests is cause for discontinuation of its use. Failure of an admixture to perform satisfactorily under job conditions is cause for rejection of the admixture.

(C) Air Entraining Agent

Provide air entraining agents that meet AASHTO M 154.

(D) Chemical Admixtures

(1) Set Retarding Admixtures

Use set retarding admixtures that meet AASHTO M 194 for Type D, water reducing and retarding admixtures.

(2) Water Reducing Admixtures

Use water reducing admixtures that meet AASHTO M 194 for Type A admixtures. Mid-range water reducing admixtures will be considered as high range water reducing admixtures if they meet the requirements for Type F water reducing admixtures.

(3) Calcium Chloride

Provide calcium chloride that meets AASHTO M 144 for Type 2, concentrated flake, pellet or other granular calcium chloride. The Engineer may waive the gradation requirement.

(4) High-Range Water Reducing Admixtures

Use high-range water reducing admixtures that meet AASHTO M 194 for Type F or Type G.

(5) Calcium Nitrite Corrosion Inhibitor

Use an approved calcium nitrite corrosion inhibitor that contains 30% solids.

(E) Other Admixtures

Admixtures not otherwise classified will be reviewed on a case-by-case basis by the Materials and Tests Unit.

1024-4 WATER

Ensure that water used to condition, wash, or as an integral part of materials is clear and free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substance. It shall not be salty or brackish. Water used in the production of concrete or grout shall be from wells or public water systems which are suitable for drinking and must meet the criteria listed in Table 1024-2.

Test water from wells at all locations. Test public water supplies from all out of state locations and in the following counties: Beaufort, Bertie, Brunswick, Camden, Carteret, Chowan, Craven, Currituck, Dare, Gates, Hyde, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrell and Washington unless the Engineer waives the testing requirements. Water from a municipal water supply in all other NC counties may be accepted by the Engineer without testing.

TABLE 1024-2 PHYSICAL PROPERTIES OF WATER		
Property	**Requirement**	**Test Method**
Compressive Strength, minimum percent of control at 3 and 7 days	90%	ASTM C1602
Time of set, deviation from control	From 1:00 hr. earlier to 1:30 hr. later	ASTM C1602
Chloride Ion Content, Max.	250 ppm	ASTM D512 *
Total Solids Content (Residue), Max.	1,000 ppm	SM 2540B *
Resistivity, Min.	0.500 kohm-cm	ASTM D1125 *

* Denotes an alternate method is acceptable. Test method used shall be referenced in the test report.

1024-5 FLY ASH

Provide fly ash that meets ASTM C618 for Class F or Class C, except ensure that the loss on ignition does not exceed 4%. Use fly ash that meets the optional physical requirements for uniformity shown in Table 3 of ASTM C618.

Do not use Class C fly ash in Portland cement concrete if the alkali content of the cement exceeds 0.4%.

All fly ash is sampled and tested by the Department as it arrives on the project at such frequency as established by the Department.

1024-6 GROUND GRANULATED BLAST FURNACE SLAG

Use blast furnace slag that meets AASHTO M 302, Grade 100. All slag is sampled and tested by the Department as it arrives on the project at such frequency as established by the Department.

1024-7 SILICA FUME

Provide silica fume (microsilica) that meets Tables 1, 2 and 3 of ASTM C1240. All silica fume is sampled and tested by the Department as it arrives on the project at such frequency as established by the Department.

1024-8 NATURAL POZZOLANS

Provide natural pozzolans that meet ASTM C618 for Class N pozzolans, except ensure that the loss on ignition does not exceed 4%. Use natural pozzolans that meet the optional physical requirements for uniformity shown in Table 2 of ASTM C618.

All natural pozzolan is sampled and tested by the Department as it arrives on the project at such frequency as established by the Department.

SECTION 1026
CONCRETE CURING MATERIALS

1026-1 GENERAL

All curing materials shall be free from impurities that may be detrimental to the concrete.

1026-2 LIQUID MEMBRANE CURING COMPOUNDS

(A) General

Liquid membrane curing compounds shall meet ASTM C309, except that when tested in the water retention test described in AASHTO T 155 the curing compound shall restrict the loss of water in the test specimen at the time of application of the compound to not

more than 0.007 ounces per square inch. Do not use curing compound until the applicable tests have been performed for each batch and has been approved by the Engineer.

The curing compound shall be Type 2, white pigmented, except where clear type is required for a particular application, the curing compound shall be Type 1D, clear or translucent with fugitive dye.

Deliver curing compound in the manufacturer's original clean, sealed containers. Legibly mark each container with the name of the manufacturer, the name of the compound, the type of compound, the manufacturer's batch number, the date of manufacture and the manufacturer's recommended shelf life.

Do not use curing compound that has been in storage for more than one year from the date of manufacture or more than the manufacturer's recommended shelf life, whichever is less.

(B) Test Procedures

Curing compound will be tested in accordance with ASTM C309, except the size of molds for making test specimens will be approximately 5.5 inches in diameter by approximately 1 inch deep, or any other size selected by the Engineer.

1026-3 POLYETHYLENE FILM

Polyethylene film shall meet ASTM C171 for white opaque polyethylene film, except that when tested for moisture retention efficiency the loss shall not be more than 0.007 oz./sq.in of surface area.

1026-4 WATER

All water used for curing concrete shall meet Article 1024-4 and Table 1024-2. Water from wells, streams, ponds or public water systems may be used.

1026-5 BURLAP

Burlap shall meet AASHTO M 182. Any class of burlap will be acceptable.

Use new burlap or burlap that has been used for no purpose other than curing concrete. New burlap shall be free from starch, filler or other substances added during manufacture, or shall be washed to remove such substances before use.

SECTION 1028
JOINT MATERIALS

1028-1 JOINT FILLER

Provide a nonbituminous type joint filler that meets AASHTO M 153 for Types I, II or III, or a bituminous type that meets AASHTO M 213. Furnish a Type 3 material certification in accordance with Article 106-3 with each lot of the joint material supplied to each project.

1028-2 HOT APPLIED JOINT SEALER

Provide a hot applied joint sealer listed on the NCDOT APL, that conforms to ASTM D6690 . Products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT APL. Furnish a Type 3 material certification in accordance with Article 106-3 for each lot of the joint sealer supplied to each project.

1028-3 LOW MODULUS SILICONE SEALANT

Provide a cold applied, single component, chemically curing low modulus silicone sealant from the NCDOT APL. Products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT APL. Acid cure sealants are not acceptable for use on Portland cement concrete. Bond breakers shall meet Article 1028-4.

(A) Silicone Sealant Types

(1) Type NS

A non-sag silicone for use in sealing horizontal and vertical joints in Portland cement concrete pavements and bridges. Tooling is required.

(2) Type SL

A self-leveling silicone used to seal horizontal joints in Portland cement concrete pavements and bridges. Tooling is not normally required.

(B) Requirements

TABLE 1028-1
PHYSICAL PROPERTIES OF SEALANT

Property	Requirement	Test Method
Peel	Minimum of 20 lb/in of width with at least 75% cohesive failure	ASTM D903 bonded on concrete block
Movement Capability and Adhesion	No adhesive or cohesive failure after 10 cycles of test movements of +100% (extension) and –50% (compression)	ASTM C719

Silicone sealant shall meet the Table 1028-1, ASTM D5893.

Furnish a Type 3 material certification in accordance with Article 106-3 for each lot of joint sealer material supplied to each project. Deliver each lot of sealant in containers plainly marked with the manufacturer's name or trademark, lot number and date of manufacture.

1028-4 BOND BREAKER

Install silicone sealant over a bond breaker to prevent the sealant from bonding to the bottom of the joint. Use bond breakers that do not stain or adhere to the sealant and are chemically inert and resistant to oils. Furnish a Type 3 material certification in accordance with Article 106-3 for each lot of bond breaker material supplied to each project.

(A) Type L

Type L backer rod is a closed-cell expanded polyethylene foam backer rod. Use this backer rod in roadway and bridge joints and with Type NS silicone only. Use Type L backer rod that complies with Table 1028-2.

(B) Type M

Type M backer rod is a closed-cell polyolefin foam backer rod which has a closed-cell skin over an open cell core. Use this backer rod in roadway and bridge joints with both silicone sealant types. Use Type M backer rod that complies with Table 1028-2.

TABLE 1028-2 PHYSICAL PROPERTIES OF TYPE L AND TYPE M BACKER ROD		
Property	**Requirement**	**Test Method**
Min. Density	2.0 lb/cf	ASTM D 1622
Min. Tensile Strength	25 psi	ASTM D 1623
Max. Water Absorption	0.5% by volume	ASTM C 509

(C) Type N

Provide bond breaking tape made from extruded polyethylene that has a pressure sensitive adhesive on one side. Bond breaking tape may be used with both types of silicone but is suitable for bridge joints only. Bond breaking tapes shall be at least 0.005 inch in thickness.

SECTION 1030
RFID TRACKING PROGRAM FOR MANUFACTURED PRODUCTS

1030-1 DESCRIPTION

Radio Frequency Identification (RFID) tracking and tagging is used for manufactured products which includes but is not limited to Prestressed Concrete Products, Precast Concrete Products, Plastic Pipe, Reinforced Concrete Pipe, Steel Products and Metal Pipe. The RFID tag/label is used for identification of manufactured products by visually reading the 24-digit code, scanning the RFID embedded chip, or scanning the printed QR/barcode. It is the responsibility of the producer to supply RFID tags approved by the Department following the requirements of Section 1030 and place them on the products that are being manufactured. The producer manages the quality control and initial production information and assigns an RFID alternate ID. It is the producer's responsibility to manage tags placed on products and upload test results once complete.

1030-2 MANUFACTURED PRODUCTS

Place the RFID tag/label on manufactured products. When accepted, the RFID tag/label item record will be updated. RFID tags/labels are identifiers for all manufactured products that must be scanned to find the approval status on the Field Inspection Report (FIR) or NCDOT vendor alternate ID found on the NCDOT APL prior to use.

RFID tag/label parameters for use on all manufactured products are as follows:

(A) Tag/Label Copy

The tag/label copy shall be block type lettering with the company name, NCDOT Facility Plant ID Number and company logo. All information shall be subsurface printed.

(B) Colors

Color of ink must be black on white background.

(C) Serialization

The bar code and human-readable equivalent shall be subsurface printed. Code 128 in 24-character hexadecimal format shall be utilized. A QR/barcode linking to the NCDOT vendor alternate ID found on the NCDOT APL shall also be subsurface printed on the label.

(D) Adhesion

Adhesives shall be non-proprietary and have a minimum 2 year above ground life span.

(E) Tag Proof

The Materials and Tests Unit must approve the tag/label. The Producer will provide an image of the tag/label and a copy of the tag/label specification to the Manufactured Products Engineer for approval.

(F) Tag Location

The location of the RFID tag/label for all manufactured products can be found in the *Guide to Placement of RFID Tags/Labels* found on Materials and Tests Unit website.

1030-3 PLASTIC PIPE

The RFID tag/label shall be placed on Plastic Pipe Products in accordance with Subarticle 1030-2(F).

RFID tag/label parameters for use on plastic pipes are as follows:

(A) Dimensions

Shall be a minimum size of 4.5 inches x 1 inch x 0.017 inches.

(B) Material

Use 0.002 inch thick Polyester; total tag thickness to be 0.017 inches.

(C) Numbering Scheme

The 24-character numbering scheme will be utilized as follows. AA00xx000000002000000000 where the first six digits identify the material and NCDOT Facility Plant ID Number replaces the xx and AA will identify polyethylene pipe while AB will identify polypropylene pipe. Numbering will start with a 2 in the billions position to prevent duplication of numbers across products. Numbering scheme must be approved by the Materials and Tests Unit.

(D) RFID inlay

The inlay shall be Alien Squiggle or comparable UHF passive inlay with a frequency range of 860-960 MHz.

(E) Read Range

The RFID tag/label shall have a minimum read range of 18 feet with a reader at 24 dBm (1/4 of maximum reader power).

1030-4 REINFORCED CONCRETE PIPE

The RFID tag/label shall be placed on Reinforced Concrete Pipe Products in accordance with Subarticle 1030-2(F).

RFID tag/label parameters for use on reinforced concrete pipes are as follows:

(A) Dimensions

Shall be a minimum size of 4 inches x 0.75 inches x 0.02 inches, with the option of being larger as approved by the Department.

(B) Material

Use 0.003 inch thick Polyester for subsurface printing. Additional polyester layers total 0.2 inch tag must be slotted on either end and contain a textured base layer.

(C) Numbering Scheme

The 24-character numbering scheme will be utilized as follows. AC00xx000000002000000000 where the first six digits identify the material and NCDOT Facility Plant ID Number replaces the xx and AC will identify concrete pipe. Numbering

will start with a 2 in the billions position to prevent duplication of numbers across products. Numbering scheme must be approved by the Materials and Tests Unit.

(D) RFID inlay

The inlay shall be Alien Higgs 3 Squiggle or comparable UHF passive inlay optional Smartrac Short Dipole R6 with a frequency range of 860-960 MHz.

(E) Read Range

The RFID tag/label shall have a minimum read range of 18 feet with a reader at 30 dBm.

1030-5 CORRUGATED METAL PIPE PRODUCTS

The RFID tag/label shall be placed on Corrugated Metal Pipe Products in accordance with Subarticle 1030-2(F).

RFID tag/label parameters for use on metal pipes are as follows:

(A) Dimensions

Shall be a minimum size of 2.875 inches x 1.375 inches x 0.085 inches, with the option of being larger as approved by the Department.

(B) Material

Use 0.002 inch thick Polyester label adhered to a non-proprietary inlay wrapped around 1/16 inch foam.

(C) Numbering Scheme

The 24-character numbering scheme will be utilized as follows. AD00xx000000002000000000 where the first six digits identify the material and NCDOT Facility Plant ID Number replaces the xx and AD will identify metal pipe. Numbering will start with a 2 in the billions position to prevent duplication of numbers across products. Numbering scheme must be approved by the Materials and Tests Unit.

(D) RFID inlay

The inlay shall be Alien Higgs 3 or comparable UHF passive inlay with a frequency range of 860-960 MHz.

(E) Read Range

The RFID tag/label shall have a minimum read range of 18 feet with a reader at 30 dBm.

1030-6 PRESTRESSED CONCRETE PRODUCTS

The RFID tag/label shall be placed on Prestressed Concrete Products in accordance with Subarticle 1030-2(F).

RFID tag/label parameters for use on prestressed concrete products are as follows:

(A) Dimensions

Shall be a minimum size of 2.75 inches x 1 inch x 0.02 inches, with the option of being larger as approved by the Department.

(B) Material

Use 0.003 inch thick Polyester for subsurface printing. Additional polyester layers total 0.2 inch tag must be slotted on either end and contain a textured base layer. Alternatively, the proprietary Cast-A-Tag can be utilized.

(C) Numbering Scheme

The 24-character numbering scheme will be utilized as follows. 000xxx000000000000000000 where the first six digits identify the material and NCDOT

Facility Plant ID Number replaces the xx. Numbering scheme must be approved by the Materials and Tests Unit.

(D) RFID inlay

The inlay shall be Alien Higgs 3 Squiggle or comparable UHF passive inlay, optional Smartrac Short Dipole R6 with a frequency range of 860-960 MHz.

(E) Read Range

The RFID tag/label shall have a minimum read range of 18 feet with a reader at 30 dBm.

1030-7 PRECAST CONCRETE PRODUCTS

The RFID tag/label shall be placed on Precast Concrete Products in accordance with Subarticle 1030-2(F).

RFID tag/label parameters for use on precast concrete products are as follows:

(A) Dimensions

Shall be a minimum size of 2.75 inches x 1 inch x 0.02 inches, with the option of being larger as approved by the Department.

(B) Material

Use 0.003 inch thick Polyester for subsurface printing. Additional polyester layers total 0.2 inch tag must be slotted on either end and contain a textured base layer. Alternatively, the proprietary Cast-A-Tag can be utilized.

(C) Numbering Scheme

The 24-character numbering scheme will be utilized as follows. 000xxx000000002000000000 where the first six digits identify the material and NCDOT Facility Plant ID Number replaces the xx. Numbering scheme must be approved by the Materials and Tests Unit.

(D) RFID inlay

The inlay shall be Alien Higgs 3 Squiggle or comparable UHF passive inlay, optional Smartrac Short Dipole R6 with a frequency range of 860-960 MHz.

(E) Read Range

The RFID tag/label shall have a minimum read range of 18 feet with a reader at 30 dBm.

1030-8 SIGN PRODUCTS

The RFID tag/label shall be placed on Sign Products in accordance with Subarticle 1030-2(F).

RFID tag/label parameters for use on signs products found on Article 901-2 and Subarticle 901-3(A) are as follows:

(A) Dimensions

Shall be a minimum size of 5 inches x 3 inch x 0.085 inches, with the option of being larger as approved by the Department.

(B) Material

Use 0.002 inch thick Polyester label adhered to a non-proprietary inlay wrapped around a 1/16 inch foam.

(C) Numbering Scheme

The 24-character numbering scheme will be utilized as follows. 000xxx000000002000000000 where the first six digits identify the material and NCDOT

Facility Plant ID Number replaces the xx. Numbering scheme must be approved by the Materials and Tests Unit.

(D) RFID inlay

The inlay shall be Alien Higgs 3 or comparable UHF passive inlay with a frequency range of 860-960 MHz.

(E) Read Range

The RFID tag/label shall have a minimum read range of 18 feet with a reader at 30 dBm.

SECTION 1032
CULVERT PIPE

1032-1 CORRUGATED METAL CULVERT PIPE

Use corrugated metal culvert pipe that is NCDOT approved, found on the Department's producer/supplier list that participate in the Department's Brand Registration program for metal culvert pipe. The producer/supplier must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT producer/supplier list. The Department will remove a manufacturer of metal culvert pipe from this program if the monitoring efforts indicated that non-specification material is being provided or test procedures are not being followed.

The following types of steel and aluminum alloy pipe and all associated accessories may be accepted under this program.

(A) Coated corrugated metal culvert pipe and pipe arches,

(B) Coated corrugated metal end sections, coupling band and other accessories,

(C) Corrugated aluminum alloy structural plate pipe and pipe arches,

(D) Corrugated aluminum alloy end sections, coupling band and other accessories, and

Field joints for each type of corrugated steel pipe or corrugated aluminum pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installation. Coupling bands may be of the following types: bands with annular corrugations; bands with helical corrugations; bands with projections (dimples); channel bands for upturned flanges, with or without annular corrugations; flat bands; and smooth sleeve-type couplers. Coupling bands shall be installed in accordance with details in plans and/or in accordance with manufacturer's recommendations.

Corrugated metal pipe, pipe arches and coupling bands shall conform to AASHTO M 196 for Corrugated Aluminum Pipe, AASHTO M 36 for Galvanized Corrugated Steel Pipe, AASHTO M 36 for Aluminized Coated Corrugated Steel Pipe.

Aluminum and aluminized pipe shall have a barrier coat applied to the faying surfaces and edges of those components coming into contact with concrete. Surface preparation and barrier coat paint systems are found in the *Thermal Spray Coatings (Metallization) Program*.

1032-2 CORRUGATED ALUMINUM ALLOY CULVERT PIPE

(A) Corrugated Aluminum Alloy Culvert Pipe and Pipe Arch

Corrugated aluminum alloy culvert pipe and corrugated aluminum alloy pipe arch culvert shall meet AASHTO M 196, except that Type IA and Type IIA pipe will not be permitted.

When elongated pipe is called for by the contract, use pipe that is shop formed to provide for a 5% vertical elongation.

(1) Coupling Bands

(a) Use corrugated coupling bands except as otherwise provided below.

(b) A hugger type corrugated band having one annular corrugation at each outside edge of the band will be acceptable.

(c) Coupling bands with projections (dimples) may be used where it is necessary to join new pipe to existing pipe having helical corrugations at the joint locations. The bands shall be formed with projections in annular rows with one projection for each corrugation of helical pipe. Use an approved sealer with this type of coupling band. Coupling bands with projections (dimples) may be used for circumferential pipe, heliacal pipe, or a combination of both.

(d) Fasten coupling bands on the ends with at least two 1/2 inch bolts.

(e) Annular corrugated bands shall have a minimum width of 10 1/2 inches where 2 2/3 inches x 1/2 inch corrugations are used.

(B) Corrugated Aluminum Alloy Pipe Tees and Elbows

Corrugated aluminum alloy pipe and corrugated aluminum alloy pipe arch tees and elbows shall meet all applicable requirements of AASHTO M 196.

(C) Acceptance

Acceptance by the Engineer of corrugated aluminum alloy culvert pipe and corrugated aluminum alloy pipe arch culvert and its accessories will be based on, but not limited to, visual inspections, classification requirements and check samples taken from material delivered to the project and conformance to the annual Brand Registration.

1032-3 CORRUGATED STEEL CULVERT PIPE

(A) Corrugated Steel Culvert Pipe and Pipe Arch

Corrugated steel culvert pipe and pipe arch shall meet AASHTO M 36 with the following exceptions:

(1) Coupling Bands

(a) Use corrugated coupling bands except as otherwise provided below.

(b) A hugger type corrugated band having one annular corrugation at each outside edge of the band will be acceptable.

(c) Coupling bands with projections (dimples) may be used where it is necessary to join new pipe to existing pipe having helical corrugations at the joint locations. The bands shall be formed with projections in annular rows with one projection for each corrugation of helical pipe. Use an approved sealer with this type of coupling band. Coupling bands with projections may be used for circumferential pipe, heliacal pipe, or a combination of both.

(d) Fasten coupling bands on the ends with at least two 1/2 inch bolts.

(e) Annular corrugated bands shall have a minimum width of 10 1/2 inches where 2 2/3 inches x 1/2 inch corrugations are used.

(2) Corrugations

Where 1/4 inch deep corrugations are permitted by AASHTO M 36, the maximum pitch of the corrugations shall be 1 7/8 inches.

Where 3 inches x 1 inch corrugations are required, the Contractor will be permitted to use 5 inches x 1 inch corrugations.

Pipe with helical corrugations shall have rerolled ends with at least 2 annual corrugations at each end.

(3) Elongated Pipe

When elongated pipe is called for by the contract, use pipe that is shop formed to provide for a 5% vertical elongation.

(4) Lifting Straps

The pipe may be furnished either with or without lifting straps for handling. Attach the lifting straps by bolting or by welding. Bolt holes for attaching the straps shall be a smooth hole that is either punched or drilled. No burning of holes will be permitted. Design the lifting straps so the holes can be plugged to prevent infiltration of backfill material.

Design the placement of lifting straps to ensure the pipe is equally supported along its axis.

(5) Coating Repair

Repair shall be in accordance with Section 1076-7.

(6) Type IA and Type IIA Pipe

Type IA and Type IIA pipe will not be permitted.

(7) Aluminized Pipe

Aluminized pipe shall meet all requirements herein except that the pipe and coupling bands shall be fabricated from aluminum coated steel sheet meeting AASHTO M 274.

(8) Marking Requirements

Pipe sections and special attachments for pipe 60 inches or larger diameter pipe shall be alphanumerically match-marked at the plant site before shipping. There may be additional markings as required by the Department's Brand Certification Program.

(B) Prefabricated Corrugated Steel Pipe End Sections

Corrugated steel end sections shall be in accordance with the details shown in the plans and Subarticle 1032-3(A). Repair end sections on which the spelter coating has been bruised or broken either in the shop or in shipping in accordance with AASHTO M 36.

(C) Corrugated Steel Pipe Tees and Elbows

Corrugated steel tees and elbows shall be in accordance with Subarticle 1032-3(A).

(D) Corrugated Steel Eccentric Reducers

Corrugated steel eccentric reducers shall be in accordance with Subarticle 1032-3(A) and the additional requirements shown below.

Construct the eccentric reducer so the invert or flow line from the large pipe through the reducer and into the small pipe is a continuous straight line.

Make the reducer from the same thickness corrugated metals as the large diameter pipe. The reducing section may be riveted or welded.

(E) Acceptance

Acceptance by the Engineer of corrugated steel culvert pipe and its accessories will be based on, but not limited to, visual inspections, classification requirements and check samples taken from material delivered to the project and conformance to the annual Brand Registration.

The reducing section shall reduce in diameter no more than 3 inches in 24 inches of length. Rivet or weld a 24 inches long constant diameter stub to each end of the reducing section to form the complete reducer.

Have the completed reducer show careful, finished workmanship in all particulars. Repair reducers on which the spelter coating has been bruised or broken either in the shop or in shipping in accordance with AASHTO M 36. Reducers that show defective workmanship will be rejected by the Engineer. The following defects are evidence of poor workmanship, and the presence of any of them in any individual reducer will constitute sufficient cause for rejection:

(1) Not meeting required dimensions,
(2) Not of the specified shape,
(3) Uneven laps,
(4) Ragged or diagonal sheared edges,
(5) Loose, unevenly lined or spaced rivets,
(6) Poorly formed rivet heads,
(7) Lack of rigidity,
(8) Dents or bends in the metal itself,
(9) Uneven welds, or
(10) Gaps in welds.

1032-4 POLYPROPYLENE CULVERT PIPE

(A) General

Use polypropylene pipe that is NCDOT approved as found on the Departments producer/supplier list and participating in the Department's *Polypropylene Pipe QA/QC Program*. The producer/supplier must be current with the applicable Product Evaluation & Audit Solutions workplan to remain on the NCDOT producer/supplier list. The Department will remove a manufacturer of polypropylene pipe from this program if the monitoring efforts indicated that non-specification material is being provided or test procedures are not being followed.

Use polypropylene culvert pipe that meets AASHTO M 330 for Type S or Type D, or ASTM F2881 or ASTM F2764 Double or Triple wall; and has been evaluated by AASHTO Product Evaluation & Audit Solutions. Bell and spigot joint seals shall meet ASTM F477.

(B) End Treatments, Pipe Tees, Elbows, and Couplers

End treatments, pipe tees and elbows shall meet AASHTO M 330, Section 7.7, ASTM F2881, Section 7.11, or ASTM F2764, Section 6.6. Couplers, where indicated on the plans, shall meet AASHTO M 330, Section 7.7, ASTM F2881, Section 7.11, or ASTM F2764, Section 6.6.

(C) Marking

Clearly mark each section of pipe, end section, tee and elbow and other accessories according to the Department's *Polypropylene Pipe QC/QA Program*:

(1) AASHTO or ASTM Designation

(2) The date of manufacture

(3) Name or trademark of the manufacturer

Clearly apply a Department approved self-adhesive RFID tag/label tagged in accordance with Section 1030 applied in accordance with Subarticle 1030-2(F). When polypropylene pipe, end sections, tees, elbows and couplers have been inspected the Department will update the RFID tag/label item record as found in the Field Inspection Report (FIR) or NCDOT alternate ID.

1032-5 WELDED STEEL PIPE FOR DRAINAGE

Welded steel pipe shall meet ASTM A139 for the grade of pipe called for in the plans.

Acceptance of welded steel culvert pipe and its accessories will be based on, but not limited to, visual inspections, classification requirements and check samples taken from material delivered to the project and conformance to the Department's welded steel pipe program.

1032-6 CONCRETE CULVERT PIPE

(A) General

Use concrete pipe from sources participating in the Department's *Concrete Pipe QC/QA Program*. A list of participating sources is available on the Department's producer/supplier approved list . The producer/supplier must be current with American Concrete Pipe Association (ACPA) or National Precast Concrete Association (NPCA) audit program to remain on the NCDOT producer/supplier list. The Department will remove a manufacturer of concrete pipe from this program if the monitoring efforts indicated that non-specification material is being provided or testing procedures are not being followed.

(B) Reinforced Concrete Culvert Pipe

Reinforced concrete culvert pipe shall meet AASHTO M 170 for the class of pipe called for in the plans except as follows:

(1) The permissible wall thickness outside of the joint configuration shall not be more than that shown in the design by more than 5% or 3/16 inch, whichever is greater.

(2) The maximum weighted average loss for both fine and coarse aggregates shall be 15% when subjected to 5 cycles of the soundness test.

(3) The maximum percentage of wear for coarse aggregates is 55%.

The design wall thickness shall be either the wall thickness shown in AASHTO M 170 for the applicable class and wall or the wall thickness shown in a modified design that has been approved by the Engineer. A wall thickness greater than permitted by the above tolerance will be cause for rejection of the pipe. The circumferential steel in single cage pipe shall not be more than 3 inches from either end of the pipe section excluding the tongue and groove. On double cage pipe, extend one cage into the tongue or groove. Place the other cage so a circumferential wire shall be not less than 2 inches from the other end of the barrel of the pipe.

(C) Precast Concrete Pipe End Sections

Precast concrete pipe end sections shall meet AASHTO M 170 and Section 1077 except those requirements pertaining to design.

Design concrete pipe end sections in accordance with the plans or with plans prepared by the manufacturer which have been approved by the Engineer. Reinforce all concrete pipe end sections. Use air entrained concrete in pipe end sections with a strength of 3,500 psi when tested in accordance with AASHTO T 22.

(D) Concrete Pipe Tees and Elbows

Concrete pipe tees and elbows shall meet AASHTO M 170 for the class of pipe tee or elbow called for in the plans.

(E) Marking

(1) Clearly etchmark the following information on the outside of each section of pipe, pipe end section, tee and elbow:

(a) Pipe class and type of wall if reinforced,

(b) The date of manufacture, and

(c) Name or trademark of the manufacturer.

Clearly apply a Department approved self-adhesive RFID tag/label tagged in accordance with Section 1030 applied in accordance with Subarticle 1030-2(F). When concrete pipe and pipe end sections have been inspected the Department will update the RFID tag/label item record as found in the Field Inspection Report (FIR) or NCDOT alternate ID. Failure of as much as 20% of any lot of pipe due to cracks, fractures, variation in alignment or other manufacturing defects will be cause for the rejection of the entire lot. The lots shall be as designated by the manufacturer before inspection. Individual lengths of pipe within the lot which were not specifically rejected but which are considered acceptable by the manufacturer may be removed from the rejected lot and resubmitted for inspection as a separate lot.

(F) Joint Materials

For connections to precast structures using grout, cement shall meet Article 1024-1, sand shall meet Article 1014-1 for fine aggregate or Article 1040-7 for mortar sand. Hydrated lime shall meet Article 1040-6.

Flexible plastic joint material shall meet ASTM C990 for flexible plastic gaskets, except as follows:

(1) The flash point, Cleveland Open Cup (C.O.C.) shall be at least 325°F.

(2) The fire point, C.O.C. shall be at least 350°F.

1032-7 CORRUGATED POLYETHYLENE (HDPE) CULVERT PIPE

(A) General

Use corrugated polyethylene pipe that is NCDOT approved as found on the Department's producer/supplier list and participating in the Department's *HDPE Pipe QC/QA Program*. The producer/supplier must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT producer/supplier list. A list of participating sources is available from the Materials and Tests Unit. The Department will remove a manufacturer of polyethylene pipe from this program if the monitoring efforts indicated that non-specification material is being provided or test procedures are not being followed.

Use corrugated polyethylene culvert pipe that meets AASHTO M 294 for Type S or Type D and has been evaluated by AASHTO Product Evaluation & Audit Solutions. Bell and spigot joint seals shall meet ASTM F477.

(B) End Treatments, Pipe Tees, Elbows and Couplers

End treatments, pipe tees and elbows shall meet AASHTO M 294, Section 7.8. Couplers, where indicated on the plans, shall meet AASHTO M 294, Section 7.8.

(C) Marking

Clearly mark each section of pipe, end section, tee and elbow and other accessories according to the Department's HDPE Pipe QC/QA Program:

(1) AASHTO Designation

(2) The date of manufacture

(3) Name or trademark of the manufacturer

Clearly apply a self-adhesive Department approved RFID tag/label tagged in accordance with Section 1030 applied in accordance with Subarticle 1030-2(F). After polyethylene pipe, end sections, tees, elbows and couplers have been inspected the Department will update the RFID tag/label item record as found in the Field Inspection Report (FIR) or NCDOT alternate ID.

1032-8 PVC PROFILE WALL DRAIN PIPE

PVC pipe shall conform to AASHTO M 304. Bell and spigot joint seals shall meet ASTM F477. The gasket shall be the sole element relied on to maintain a tight joint. Watertight joints shall be watertight in accordance with AASHTO M 304, unless a higher pressure rating is specified in the plans.

SECTION 1034
SANITARY SEWER PIPE AND FITTINGS

1034-1 CLAY PIPE

Use extra strength vitrified clay sewer pipe conforming to ASTM C700. Manufacture all joints and seals in accordance with ASTM C425.

1034-2 PLASTIC PIPE

(A) PVC Gravity Flow Sewer Pipe

Use PVC pipe that conforms to ASTM D3034 with a minimum SDR of 35. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D3212.

(B) PVC Force Main Sewer Pipe

(1) Pressure Rated Pipe

Use PVC pipe conforming to ASTM D2241 or AWWA C905 with a minimum SDR of 21 and minimum pressure rating of 200 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D3139 or pipe with butt fused joints made from ASTM D1784 Class 12454B plastic formulated for fusing.

Use PVCO pipe conforming to ASTM F1483 or AWWA C909 for molecularly oriented pipe with a minimum pressure rating of 200 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D3139.

(2) Pressure Class Pipe

Use PVC pipe conforming to AWWA C900 with a minimum DR of 18 and a minimum pressure class of 235 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D3139 or pipe with butt fused joints made from ASTM D1784 Class 12454B plastic formulated for fusing.

(C) Polyethylene (PE) Pipe Force Main Sewer Pipe

Use PE pipe and tubing that conforms to AWWA C901 or AWWA C906 with a minimum pressure class of 200 psi.

1034-3 CONCRETE SEWER PIPE

Use reinforced concrete sewer pipe conforming to ASTM C76 or AASHTO M 170 with a Class III minimum rating. Use pipe with gasket joints conforming to ASTM C443 or ASTM C990 as specified in the plans.

1034-4 DUCTILE IRON PIPE

(A) Gravity Flow Sewer Pipe

Use ductile iron pipe that conforms to ASTM A746 or AWWA C151/A21.51.

Use ductile iron pipe fittings and specials conforming to AWWA C110/A21.10 for standard size fittings or AWWA C153/A21.53 for compact fittings.

Use pipe and fittings with push-on joints conforming to AWWA C111/A21.11.

(B) Force Main Sewer Pipe

Use ductile iron pipe that conforms to AWWA C151/A21.51.

Use ductile iron pipe fittings and specials conforming to AWWA C110/A21.10 for standard size fittings or AWWA C153/A21.53 for compact fittings. Manufacture fittings with a cement mortar lining and a seal coat in accordance with AWWA C104/A21.4.

Use pipe and fittings with either mechanical joints or push-on joints conforming to AWWA C111/A21.11. When required or necessary, use approved type joint restraint devices with a minimum working pressure rating of 200 psi and a factor of safety of 2.

SECTION 1036
WATER PIPE AND FITTINGS

1036-1 GENERAL

All materials when used to convey potable drinking water shall meet the National Sanitation Foundation Standard No. 61. All materials in contact with potable water shall be in conformance with Section 1417 of the Safe Drinking Water Act.

1036-2 COPPER PIPE

For indoor plumbing use copper pipe and sweated fittings conforming to ASTM B88 for the type and temper called for in the plans and specifications. Cast fittings for copper pipe shall meet ASTM B61 or ASTM B62.

For buried service, use copper water pipe and tube conforming to ASTM B88 soft annealed Type K. Use flared or compression type fittings conforming to AWWA C800 and local plumbing codes to connect pipe and tube.

1036-3 PLASTIC PIPE

(A) PVC Pipe

(1) Pressure Rated Pipe

Use PVC pipe conforming to ASTM D2241 or to AWWA C905 with a minimum SDR of 21 and minimum pressure rating of 200 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D3139 or pipe with butt fused joints made from ASTM D1784 Class 12454B plastic formulated for fusing.

Use PVCO pipe conforming to ASTM F1483 or to AWWA C909 for molecularly oriented pipe with a minimum pressure rating of 200 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D3139.

(2) Pressure Class Pipe

Use PVC pipe conforming to AWWA C900 with a minimum DR of 18 and a minimum pressure class of 235 psi. Use pipe with push-on type joints having bells made as an integral part of the pipe conforming to ASTM D3139 or pipe with butt-fused joints made from ASTM D1784 Class 12454B plastic formulated for fusing.

(B) Polyethylene (PE) Pipe

Use PE water pipe and tubing that conforms to AWWA C901 or AWWA C906 with a minimum pressure class of 200 psi.

1036-4 STEEL PIPE

(A) Water Pipe

Use galvanized steel pipe meeting ASTM A53 for standard weight. Fittings for steel water pipe shall meet ASTM A126 for Class B iron or of ASTM A197. Galvanize all fittings in accordance with ASTM A153.

(B) Encasement Pipe

Use steel pipe meeting an ASTM specification with the minimum yield strength of 35,000 psi. Use pipe that is circular in shape and straight in length.

1036-5 DUCTILE IRON PIPE AND FITTINGS

Use ductile iron pipe that conforms to AWWA C151/A21.51.

Use ductile iron pipe fittings and specials conforming to AWWA C110/A21.10 for standard size fittings or AWWA C153/A21.53 for compact fittings. Manufacture fittings with a cement mortar lining and a seal coat in accordance with AWWA C104/A21.4.

Use either mechanical joints or push-on joints conforming to AWWA C111/A21.11. When required or necessary, use approved type joint restraint devices with a minimum working pressure rating of 200 psi and a factor of safety of 2.

1036-6 FIRE HYDRANTS

Use dry barrel type fire hydrants conforming to AWWA C502 with a minimum 4 1/2 inch diameter valve opening with a 6 inch mechanical joint inlet connection, with two 2 1/2 inch hose connections and with one 4 1/2 inch pumper connection. Outlets shall have national standard fire hose coupling threads. Use fire hydrants with a minimum bury length of 36 inches. Securely chain nipple caps to the barrel. Paint hydrants with one coat of primer paint and two coats of an approved paint of the owner's standard color. Apply the final coat after hydrant installation.

1036-7 WATER VALVES

(A) Gate Valves

Use iron body gate valves which conform to AWWA C500 for bronze mounted, double disc, parallel seat type valves or to AWWA C509 for resilient seat-type valves or to AWWA C515 for reduced-wall, resilient seat gate valves. For buried service use gate valves with non-rising stems, 2 inch square operating nuts, O-ring seals and which open by turning counter clockwise. Gate valves shall have mechanical joint ends conforming to AWWA C111/A21.11. Gate valves shall have a design working water pressure of 200 psi.

(B) Bronze Gate Valves

Use bronze gate valves conforming to ASTM B62 with tee head operating nuts and solid wedges. Use valves with a design working pressure of 200 psi.

(C) Tapping Valves

Use tapping valves conforming to Subarticle 1036-7(A) with appropriately sized openings, with flanged by mechanical joint ends and pressure rated at 200 psi.

(D) Insertion Valves

(1) Housing-Seated Insertion Valves

Use iron body insertion valves which conform to AWWA C515 for reduced-wall, resilient seat gate valves, with the exception that the valve body may be constructed of two pieces. For buried service use insertion valves with non-rising stems, 2 inch square operating nuts, O-ring seals and which open by turning counterclockwise. Insertion valves shall have mechanical joint ends conforming to AWWA

C111/A21.11. Insertion valves shall have a minimum design working water pressure of 200 psi.

(2) Pipe-Seated Insertion Valves

Use a pipe-seated insertion valve composed of a tapping sleeve assembly and a valve bonnet. Use ductile iron or Type 304 stainless steel tapping sleeve type bodies. Use either the split sleeve type with mechanical joint ends or the full circle type with double seals. Manufacture the outlet flange to mate with the bonnet. For buried service use insertion valves with non-rising stems, 2 inch square operating nuts, O-ring seals and which open by turning counterclockwise. Insertion valves shall have a minimum design water pressure of 200 psi. Coat iron bodies and bonnets at the factory with an epoxy in conformance with AWWA C210 or AWWA C213.

(E) Plug Valves

Use plug valves which conform to AWWA C517. Provide mechanical joint ends conforming to AWWA C111/A21.11.

1036-8 SLEEVES, COUPLINGS AND MISCELLANEOUS

(A) Tapping Sleeves

Use ductile iron or Type 304 stainless steel tapping sleeves pressure rated at 200 psi. Use either the split sleeve type with mechanical joint ends or the full circle type with double seals. Manufacture the outlet flange to mate with the tapping valve flange.

(B) Transition Sleeves and Couplings

Use sleeve type couplings for transitioning between plain ends of different pipe types. Manufacture couplings in conformance with AWWA C219 for a rated working pressure of 200 psi. Coat the coupling at the factory with an epoxy in conformance with AWWA C210 or AWWA C213.

1036-9 SERVICE LINE VALVES AND FITTINGS

Use corporation stops and curb stops of all bronze material and high-pressure construction conforming to AWWA C800.

Use tapping saddles of high-pressure construction, shaped to conform to the pipe and in conformance with AWWA C800.

Use high-pressure fittings manufactured in conformance with AWWA C800.

SECTION 1040
MASONRY

1040-1 BRICK

Use clay or shale brick that meets ASTM C62 or ASTM C216 for Grade SW, except as otherwise provided herein.

Use brick of uniform standard commercial size, with straight and parallel edges and square corners that are burned hard and entirely true, free from injurious cracks and flaws, tough, strong and have a clear ring when struck together. The sides, ends and faces of all brick shall be plane surfaces at right angles and parallel to each other.

Brick of the same manufacturer shall not vary more than ± 1/16 inch in thickness, ± 1/8 inch in width and ± 1/4 inch in length.

Concrete brick may be used instead of clay or shale brick when designated in the plans or in the specifications. Concrete brick shall meet ASTM C55 for Grade S-II except that the absorption of brick used in minor drainage structures shall not exceed 10 pcf.

1040-2 CONCRETE BUILDING BLOCK

Use concrete building block from sources that participate in the Department's *Solid Concrete Masonry Brick/Unit QC/QA Program*. A list of these sources in North Carolina and adjoining states is available from the Materials and Tests Unit in Raleigh.

Use concrete building block that meets ASTM C90. Block shall be pink in color and substantially free from chips and cracks.

Use solid concrete block instead of clay brick for minor drainage structures that meet ASTM C139 except that the nominal dimensions shall be 4 inches x 8 inches x 16 inches.

Concrete block for block manholes shall meet ASTM C139.

1040-3 CONCRETE PAVING BLOCK

Use concrete paving block from sources that participate in the Department's Solid Concrete Masonry Brick/Unit QC/QA Program. A list of these sources in North Carolina and adjoining states is available from the Materials and Tests Unit in Raleigh.

Use concrete paving block that meet ASTM C139, except that the nominal dimensions shall be 4 inches x 8 inches x 16 inches. The block shall have a uniform surface color and texture.

1040-4 SEGMENTAL RETAINING WALL UNITS

Use segmental retaining wall (SRW) units from sources that participate in the Department's *Solid Concrete Masonry Segmental Retaining Wall Units QC/QA Program*. A list of these sources in North Carolina and adjoining states is available from the Materials and Tests Unit in Raleigh.

Use freeze-thaw durable SRW units when noted in the contract. Unless required otherwise in the contract, provide SRW units with a vertical straight face and a concrete gray color with no tints, dyes or pigments. Do not begin unit production until sample SRW units of the type, face and color proposed for the project are approved by the Engineer.

Use SRW units that meet ASTM C1372 except for Table 1040-1 requirements.

TABLE 1040-1
SRW UNIT REQUIREMENTS

Property	Requirement	Test Method
Compressive Strength for SRW Units	4,000 psi min	ASTM C140
Compressive Strength for Freeze-Thaw Durable SRW Units	5,500 psi min	ASTM C140
Absorption	5% max	ASTM C140
Durability for Freeze-Thaw Durable SRW Units	1% max[A]	ASTM C1262

A. Weight loss for 4 of 5 specimens after 150 cycles in water.

1040-5 CEMENT

Portland cement shall meet Article 1024-1.

Masonry cement shall meet ASTM C91.

1040-6 HYDRATED LIME

Hydrated lime shall meet ASTM C207 for Type N.

1040-7 MORTAR SAND

Mortar sand shall meet Article 1014-1, except it shall meet the gradation requirements for No. 4S sand shown in Table 1005-2.

1040-8 WATER

Water shall meet Article 1024-4.

1040-9 MORTAR

Proportion mortar used in all brick and block masonry by volume as shown below. Do not add any more water than is necessary to make a workable mixture.

Mix No. 1: 1 part Portland cement
1/4 part hydrated lime
3 3/4 parts mortar sand (maximum)

Mix No. 2: 1 part Portland cement
1 part masonry cement
6 parts mortar sand (maximum)

Apply Articles 1040-5, 1040-6, 1040-7 and 1040-8 to all cement, hydrated lime, mortar sand and water.

For the hydrated lime and cement portion of Mix No. 1, the Contractor may substitute Type M or Type S masonry cement that meets ASTM C270 for Type S masonry cement the minimum compressive strength of the test specimens shall be 2,500 psi at 28 days and the test specimens shall be composed of one part Type S masonry cement and 3 parts sand. Furnish a Type 3 certification for the Type M or Type S masonry cement in accordance with Article 106-3.

1040-10 ADMIXTURES

Use admixtures that are on the NCDOT APL.

SECTION 1042
RIP RAP MATERIALS

Use field stone or rough unhewn quarry stone for plain rip rap. Use stone that is sound, tough, dense, resistant to the action of air and water and suitable in all other respects for the purpose intended. Where broken concrete from demolished structures or pavement is available, it may be used in place of stone provided that such use meets with the approval of the Engineer. However, the use of broken concrete that contains reinforcing steel will not be permitted.

All stone shall meet the approval of the Engineer. While no specific gradation is required, there shall be equal distribution of the various sizes of the stone within the required size range. The size of an individual stone particle will be determined by measuring its long dimension.

Stone or broken concrete for rip rap shall meet Table 1042-1 for the class and size distribution.

TABLE 1042-1
ACCEPTANCE CRITERIA FOR RIP RAP AND STONE FOR EROSION CONTROL

Class	Required Stone Sizes, inches		
	Minimum	Midrange	Maximum
A	2	4	6
B	5	8	12
1	5	10	17
2	9	14	23

No more than 5.0% of the material furnished can be less than the minimum size specified nor no more than 10.0% of the material can exceed the maximum size specified.

SECTION 1043
AGGREGATE FROM CRUSHED CONCRETE

1043-1 GENERAL

Aggregate from crushed concrete is a recycled product made by crushing concrete obtained from concrete truck clean out, demolition of existing concrete structures or pavement, or similar sources, which have been processed at a crushing facility. It does not include concrete pavements that are rubblelized, broken or otherwise crushed in place on the roadway, without having been processed at a crushing facility.

The crushed material must meet all sources approval requirements described in Sections 1005 and 1006 with the exception of the sodium sulfate test requirement.

Sampling and acceptance for the determination of gradation, LL and PI will be performed as described in the *Aggregate QC/QA Program Manual* and the *Aggregate Sampling Manual*.

1043-2 AGGREGATE BASE COURSE AND SELECT MATERIAL CLASS IV

The material shall meet the ABC gradation. The LL of the material shall be raised 5 points to no more than 35.

1043-3 AGGREGATE SHOULDER BORROW

The material shall meet Section 1019.

1043-4 CLEAN COARSE AGGREGATE FOR ASPHALT

The material shall meet the gradation of a standard size in Table 1005-1 and Subarticle 1012-1(B). Use of the material shall be approved by the Engineer, and the mix shall meet all requirements.

1043-5 CLEAN COARSE AGGREGATE FOR CONCRETE

The material shall meet the gradation of a standard size in Table 1005-1 and Subarticle 1014-2(C). Use of the material is restricted to Class B concrete mixes only. Use of the material shall be approved by the Engineer, and the concrete shall meet all requirements.

SECTION 1044
SUBSURFACE DRAINAGE MATERIALS

1044-1 SUBDRAIN FINE AGGREGATE

Subdrain fine aggregate shall meet Class III select material, Type 1 or Type 3.

1044-2 SUBDRAIN COARSE AGGREGATE

Subdrain coarse aggregate shall meet Class V select material.

1044-3 PIPE AND FITTINGS

Pipe and fittings may be, at the option of the Contractor, either concrete, corrugated steel, bituminized fiber or corrugated plastic.

1044-4 CONCRETE PIPE AND FITTINGS

Non-perforated concrete pipe and pipe fittings shall meet AASHTO M 86 for standard strength nonreinforced concrete pipe.

Perforated concrete pipe shall meet AASHTO M 175 for standard strength perforated nonreinforced concrete underdrainage pipe.

Joint materials shall meet Section 1028.

1044-5 CORRUGATED STEEL PIPE AND FITTINGS

Non-perforated corrugated steel pipe and pipe fittings shall meet Subarticle 1032-3(A).

Perforated corrugated steel pipe shall meet AASHTO M 36.

Fabricate the corrugated steel pipe from steel sheets having a minimum thickness of 0.052 inch.

1044-6 PVC PIPE

Solid Wall PVC pipe shall meet ASTM D1785.

Perforated Solid Wall PVC pipe shall meet AASHTO M 278.

1044-7 CORRUGATED PLASTIC PIPE AND FITTINGS

Corrugated HDPE pipe and fittings shall meet AASHTO M 252, except that the maximum stretch resistance shall be 10%.

1044-8 OUTLET PIPE

Outlets constructed of PVC Schedule 40 pipe shall meet ASTM D1785. HDPE pipe shall meet AASHTO M 252.

SECTION 1046
GUARDRAIL MATERIALS

1046-1 GENERAL

Use guardrail materials meeting requirements of the Department's Brand Registration Program for guardrail and are listed on Department's approved producer/suppliers list or NCDOT APL. The producer/supplier and products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT producer/supplier list and NCDOT APL.

The following types of guardrail materials and all associated accessories may be accepted under this program: rail elements, posts and offset blocks, terminal sections, anchor units, transition sections and hardware.

1046-2 RAIL ELEMENTS

The rail element and terminal sections shall meet AASHTO M 180 for Class A, Type 2.

1046-3 POSTS AND OFFSET BLOCKS

(A) General

(1) The Contractor may furnish any one of the following types of steel guardrail posts. Only one type of post will be permitted at any one continuous installation.

Use structural steel posts throughout the project, unless otherwise directed by the Engineer or detailed in the plans.

(a) Steel W6 x 8.5 or W6 x 9.0 posts

(b) Steel 4.5 inches x 6.0 inches C-shape posts

(2) The Contractor may at his option furnish either of the following types of treated timber posts if specifically directed by the Engineer or detailed in the plans. Only one type of post will be permitted at any one continuous installation.

(a) Timber 6 inch x 8 inch posts

(b) Timber 8 inch x 8 inch posts

(B) Structural Steel Posts

Fabricate steel posts for guardrail of the size and weight shown in the plans from structural steel complying with Section 1072. Metal from which C-shape posts are fabricated shall meet ASTM A1011 for any grade of steel except mechanical requirements that shall meet ASTM A36. Punch or drill the holes for connecting bolts. Burning will not be permitted. After fabrication the posts shall be galvanized in accordance with Section 1076.

(C) Treated Timber Posts

Timber guardrail posts shall be of treated southern pine meeting Section 1082.

Bore bolt holes to a driving fit for the bolts. A minus tolerance of 1% will be allowed in the length of the post. Perform all framing and boring before the posts receive preservative treatment.

(D) Offset Blocks

Provide 8 inch deep recycled plastic or composite offset blocks approved for use with the guardrail shown in the plans. Only one type of offset block will be permitted at any one continuous installation.

Treated timber offset blocks with steel beam guardrail will not be allowed unless directed by the Engineer or detailed in the plans. Steel offset blocks with steel beam guardrail will not be allowed.

Recycled plastic or composite offset blocks shall be made from no less than 50% recycled plastic or composite and shall meet the requirements in Table 1046-1.

TABLE 1046-1
COMPOSITE OFFSET BLOCKS

Property	Requirement
Minimum Specific Gravity	0.950
Min. Compressive Strength in Lateral Direction	1,600 psi
Maximum Water Absorption	10% by weight
Maximum Termite and Ant Infestation	10%
Approval	Approved for use on the NCDOT APL

1046-4 HARDWARE

Provide all hardware as indicated in the plans that is galvanized in accordance with ASTM A153.

1046-5 ANCHORS AND ANCHOR ASSEMBLIES

Each shipment of guardrail terminal end sections, anchors and anchor assemblies shall be shipped from the manufacture with a current parts list and installation guide. Units not having the above documents will be rejected by the Engineer.

Articles 1046-1, 1046-2 and 1046-3 are applicable to rail elements, terminal sections, posts, offset blocks and hardware.

Reinforcing steel shall meet Article 1070-2. Steel plates shall meet ASTM A36. Anchor rods shall meet ASTM A663 for Grade 65.

Anchor cable shall be 3/4 inch wire rope having a minimum breaking strength of 21.4 tons and galvanized. Use commercial quality galvanized steel cable thimbles. Use commercial quality drop forged galvanized steel cable clips. The fitting and stud for the anchor cable shall be suitable for cold swaging and be galvanized. After being swaged on the cable, the fitting and stud assembly, including swaged joint and cable, shall have a minimum breaking strength of 21.4 tons.

Perform welding in accordance with Article 1072-18.

Welded components shall be galvanized after welding in accordance with ASTM A123. All other metal parts shall be galvanized in accordance with ASTM A153, except where otherwise specified in Articles 1046-1, 1046-2 and 1046-3.

1046-6 REPAIR OF GALVANIZING

Perform repair of galvanizing in accordance with Article 1076-7.

1046-7 CABLE GUIDERAIL

Posts, hardware and miscellaneous components shall meet the applicable requirements of this Section, the plans and the manufacture's requirements.

Furnish cable guiderail manufactured in accordance with AASHTO M 30, Type 1, Class A.

For concrete anchors, furnish Class A concrete if cast in place or use concrete meeting Section 1077, if using precast concrete anchors.

Cable guiderail must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan and is not covered under the Brand Certification Program for guardrail materials. Sample cable guiderail according to the *Minimum Sampling Guide*.

1046-8 ACCEPTANCE

Acceptance of guiderail materials and its accessories will be based on, but not limited to, visual inspections, classification requirements and check samples taken from material delivered to the project and conformance to the annual Brand Registration.

SECTION 1050
FENCE MATERIALS

1050-1 GENERAL

All fencing material and accessories shall meet Section 106.

(A) Chain Link Fence

Furnish either galvanized steel fence framework or aluminum alloy fence framework unless otherwise specified. Use the same type of fabric and framework materials throughout the project.

Where galvanized steel framework is used, the fence fabric may be either galvanized steel or aluminum coated steel, except where galvanized steel fabric is specified in the contract. The Contractor may furnish any of the following galvanized steel framework systems:

System G1

Line Posts:	Steel Pipe
Terminal Posts (End, Corner, or Brace Posts):	Steel Pipe
Gate Posts, Double Gate:	Steel Pipe
Gate Posts, Single Gate:	Steel Pipe
Brace Rail and Top Rail [A]	Steel Pipe

System G2

Line Posts:	Steel H Post
Terminal Posts (End, Corner, or Brace Posts):	Steel Pipe
Gate Posts, Double Gate:	Steel Pipe
Gate Posts, Single Gate:	Steel Pipe
Brace Rail and Top Rail [A]	Steel Pipe

System G3

Line Posts:	Roll Formed Steel
Terminal Posts (End, Corner, or Brace Posts):	Steel Pipe
Gate Posts, Double Gate:	Steel Pipe
Gate Posts, Single Gate:	Steel Pipe
Brace Rail and Top Rail [A]:	Steel Pipe or Roll Formed Pipe

A. Top rail to be used instead of tension wire only where called for in the itemized proposal.

Where an aluminum alloy framework is used, the fence fabric may be either aluminum alloy or aluminum coated steel. The Contractor may furnish any of the following aluminum alloy framework systems:

System A1

Line Posts:	Aluminum Post
Terminal Posts (End, Corner, or Brace Posts):	Aluminum Pipe
Gate Posts, Double Gate:	Aluminum Pipe
Gate Posts, Single Gate:	Aluminum Pipe
Brace Rail and Top Rail[A]:	Aluminum Pipe

System A2

Line Posts:	Aluminum H Post
Terminal Posts (End, Corner, or Brace Posts):	Aluminum Pipe
Gate Posts, Double Gate:	Aluminum Pipe
Gate Posts, Single Gate:	Aluminum Pipe
Brace Rail and Top Rail[A]:	Aluminum Pipe

A. Top rail to be used instead of tension wire only where called for in the itemized proposal.

(B) Wire Gauge

TABLE 1050-1
WIRE DIAMETER

Size Coated Wire, gauge	Nominal Diameter of Wire, inch
6	0.192
7	0.177
9	0.148
10 1/2	0.128
11	0.120
11 1/2	0.113
12	0.106
12 1/2	0.099
13	0.092
13 1/2	0.086
14	0.080
15 1/2	0.067
16 1/2	0.058

Whenever the term gauge is used in this section to refer to a size of wire, it will be construed to mean the United States Steel Wire Gauge, SWG (U.S.), regardless of whether or not the base metal of the wire is steel or a nonferrous metal.

1050-2 TIMBER POSTS AND BRACES

(A) General

Use treated southern pine meeting Articles 1082-2 and 1082-3 for all timber posts and braces, except as otherwise specified herein. Posts and braces may be either round or square provided that the same shape is used throughout the project for both the posts and the braces. Post and brace sizes are shown in the plans in inches. The size refers to the diameter for round pieces, or to the edge dimension for square pieces. Square posts and braces shall be fully dressed S4S. An allowable tolerance of 1/2 inch scant for square pieces will be permitted from the dimensions called for in the plans.

Cut round wood posts and braces from sound solid trees, free from short or reverse bends in more than one plane. Do not use log veneer cores for posts and braces unless they contain at least 1 inch of sapwood for their entire circumference on both ends. The post or brace shall not deviate more than 1 inch at any point from a straightedge held longitudinally against the piece.

All posts shall be free from ring shake, season cracks more than 1/4 inch wide, splits in the ends and contain no unsound knots. Sound knots will be permitted provided the width of the knot does not exceed 1/3 the diameter of the post where it occurs. Groups of knots or any combination of defects that will impair the strength of the piece will not be permitted. The pieces shall show not less than 3 annual rings per inch and not less than 30% of summer wood.

A tolerance of 1 inch plus and 1/2 inch minus will be allowed for the diameter of round posts and braces, measured at the small end after peeling. Where they are out of round, this tolerance will apply to the smaller diameter, and the larger diameter shall not exceed the smaller by more than 20%. The maximum rate of increase in diameter at the butt shall be 1 1/2 inches in 10 feet.

A minus tolerance of 1% will be allowed in the length of both round and square posts. Cut the ends square.

(B) Optional Steel Posts and Braces

Steel posts and braces for woven wire fence instead of timber posts and braces are permitted in areas located in or west of Vance, Franklin, Wake, Lee, Moore and Richmond Counties. Use the same type of fence post and brace throughout the project. The optional steel posts and braces shall meet Subarticle 1050-3(B).

1050-3 METAL POSTS AND RAILS

(A) Chain Link Fence

Posts shall meet AASHTO M 181 except as otherwise provided herein.

Steel H posts shall have a minimum yield strength of 45,000 psi and weigh 3.26 lbs/ft. Galvanize steel H posts in accordance with ASTM F1043 with a Type A coating. Aluminum H posts shall weigh 1.25 lbs/ft.

Roll formed steel line posts shall be a 1.625 inch x 1.875 inch section weighing 2.40 lbs/lf after galvanizing and be formed from 0.121 inch thick sheet having a minimum yield strength of 45,000 psi. Roll formed steel brace rails and top rails shall be a 1.250 inch x 1.625 inch section weighing 1.35 lbs/lf after galvanizing and be formed from 0.080 inch thick sheet steel having a minimum yield strength of 45,000 psi. Galvanize all roll formed members after fabrication in accordance with ASTM F1043 with a Type A coating.

Vinyl coated posts shall be pipe posts meeting AASHTO M 181 with a fusion bonded vinyl coating at least 6 mils thick. The vinyl shall meet Section 6 of AASHTO M 181, or if a standard color not listed in AASHTO M 181 is used, the vinyl shall meet the color requirements in ASTM F934, Table 1.

Furnish brace rails with suitable metal connections to fasten them securely to the posts. Provide the top rail not less than 6 inches long with a thickness of at least 0.051 inch if steel, or 0.062 inch if 6063-T6 aluminum alloy and in lengths of at least 15 feet. The complete top rail assembly shall form a continuous rail passing through the top fittings of the line posts and be furnished with suitable metal connections to fasten it to the posts at each end.

For pipe 1.90 inches O.D. and under, the outside diameter at any point shall not vary more than 1/64 inch over no more than 1/32 inch under the standard specified. For pipe 2.375 inches O.D. and over, the outside diameter shall not vary more than ± 1% from the standard specified nor shall the minimum wall thickness at any point be more than 12.5% under the nominal wall thickness specified.

A 10% minimum weight tolerance will be allowed for all steel posts and rails.

(B) Woven Wire Fence

Steel posts used instead of 4 inch timber posts shall be a standard studded T-section 7.5 feet long designed exclusively for use as a fence post and be equipped with a metal anchor plate securely attached to the post. The T-posts shall weigh 1.33 lbs/lf exclusive of the weight of the anchor plate, and have a total weight, including anchor plate, of 10.65 lbs. Nominal dimensions of the T-post shall be 1 3/8 inches wide and 1 3/8 inches deep. A tolerance of ± 3/16 inch will be permitted from these nominal dimensions. The anchor plate shall be sufficiently sturdy to withstand the strain of driving with no loss of effectiveness, and have a minimum area of 14.0 square inches.

Steel posts used instead of 5 inch timber posts may be either tubular posts or angle posts. They shall be 8 feet long and be embedded in a concrete anchor at least 3.3 feet deep and 10 inches in diameter. Fit tubular posts with ornamental tops that fit over the top of the post to cap against moisture. Fabricate the tubular posts from 2 inch diameter pipe meeting AASHTO M 181 for Grades 1 or 2 metallic coated posts and rails. Fabricate angle posts from angle sections measuring 2 1/2 inches x 2 1/2 inches x 1/4 inch, ± 1/16 inch on the 2 1/2 inch dimensions and ± 0.015 inch on the 1/4 inch dimension and weighing 4.10 lbs/ft.

Use steel braces with steel posts and either tubular braces or angle braces to match the posts. Furnish the braces with suitable metal connections to fasten them securely to the posts. Fabricate tubular braces from 1 1/4 inch diameter pipe meeting AASHTO M 181 for Grades 1 or 2 metallic coated posts and rails. Fabricate angle braces from angle sections measuring 2 inches x 2 inches x 1/4 inch ± 3/64 inch on the 2 inch dimensions and ± 0.010 inch on the 1/4 inch dimension and weighing 3.19 lbs/ft.

A 10% minimum weight tolerance will be allowed for all steel posts and braces.

For pipe 1.90 inches O.D. and under, the outside diameter at any point shall not vary more than 1/64 inch over nor more than 1/32 inch under the standard specified. For pipe 2.375 inch O.D. and over, the outside diameter shall not vary more than ± 1% from the standard specified nor shall the minimum wall thickness at any point be more than 12.5% under the nominal wall thickness specified.

Galvanize all steel posts and braces other than tubular members in accordance with ASTM A123.

1050-4 BARBED WIRE

Barbed wire shall meet ASTM A121 except as otherwise provided in this subarticle.

The barbed wire may be either galvanized steel or aluminum coated steel except where aluminum chain-link fabric is used, galvanized steel barbed wire shall not be used. Use the same type of material throughout the project. All barbed wire shall have 4 point barbs spaced not more than 5 inches apart. Single strand barbed wire will not be acceptable.

Two strand galvanized steel barbed wire shall be fabricated from either 12 1/2 gauge or 15 1/2 gauge strand wire with 4 point galvanized steel 14 gauge barbs. The 12 1/2 gauge shall be Standard Grade with a Class 3 coating on the wire and a Class 1 coating on the barbs. The 15 1/2 gauge shall be Chain Link Fence Grade with a Class 3 coating on both the wire and barbs.

Two strand aluminum coated steel barbed wire shall be fabricated from two strands of 12 1/2 gauge aluminum coated steel wire with the 4-point barbs being either 14 gauge aluminum coated steel or aluminum alloy wire.

1050-5 WOVEN WIRE

Woven wire fencing shall conform to ASTM A116 or AASHTO M 279. The fence fabric shall be 47 inches high, with 10 horizontal strands. Space the strands 3 inches apart at the bottom and 8 inches apart at the top with progressive spacing between. Space vertical strands at 6 inch intervals. Any of the following styles and coating classes may be used.

(A) Style 1047-6-9, Grade 60 (all horizontal and vertical strands of wire shall be 9 gauge) with a Class 3 zinc coating.

(B) Style 1047-6-11, Grade 60 (top and bottom horizontal strands to be 9 gauge wire, all other strands to be 11 gauge) with a Class 3 zinc coating.

(C) Style 1047-6-12 1/2, Grade 125 (top and bottom horizontal strands of wire to be no smaller than 10 1/2 gauge with a minimum breaking strength of 1610 lbs., all other strands to be no smaller than 12 1/2 gauge with a minimum breaking strength requirement for horizontal strands of 960 lbs. with a Class 3 coating.

Brace wire shall be a 9 gauge steel in accordance with ASTM A641, except that the minimum zinc coating shall be 0.80 ounces per sf.

1050-6 CHAIN LINK FABRIC

Chain link fence fabrics shall meet AASHTO M 181. Galvanized steel fabric shall have a Class D coating. Polyvinyl coated fabric shall be Type IV, Class A or B and the vinyl coating shall be a standard color meeting AASHTO M 181 or ASTM F934 Table 1. Glare screen fabric with a 0.5 inch mesh shall have a Class 1 zinc coating in accordance with ASTM A392. The height of the chain link fence fabrics shall be as shown in the pay item description. Weave the fabric from 11 gauge wire, unless otherwise required by the contract. Glare screen fabric shall be 11 1/2 gauge unless otherwise required by the contract.

1050-7 FENCE FITTINGS, HARDWARE AND ACCESSORIES

All fittings, hardware and accessories shall meet AASHTO M 181, AASHTO M 232, ASTM F626 OR ASTM A641 or ASTM A809 except for the size, type and coating requirement as shown below in Table 1050-2 and elsewhere in this article.

Galvanize bolts, nuts, washers and other threaded items in accordance with AASHTO M 232.

Where shown in the plans, fit the posts with ornamental tops. The base of tops to be used with pipe posts shall fit over the top of the post to guard against moisture.

Tension wire for use with galvanized steel chain link fabric shall meet AASHTO M 181 for zinc coated tension wire. Tension wire for use with aluminum or aluminum coated chain link fabric may be either aluminum coated tension wire meeting AASHTO M 181, or solid aluminum wire with a minimum diameter of 0.192 inch. The aluminum for solid aluminum wire shall meet ASTM B211 for Alloy 5056 or 6061, and have a minimum breaking strength of 1,216 lbs. force and a minimum elongation of 10%. Tension wire for use with guardrail mounted glare screen fabric shall be 6 gauge and for barrier mounted glare screen the wire shall be 9 gauge unless otherwise required by the contract.

Vinyl coated fittings and accessories shall be galvanized steel or aluminum coated steel meeting this article and have a bonded vinyl coating. The vinyl shall meet Section 6 of AASHTO M 181 and be a standard color meeting AASHTO M 181 or ASTM F934 Table 1. The vinyl

coating shall be at least 6 mils thick, except that the coating on tension wire, hog rings and tie wires shall be 6 to 10 mils thick.

1050-8 REPAIR OF GALVANIZING

Repair of galvanizing shall be in accordance with Article 1076-7. Do not use aerosol can products for repairs

TABLE 1050-2
PROPERTIES OF FENCING MATERIALS

Item	Gauge or Diameter, inch	Coating, oz/sf	Coating, oz/sf, Aluminum	Remarks
Tie wires, steel	9	0.90	0.40	For fastening chain link fabric and tension wire to tubular sections or to roll formed steel line posts.
Tie wires, Aluminum	6	-	-	Alloy 1350-H19 or approved equal.
Clips, steel wire	7	0.90	-	For fastening chain link fabric and tension wire to H- posts.
Clips, steel wire	11	0.85	-	For fastening woven wire fabric to steel posts.
Hog rings, steel	12	0.80	0.40	For fastening chain link fabric to tension wire.
Hog rings, aluminum	9	-	-	Alloy 1350-H19 or approved equal.
Truss rod, steel	5/16	2.00	-	-
Tension (stretcher) bars, steel	3/16 x 3/4	1.50	-	For connection of 1 3/4" or 2" fabric to end, gate and corner posts for fabric heights over 5 ft.
Tension (stretcher) bars, steel	3/16 x 5/8	1.50	-	For connection of 1 3/4" or 2" fabric to end, gate and corner posts for fabric heights up to 5 ft.
Tension (stretcher) bars, steel	1/4 x 3/8	1.50	-	For connection of 1" fabric to end, gate, and corner posts.
Staples, Nails or	9	0.35	-	For fastening woven wire to timber posts. Shall be the size and shape shown in the plans.
Tension wire braces	9	0.90	0.40	For woven wire fence.
Post and line caps	-	1.30	-	For installation on top of posts to guard against moisture.
Rail and brace ends (pressed steel or cast iron)	-	1.30	-	-
Top rail steel sleeves	0.051	1.30	-	For rail connections. shall be fabricated to prevent movement along the rail.
Tension band	14	1.30	-	For fastening tension bar to posts.
Brace band	12	1.30	-	For fastening rail to posts.
Barbed wire extension arms (pressed steel or cast iron)	14	1.30	-	Shall be fitted with clips or slots for attaching the barbed wire to the arms.
Hinges, latches	-	2.00	-	-

SECTION 1052
LIME STABILIZERS

1052-1 LIME

(A) Chemical Requirements

Quicklime and hydrated lime for soil stabilization shall meet ASTM C977 except that it shall contain at least 86% available calcium oxide (CaO) on an LOI-free basis.

(B) Physical Requirements

(1) Hydrated Lime

Hydrated lime shall have at least 85% passing a No. 200 sieve.

(2) Quicklime

Grade quicklime so 100% passes a 1/4 inch sieve.

(C) Sampling and Inspection

Furnish Type 1 or Type 2 material certifications with each shipment of lime attesting that the lime meets the specifications in accordance with Article 106-3; however, the material will be subject to inspection, test or rejection by the Engineer at any time.

Lime from more than one source or more than one type may be used on the same project, but the different limes shall not be mixed. Protect the lime from exposure until used and sufficiently dry it to flow freely when handled.

SECTION 1054
DRAINS

1054-1 DECK DRAINS

Provide deck drains made of PVC pipe. Use the type of pipe as shown in the plans.

PVC pipe shall meet ASTM D1785 or D2665, and have four 1/2 inch square lugs shop glued at approximately equal spacing around the pipe at 4 inches from the top end of each deck drain.

SECTION 1056
GEOSYNTHETICS

1056-1 DESCRIPTION

Provide geosynthetics for subsurface drainage, separation, stabilization, reinforcement, erosion control, filtration and other applications in accordance with the contract. Use geotextiles, geocomposite drains and geocells that are on the NCDOT APL. Products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT APL. Prefabricated geocomposite drains include sheet, strip and vertical drains (PVDs), i.e., "wick drains" consisting of a geotextile attached to and/or encapsulating a plastic drainage core. Geocells are comprised of ultrasonically welded polymer strips that when expanded form a 3D honeycomb grid that is typically filled with material to support vegetation. Define geotextiles, geogrids, geocomposite drains and geocells as geosynthetics.

If necessary or required, hold geotextiles, geogrids and sheet drains in place with new wire staples, i.e., "sod staples" that meet Subarticle 1060-8(D) or new anchor pins. Steel anchor pins shall have a diameter of at least 3/16 inch, a length of at least 18 inches, a point at one end and a head at the other end that will retain a steel washer with an outside diameter of at least 1.5 inches.

1056-2 HANDLING AND STORING

Load, transport, unload and store geosynthetics so geosynthetics are kept clean and free of damage. Label, ship and store geosynthetics in accordance with Section 7 of AASHTO M 288. Geosynthetics with defects, flaws, deterioration or damage will be rejected by the Engineer. Do not unwrap geosynthetics until just before installation. Do not leave geosynthetics exposed for more than 7 days before covering except for geotextiles for temporary wall faces and erosion control.

1056-3 CERTIFICATIONS AND IDENTIFICATION

Provide Type 1, Type 2 or Type 4 material certifications in accordance with Article 106-3 for geosynthetics except certifications are not required for Type 1 through Type 3 geotextiles and Type 5a geotextiles. Type 1, Type 2 or Type 4 material certifications in accordance with Article 106-3 are required for Type 4a geotextiles. Define "machine direction" (MD), "cross-machine direction" (CD) and "minimum average roll value" (MARV) in accordance with ASTM D4439. Provide certifications with MARV for geosynthetic properties as required. Test geosynthetics using laboratories accredited by the Geosynthetic Accreditation Institute (GAI) to perform the required test methods. Sample geosynthetics in accordance with ASTM D4354.

Allow the Engineer to visually identify geosynthetic products before installation. Open packaged geosynthetics just before use in the presence of the Engineer to verify the correct product. Geosynthetics that are missing original packaging or product labels or that have been unwrapped or previously opened will be rejected unless otherwise approved by the Engineer.

1056-4 GEOTEXTILES

Provide geotextile types and classes in accordance with the contract.

Use woven or nonwoven geotextiles with properties that meet Table 1056-1.

TABLE 1056-1
GEOTEXTILE REQUIREMENTS

Property[A]	Requirement (MARV[A])					Test Method
	Type 1	**Type 2**	**Type 3[B]**	**Type 4a**	**Type 5a[C]**	
Typical Application	*Shoulder Drains*	*Under Rip Rap*	*Silt Fence Fabric*	*Soil Stabilization*	*Subgrade Stabilization*	
Elongation (MD & CD)[A]	≥ 50%	≥ 50%	≤ 25%	< 50%	< 50%	ASTM D4632
Grab Strength (MD & CD)[A]	Table 1[D], Class 3	Table 1[D], Class 1	100 lb	-	-	ASTM D4632
Tear Strength (MD & CD)[A]			-			ASTM D4533
Puncture Strength			-			ASTM D6241
Ultimate Tensile Strength (MD & CD)[A]	-	-	-	2,400 lb/ft	Table 12[D], Class 4A	ASTM D4595
Permittivity	Table 2[D], 15% to 50% *in Situ* Soil Passing 0.075 mm	Table 6[D], 15% to 50% *in Situ* Soil Passing 0.075 mm	Table 7[D]	Table 12[D], Class 4A	Table 12[D], Class 4A	ASTM D4491
Apparent Opening Size						ASTM D4751
UV Stability (Retained Strength)						ASTM D4355

A. MD, CD and MARV per Article 1056-3.
B. Minimum roll width of 36 inches required.
C. Minimum roll width of 13 feet required unless otherwise approved by the Engineer for the application.
D. Per AASHTO M 288.

1056-5 GEOCOMPOSITE DRAINS

Provide geocomposite drain types in accordance with the contract and with properties that meet Table 1056-2.

TABLE 1056-2
GEOCOMPOSITE DRAIN REQUIREMENTS

Property	Requirement			Test Method
	Sheet Drain	**Strip Drain**	**Wick Drain**	
Width	≥ 12"	12" ±1/4"	4" ±1/4"	N/A
In-Plane Flow Rate[A] (with gradient of 1.0 and 24-hour seating period)	6 gpm/ft @ applied normal compressive stress of 10 psi	15 gpm/ft @ applied normal compressive stress of 7.26 psi	1.5 gpm[B] @ applied normal compressive stress of 1.45 psi	ASTM D4716

A. MARV per Article 1056-3.
B. Per foot of width tested.

For sheet and strip drains, use accessories (e.g., pipe outlets, connectors, fittings, etc.)

recommended by the Drain Manufacturer. Provide sheet and strip drains with Type 1 geotextiles heat bonded or glued to HDPE, polypropylene or high impact polystyrene drainage cores that meet Table 1056-3.

TABLE 1056-3
DRAINAGE CORE REQUIREMENTS

Property	Requirement		Test Method
	Sheet Drain	Strip Drain	
Thickness	1/4"	1"	ASTM D1777 or D5199
Compressive Strength[A]	40 psi	30 psi	ASTM D6364

A. MARV per Article 1056-3.

For wick drains with a geotextile wrapped around a corrugated drainage core and seamed to itself, use drainage cores with an ultimate tensile strength of at least 225 lbs. per 4 inch width in accordance with ASTM D4595 and geotextiles with properties that meet Table 1056-4.

TABLE 1056-4
WICK DRAIN GEOTEXTILE REQUIREMENTS

Property	Requirement	Test Method
Elongation	≥ 50%	ASTM D4632
Grab Strength	Table 1[A], Class 3	ASTM D4632
Tear Strength		ASTM D4533
Puncture Strength		ASTM D6241
Permittivity[B]	0.7 sec^{-1}	ASTM D4491
Apparent Opening Size (AOS)	Table 2[A], > 50% *in Situ* Soil Passing 0.075 mm	ASTM D4751
UV Stability (Retained Strength)		ASTM D4355

A. Per AASHTO M 288.
B. MARV per Article 1056-3.

For wick drains with a geotextile fused to both faces of a corrugated drainage core along the peaks of the corrugations, use wick drains with an ultimate tensile strength of at least 1,650 lbs. per 4 inch width in accordance with ASTM D4595 and geotextiles with a permittivity, AOS and UV stability that meet Table 1056-4.

1056-6 GEOCELLS

Manufacture geocells from virgin polyethylene resin with no more than 10% rework, also called "regrind", materials. Use geocells made from textured and perforated HDPE strips with an open area of 10% to 20% and properties that meet Table 1056-5.

TABLE 1056-5 GEOCELL REQUIREMENTS		
Property	**Requirement**	**Test Method**
Cell Depth	4"	N/A
Fully Expanded Cell Area	100 sq.in. max	N/A
Sheet Thickness	50 mil -5%, +10%	ASTM D5199
Density	58.4 pcf min	ASTM D1505
Carbon Black Content	1.5% min	ASTM D1603 or D4218
ESCR[A]	5000 hr min	ASTM D1693
Coefficient of Direct Sliding (with material that meets AASHTO M 145 for soil classification A-2)	0.85 min	ASTM D5321
Short-Term Seam (Peel) Strength (for 4" seam)	320 lb min	USACE[C] Technical Report GL-86-19, Appendix A
Long-Term Seam (Hang) Strength[B] (for 4" seam)	160 lb min	

A. Environmental Stress Crack Resistance.

B. Minimum test period of 168 hours with a temperature change from 74°F to 130°F in 1-hour cycles.

C. USACE

Provide geocell accessories (e.g., stakes, pins, clips, staples, rings, tendons, anchors, deadmen, etc.) recommended by the Geocell Manufacturer.

SECTION 1060
LANDSCAPE DEVELOPMENT MATERIALS

1060-1 GENERAL

Supply certifications for all landscape development materials as required below. If no certification is required, supply the Department with a statement certifying that all materials conform to these specifications and those of the NC Department of Agriculture and Consumer Services (NCDA&CS) or both. All landscape development materials shall comply with all applicable Federal and State domestic plant quarantines.

1060-2 FERTILIZER

The quality of all fertilizer and all operations in connection with the furnishing of this material shall comply with the North Carolina Commercial Fertilizer Law and with the rules and regulations, adopted by the North Carolina Board of Agriculture in accordance with said law, in effect at the time of sampling. All fertilizer will be subject to sampling and testing by the Engineer, or by an authorized representative of the North Carolina Department of Agriculture and Consumer Services, or both.

Dry fertilizer shall be manufactured from cured stock. Care for the fertilizer during handling and storing in such a manner that it will be protected against hardening, caking or loss of plant food values. Pulverize any hardened or caked fertilizer to its original condition before using.

1060-3 LIMESTONE

The quality of all limestone and all operations in connection with the furnishing of this material shall comply with the North Carolina Agricultural Liming Materials and Landplaster Act, and with the rules and regulations, adopted by the North Carolina Board of Agriculture and Consumer Services in accordance with said law, in effect at the time of sampling. All limestone will be subject to sampling and testing by the Engineer, or by an authorized representative of the North Carolina Department of Agriculture, or both.

Limestone shall be agricultural grade ground limestone. Either dolomitic or calcitic limestone may be used.

All limestone shall contain not less than 90% calcium carbonate equivalents. Dolomitic limestone shall contain not less than 10% of magnesium. Grade dolomitic limestone so at least 90% will pass through a U.S. Standard 20 mesh screen and at least 35% will pass through a U.S. Standard 100 mesh screen. Grade calcitic limestone so at least 90% will pass through a U.S. Standard 20 mesh screen and at least 25% will pass through a U.S. Standard 100 mesh screen. Where the current grading requirements of the North Carolina Board of Agriculture are different from the above, the requirements of the Board of Agriculture will apply.

During handling and storing, care for the limestone in such manner that it will be protected against hardening or caking. Pulverize any hardened or caked limestone to its original condition before using.

1060-4 SEED

The quality of all seed and all operations in connection with the furnishing of this material shall comply with the North Carolina Seed Law and with the rules and regulations, adopted by the North Carolina Board of Agriculture and Consumer Services in accordance with said law, in effect at the time of sampling, and with the quality requirements of the specifications. All seed will be subject to sampling by the Engineer, or by an authorized representative of the North Carolina Department of Agriculture and Consumer Services, or both; and will be tested by the North Carolina Department of Agriculture. Supplementary testing for seed germination may be performed by the Engineer.

The quality of all seed will be based on the percentage of pure live seed, which will be computed by multiplying the percentage of purity by the percentage of germination and dividing the result by 100.

Seed shall have been approved by the North Carolina Department of Agriculture and Consumer Services before being sown. No seed will be accepted with a date of test more than 8 months before the date of sowing, excluding the month in which the test was completed. Such testing, however, will not relieve the Contractor from responsibility for furnishing and sowing seed that meets these specifications at the time of sowing. The Engineer may retest seed for germination after 5 months of storage; at the beginning of each normal seeding season for the particular kind of seed involved or at any time that the condition of the seed appears to have deteriorated.

When a low percentage of germination causes the quality of the seed to fall below the minimum pure live seed specified, the Contractor may elect, subject to the approval of the Engineer, to increase the rate of application sufficiently to obtain the minimum pure live seed content specified, provided that such an increase in the rate of application does not cause the quantity of noxious weed seed per acre or square yard, as the case may be, to exceed the quantity that would be allowable at the regular rate of application.

Furnish and deliver each of the species or varieties of seed in separate bags. If seed is to be mixed before sowing, perform such mixing in a commercial seed mixing machine, or by an equally thorough means, after sampling and testing have been completed.

During handling and storing, care for the seed in such a manner that it will be protected from damage by heat, moisture, rodents or other causes.

1060-5 MULCH FOR EROSION CONTROL

Mulch for erosion control shall consist of grain straw, or other acceptable material, and be approved by the Engineer before being used. All mulch shall be reasonably free from mature seedbearing stalks, roots or bulblets of Johnson Grass, Nutgrass, Sandbur, Wild Garlic, Wild Onion, Crotalaria, Witchweed and an excessive amount of restricted noxious weeds as defined by the North Carolina Board of Agriculture at the time of use of the mulch. Loose and separate straw mulch that is matted or lumpy before being used.

Tacking material shall be one of the following:

(A) Emulsified Asphalt

Asphalt emulsion tack shall conform to the requirements of AASHTO M 140. The emulsified asphalt may be rapid setting, medium setting or slow setting.

(B) Cellulose Hydromulch

Cellulose hydromulch products shall be non-toxic, weed-free, prepackaged cellulose fiber (pulp) material containing no more than 3% ash or other inert materials. Cellulose hydromulches may contain dyes or binders specifically formulated to enhance the adhesive qualities of the hydromulch.

Wood fiber or wood fiber blend hydromulches may be substituted for cellulose hydromulch at the same application rate.

(C) Other Tackifiers

Other approved materials, specifically designed and manufactured for application as a straw mulch tacking agent, may be used at the manufacturer's recommended rate.

1060-6 SPRIGS

Sprigs shall consist of freshly dug live stolons or rhizomes of perennial grasses, at least 2 inches in length, and be first class representatives of the required species or varieties specified in the specifications. The areas from which sprigs are to be obtained shall be free from Johnson Grass, Nutgrass, Sandbur, Wild Garlic, Wild Onion, Crotalaria, Witchweed and an excessive amount of restricted noxious weeds as defined by the North Carolina Board of Agriculture at the time of digging the sprigs. The areas shall have been mowed and raked, burned off, or otherwise prepared in a manner acceptable to the engineer before digging of sprigs begins.

1060-7 SOD

Sod shall consist of a live, dense, well-rooted growth of permanent grasses, free from Johnson Grass, Nutgrass, Sandbur, Wild Garlic, Wild Onion, Crotalaria, Witchweed and an excessive amount of restricted noxious weeds as defined by the North Carolina Board of Agriculture and Consumer Services at the time of cutting the sod. Mow the area from which sod is to be obtained to a height of not more than 2 inches. Rake free of grass clippings and debris and otherwise prepared in a manner satisfactory to the Engineer before cutting of sod begins.

Cut the sod into rectangular sections of sizes convenient for handling without breaking or loss of soil. Cut it with a sod cutter or other acceptable means to a depth that will retain in the sod practically all of the dense root system of the grass.

During wet weather, allow the sod to dry sufficiently before lifting to prevent tearing during handling and placing. During extremely dry weather, water it before lifting if such watering is necessary to ensure its vitality and to prevent loss of soil during handling.

1060-8 MATTING FOR EROSION CONTROL

(A) General

Matting for erosion control shall be excelsior matting or straw matting. Furnish a Type 3 material certification in accordance with Article 106-3 certifying that the matting meets this article. Other acceptable material manufactured especially for erosion control may be used when approved by the Engineer in writing before being used. Matting for erosion control shall not be dyed, bleached or otherwise treated in a manner that will result in toxicity to vegetation.

(B) Excelsior Matting

Excelsior matting shall consist of a machine produced mat of curled wood excelsior at least 47 inches in width and weigh 0.975 lb/sy with a tolerance of ± 10%. At least 80% of the

individual excelsior fibers shall be 6 inches or more in length. Evenly distribute the excelsior fibers over the entire area of the blanket. Cover one side of the excelsior matting with an extruded plastic mesh. The mesh size for the plastic mesh shall be no more than 1 inch x 1 inch.

(C) Straw Matting

Straw matting shall consist of a machine produced mat of 100% grain straw. The straw matting shall have a width of at least 48 inches and no more than 90 inches and weighing at least 0.50 lb/sy and no more than 0.75 lb/sy. Evenly distribute the straw over the entire area of the blanket. Cover one side of the blanket with photodegradable netting with a maximum mesh (netting) size of 0.75 inch x 0.75 inch sewn together with a degradable thread. The grain straw shall contain no weed seeds. Package each roll separately.

(D) Wire Staples

Staples shall be machine made of No. 11 gauge new steel wire formed into a U-shape. The size when formed shall be not less than 6 inches in length with a throat of not less than 1 inch in width.

1060-9 WATER

Water used in the planting or care of vegetation shall meet Class C freshwaters as defined in 15A NCAC 02B.0200.

1060-10 NURSERY GROWN PLANT MATERIALS

(A) General

Use all plants as called for by the contract.

Container grown plants may be used instead of balled and burlapped plants or bare rooted plants provided written approval for such use has been obtained from Engineer.

Grading of plants, size of root balls and type and minimum dimensions of containers shall conform to the *American Standard for Nursery Stock*. Do not cut back plants from larger sizes to meet the sizes called for in the contract.

Botanical names referred to in the contract are taken from *Hortus Third, the Bailey Hortorium* (MacMillan Publishing Co., Inc.). All plants delivered shall be true to name. Each plant, or group of the same species, variety and size of plant, shall be legibly tagged with the name and size of the plant.

All plants shall be first-class representatives of their species or varieties. The root system shall be vigorous and well developed. The branch systems shall be of normal development and free from disfiguring knots, sun scald injuries, abrasions of the bark, dead or dry wood, broken terminal growth or other objectionable disfigurements. Trees shall have reasonably straight stems and be well branched and symmetrical in accordance with their natural habits of growth.

All plants shall be free from plant diseases and insect pests. All shipments of plants shall comply with all nursery inspection and plant quarantine regulations of the states of origin and destination, as well as with Federal regulations governing interstate movement of nursery stock. Any nursery stock used on highway landscape projects shall be accompanied by a valid copy of a certificate of inspection, which has been granted by the North Carolina Department of Agriculture and Consumer Services, Entomology Division. Fire ant treatment certification, where applicable, is required.

When nursery stock from other states is used on projects in North Carolina, this stock shall be accompanied by a tag or certificate stating that the nursery stock has been inspected and certified by an authorized official of the state of origin as apparently free from injurious plant pests.

All plant materials are subject to inspection at any time by the Engineer. Any such inspection before or during planting operations, however, will not be construed as final acceptance of the plants involved.

All geophytes; bulbs, corms and tuberous plants; shall be synonymous to the term “plant” within the contract. Examples include, but are not limited to, Narcissi (Daffodil), Tulipa (Tulip), Iris and Canna; the terms “bulb”, “corm”, “tuber”; and specific plant names such as “Daffodil”, “Tulip”, “Canna lily”, etc.

(B) Balled and Burlapped Plants

Dig plants to be balled and burlapped so as to retain a firm ball of soil and the plant’s fibrous root system. The soil in the ball shall be the original and undisturbed soil in which the plant has been grown. Dig, wrap, transport and handle the plant so the soil in the ball shall not become frozen, loosened, cause stripping of the small feeding roots nor movements of the soil away from contact with such roots.

(C) Container Grown Plants

Container grown plants shall be healthy, vigorous, well-rooted and established in the container in which they are delivered. These plants shall be in the container long enough for the fibrous roots to have developed so the root mass will retain its shape and hold together when removed from the container. The container shall be sufficiently rigid to firmly hold the soil protecting the root mass during transporting, handling and planting. The soil shall not be allowed to become frozen.

(D) Bare Root Plants

Bare root plants shall have a heavy fibrous root system that has been developed by proper cultural treatment. Dig, package, transport and handle bare root plants in a manner that will prevent injury to or drying out of the trunks, branches or roots, or freezing of the roots. Bare root plants damaged through improper handling, freezing, drying out, etc. will result in rejection of material.

(E) Plant Substitution

No change in the specifications (species, variety, size, caliper, furnish) will be made without written approval of the Engineer. Present all requests for substitutions in writing and include a listing of the sources contacted in an attempt to secure specified plant material. Requests for substitutions shall include the botanical name, common name, cultivar, where applicable, size, caliper and furnish description of the proposed substitute. No increase in compensation will be made to the Contractor as a result of the use of approved substitute plants. The Department reserves the right to locate specified plant material for the project when it has knowledge that specified material is available.

(F) Geophytes

Geophytes; bulbs, corms and tuberous plants; shall be healthy and free of disease caused by fungi, nematodes, bacteria and wilt. Plants that are lightweight and lacking adequate mass will result in rejection. Plants shall be firm and absent of discolored patches with soft or spongy areas or signs of rot, slime or mold. Plants with new root growth will result in rejection.

Dig, package, transport and handle these plants as to prevent injury, drying out, excessive wetness or freezing. Damaged plants through improper handling, freezing, drying out or excessive moisture will result in rejection.

All geophytes, bulbs, corms and tuberous plants shall be inspected for size and condition and plants rejected by the Engineer shall be removed from the supply before planting.

1060-11 MULCH FOR PLANTING

Use mulch for planting as specified in the specifications, shown in the plans, or approved by the Engineer. Mulch for planting shall not contain substances injurious to plants or which will inhibit normal development and growth of plants. Mulch for a project shall come from a single source, as approved by the Engineer, unless an additional source is submitted and approved before use.

1060-12 MATERIALS FOR STAKING OR GUYING

(A) Stakes

Use stakes made of cypress, cedar, oak, locust or other acceptable wood free from defects that would compromise the strength of the stake. Stakes shall be at least 2 inches x 2 inches (nominal). Use stakes of the size and length as shown in the plans.

(B) Wire

Wire shall be new soft No. 14 gauge steel wire or as shown in the plans.

(C) Hose

Hose to be used with wire shall have a minimum inside diameter of 1/2 inch. All hose shall be garden type hose composed of rubber and fabric, or as shown in the plans.

(D) Other

Other staking and guying materials may be used if a sample is submitted and approved by the Engineer before use.

1060-13 HERBICIDES

The herbicide to be used for a particular application shall be as specified or approved by the Engineer prior to their application.

Herbicides shall be properly labeled and registered with the United States Department of Agriculture and the North Carolina Department of Agriculture and Consumer Services. A container shall contain only the herbicide that meets the analysis guaranteed on the label. Keep all herbicides in such original labeled containers until used.

Herbicide application shall only be conducted by individuals who possess a pesticide license from the NC Department of Agriculture and Consumer Services or individuals under their direction and who has read, understands, and follows the herbicide labeling before applying the product.

1060-14 COIR FIBER MAT

Coir fiber mat shall consist of 100% coconut fiber (coir) twine woven into high strength matrix. The coir fiber mat shall have a thickness of at least 0.30 inch and weigh at least 20 ounces per square yard. The coir fiber mat shall have a dry tensile strength of at least 1,348 x 626 lbs/ft. The coir fiber mat shall have an observed flow velocity of 11 feet per second. The coir fiber mat shall have a C-Factor of 0.002. The minimum width of the coir fiber mat shall be 6.5 feet and the measured open area shall be 50%.

1060-15 COMPOST

Test methods for the compost should follow USCC TMECC guidelines for laboratory procedures. A sample shall be submitted to the Engineer for approval prior to being used and must comply with all local, state and federal regulations.

(A) Chemical Requirements

pH between 5.0-8.0 in accordance with TMECC 04.11-A, "Electrometric pH Determinations for Compost".

(B) Physical Requirements

(1) Weed free.
(2) Derived from a well-decomposed source of organic matter.
(3) Produced using an aerobic composting process meeting CFR 503 regulations Including time and temperature data indicating effective weed seed, pathogen and insect larvae kill.
(4) Free of any refuse, contaminants or other materials toxic to plant growth.
(5) Non-composted products will not be accepted by the Engineer.
(6) For seeded Compost Blankets, seed should be incorporated at the time of application in the entire depth of the compost blanket, at rates per foot, per square yard, or per acre, as acceptable to the Engineer. The following particle sizes shall also be followed: 100% passing a 2 inch sieve; 99% passing a 1 inch sieve; minimum of 60% passing a 1/2 inch sieve. All other testing parameters remain the same. The seeding rates are generally similar or slightly higher than those used when considering application of seed via hydroseeding or other seeding methods.
(7) Moisture content of less than 60% in accordance with standardized test methods for moisture determination.
(8) Material shall be relatively free (<1% by dry weight) of inert or foreign man-made materials.

SECTION 1070
REINFORCING STEEL

1070-1 GENERAL

All reinforcing steel and welded wire reinforcement must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan. Standard drawing details for reinforcement products are found in the *Roadway Standard Drawings.*

Steel reinforcement shall be stored above the surface of the ground on platforms, skids, or other supports and shall be protected from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, loose rust or scale, mortar, paint, grease, oil, or other nonmetallic coatings which could reduce bond as determined by the Engineer. Reinforcing steel placement and fastening shall conform to the requirements of AASHTO LRFD Bridge Construction Specifications, Section 9 and these specifications of which the more stringent shall apply.

When approved by the Engineer, field welding of reinforcing steel materials shall be performed in accordance with Section 1072 and at a minimum, comply with the current edition of AWS D1.4.

1070-2 STEEL BAR REINFORCEMENT FOR ROADS AND STRUCTURES

Use reinforcing steel provided by a NCDOT approved facility as found on the Department's producer/supplier list. All producer/suppliers must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT producer/supplier list. Supply deformed steel bar reinforcement conforming to ASTM A615 for Grade 60. For uncoated deformed and/or plain reinforcing, furnish the Engineer a Type 1 certification in accordance with Article 106-3 and attach it to *Materials and Tests Form 913* for each shipment of reinforcing material. Bend and cut during fabrication with tolerances in accordance with the AASHTO LRFD Bridge Construction Specifications, Section 9. Bend the bars cold to the details shown in the plans.

Weld steel bar reinforcement only where shown in the plans or approved by the Engineer. When welding steel bar reinforcement use bars conforming to ASTM A706.

1070-3 COLD DRAWN STEEL WIRE AND WIRE REINFORCEMENT

Provide cold drawn steel wire for use as spirals or in fabricated form for the reinforcement of concrete meeting AASHTO M 336. When required by the plans, apply epoxy coating by a NCDOT approved facility.

Use steel welded wire reinforcement, plain or deformed, conforming to AASHTO M 336.

1070-4 REINFORCING STEEL BAR SUPPORTS

Provide all wire bar supports of smooth cold drawn industrial quality basic wire having a minimum tensile strength of 65,000 psi. When the legs of the bar supports are in contact with the forms, ensure that the entire leg of the bar support is stainless steel wire or a minimum thickness of 1/4 inch stainless steel at points of contact with the forms. Use stainless steel wire meeting ASTM A493 except having a minimum chromium content of 16% and a minimum tensile strength of 95,000 psi. Ensure that wire sizes, height tolerance, and leg spacing for wire bar supports are in accordance with the *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute.

As an option to the stainless steel wire for the legs of bar supports at points of contact with the forms, provide legs of cold drawn steel wire plastic protected in accordance with the *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute, except provide plastic protection by dipping or by premolded plastic tips in accordance with ANSI/CRSI-RB4. Do not use plastic legs molded to the top wire.

Use plastic bar supports meeting the requirements listed in ANSI/CRSI-RB4 published by the Concrete Reinforcing Steel Institute only when approved by the Engineer.

1070-5 PRESTRESSING STRAND

Use prestressing strands for use in prestressed concrete consisting of seven wire strands, stress relieved after manufacture to remove internal stresses. Use the size and the grade of the strand as shown in the plans. Use strands conforming to AASHTO M 203 except provide a specimen for test purposes, if required, from each reel of cable instead of each 20 ton production lot.

For precast prestressed deck panels, use 3/8 inch round seven-wire stress-relieved Grades 250 or 270 prestressing strands meeting AASHTO M 203.

Mark the outer layer of each reel pack of strand with a wide color band as follows: white for Grade 270 stress relieved strand, green for low relaxation strand, and a double marking of green and red for special low relaxation strand. In addition, attach a metal tag to each reel pack labeled in accordance with AASHTO M 203.

1070-6 DOWELS AND TIE BARS FOR PORTLAND CEMENT CONCRETE PAVEMENT

Use dowel and tie bars from the Department's approved producer/supplier list. Use smooth plain round steel dowel bars conforming to AASHTO M 31 Grade 60 conforming to the *Roadway Standard Drawings*. Do not use dowel bars with burred ends. A tolerance of ± 1/4 inch is permitted from the dowel length required by the plans. A straightness tolerance of 0.075 inch from a straight line is permitted.

Epoxy coat and fabricate all dowel bars/baskets by a NCDOT approved facility as found on the Department's producer/supplier list.

Use dowel assemblies for supporting dowel bars of rigid construction capable of holding the dowel bars in proper position during placing of concrete, and of such design to permit unrestricted movement of the pavement slab. Use wire for dowel assemblies meeting AASHTO M 336. Use a dowel assembly that holds the dowels in the required position within a tolerance

of ± 1/4 inch in vertical and horizontal planes. Obtain written approval from the Engineer for the dowel assembly before use.

Coat dowel bars and the entire dowel assembly with an approved wax base coating. Apply the coating by dipping or spraying such that the wax coating on the dowel bars is of uniform thickness sufficient to allow pulling of the dowel from the concrete as provided in AASHTO T 253 Type B coated dowel.

When required by the Department's Minimum Sampling Guide, furnish for testing one dowel basket assembly for each 200 assemblies incorporated into the project. Each Department approved producer/supplier, coater and fabricator shall provide the Department a Type 1 material certification in accordance with Article 106-3, M&T DB-06 Dowel Basket Fabrication Report and when required by the Engineer the *Materials and Tests Form 913* for all coated dowel baskets and loose dowels with each shipment.

Use deformed tie bars conforming to AASHTO M 31 for Grade 40 or Grade 60.

Storage, handling and transportation of epoxy coated dowel and/or tie bars shall be in accordance with Section 1070-7(D).

1070-7 EPOXY COATED REINFORCING STEEL

(A) General

Use reinforcing steel from the Department's approved producer/supplier list. All producer/suppliers must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT producer/supplier list. Facilities coating and fabricating epoxy coated reinforcing steel shall establish proof of their competency and responsibility in accordance with the Concrete Reinforcing Steel Institute's Fusion Bonded Epoxy Coating Applicator Plant Certification Program. Registration and certification of the plant or shop under the CRSI Program and submission of the valid annual certificate to the State Materials Engineer is required before beginning any coating. The same requirement applies to coaters subcontracting work from the coater directly employed by the contractor.

Obtain approval of each coater and/or fabricator of epoxy coated reinforcing steel before coating or fabrication of bars. The coating applicator and/or fabricator is responsible for establishing and maintaining an effective quality control program, and employ equipment for cleaning, coating and/or fabricating that produces coated material conforming to the *Standard Specifications.*

Include in requests for approval a well-defined quality control program and direct the requests to the State Materials Engineer. Before Department approval is issued, the condition of equipment for blast cleaning, coating and/or fabricating material is evaluated by the Engineer for determining the equipment capability of producing a coated product conforming to the *Standard Specifications*. Use Department approved epoxy coating and fabricating companies as found on the Department's approved producer/supplier list.

(B) Coating Materials

Obtain approval for the epoxy resin powder before use. A list of prequalified powder sources is available from the State Materials Engineer.

(C) Coated Reinforcing Steel

Use coated steel reinforcing bars meeting AASHTO M 31, Grade 60 and free of contaminants such as oil, grease and paint. Use bars free of surface irregularities as defined in ASTM A775 and/or that produce holidays in the coating.

(D) Handling, Storage and Transportation

When handling, storing and transporting coated steel reinforcing bars, all contact areas shall be padded.

All bundling bands shall be padded or suitable banding shall be used to prevent damage to the coating. All bundles of coated steel reinforcing bars shall be lifted with a strong back, spreader bar, multiple supports, or a platform bridge to prevent bar-to-bar abrasion from sags in the bundles of coated steel reinforcing bars. Packaging of uncoated and coated bars is strictly prohibited. When loading/unloading coated bars; pallets, bags or bundles shall not be dropped or dragged.

During storage, protect steel reinforcement at all times from damage and make sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials until the time of placement. For storage outside at the fabrication shop and project site, store epoxy coated reinforcing steel bars at least 1 foot above the ground on wooden or padded supports placed 10 feet apart, and completely cover with an opaque cloth, canvas or woven fiber reinforced polyethylene white tarp. Storage of uncoated and coated material shall not be mixed or in direct contact. Do not use solid plastic sheeting. Cover the bars such that adequate ventilation is provided to prevent condensation from forming on the material during storage, and completely protect the bars from direct sunlight. Do not allow water to pond under the epoxy coated reinforcing steel. Do not expose epoxy coated reinforcing steel to outdoor weather for more than 30 days. If the coated steel reinforcing bars are stored outdoors without cover, the date on which the coated bars are placed outdoors shall be recorded on the identification tag for the bundled steel.

Transport the bundled bars from the producer/supplier to the project site with padding, such as carpet padding, placed over each bundle of steel upon which another bundle of steel is placed unless wooden spacers are placed between each bundle to prevent contact. Load all bundles of bars horizontally for transporting. Transport the bars on a flatbed trailer. Do not allow the length of bars to exceed 8 feet beyond the trailer bed. Repair coating damage associated with handling and transporting or other causes in accordance to Subarticle 1070-7(E). Coated steel reinforcing bars should be off-loaded as close as possible to their points of placement or under the crane so that the bars can be hoisted to the area of placement to minimize re-handling. If the material is being transported in adverse weather conditions the producer/supplier, coater, fabricator and/or Contractor shall co-coordinate a material protection plan, test for the presence of chlorides, and, if necessary, clean the material as directed by the Engineer.

(E) Field Coating Repair

The maximum amount of repaired damaged coating shall not exceed 1% of the total surface area in each 0.3 m [1 foot] of the bar. This limit on repaired damaged coating shall not include sheared or cut ends that are coated with patching material. When degraded coating is observed additional inspection or non-destructive testing may be required by the Engineer at no additional cost to the Department.

Ensure the Contractor uses a Department approved patching or repair material that is compatible with the coating and inert in concrete. When repair is required, clean the areas in accordance to SSPC-SP 1 prior to performing additional surface preparation. Surface preparation shall be in accordance with SSPC-SP 11 (Power Tool Cleaning to Bare Metal) and/or in accordance with the manufacturers recommendations. The more stringent of the two shall apply. Ensure that the material is suitable for making repairs with a minimum dry film thickness of 7 mils. Ensure that the Contractor has a copy of the manufacturer's written instructions for application of the patching material and the instructions are closely followed during any coating damage repair. Do not apply any patch material when the surface temperature of the steel or the air temperature is below 40°F. Do not ship or place steel until the patch material is dry to the touch.

1070-8 SPIRAL COLUMN REINFORCING STEEL

Furnish spiral column reinforcing steel with the following areas and weights as required in Table 1070-1 and in the plans.

TABLE 1070-1 SPIRAL COLUMN REINFORCEMENT STEEL PROPERTIES			
Material	**Size**	**Area, sq.in.**	**Weight, lb/ft**
Plain Cold Drawn Wire	W 20	0.20	0.668
	W 31	0.31	1.043
Deformed Cold Drawn Wire	D-20	0.20	0.680
	D-31	0.31	1.054
Plain or Deformed Bar	#4	0.20	0.668
	#5	0.31	1.043

Use cold drawn wire conforming to AASHTO M 336. Use plain or deformed bars conforming to AASHTO M 31 for Grade 60. Use deformed cold drawn wire conforming to AASHTO M 225.

The diameter of the spiral reinforcing steel is the outside to outside measurement of the bars or wire, with an allowance of 1/2 inch more or 1/2 inch less than the specified diameter as shown in the plans.

Furnish spirals with 1.5 extra turns at top and at bottom of the completed spiral cage. Where splicing of the spirals is necessary other than those shown in the plans, provide a minimum lap splice of 3 feet.

Do not weld on the spiral reinforcing steel.

When required by the plans, use epoxy coated spiral column reinforcing steel and spacers provided by a NCDOT approved supplier available on the Department's approved producer/supplier list.

Use the minimum number of spiral spacers as shown in the plans. Ensure a minimum section modulus per spiral spacer of 0.030 cu. in.

1070-9 MECHANICAL BUTT SPLICES

When called for by the contract or when approved by the Engineer, use a mechanical butt reinforcing steel splice from an approved source that is found on the Department's producer/supplier list. Use a standard metal filled sleeve, cement mortar filled sleeve, threaded steel couplings, forged steel sleeve or cold-forged sleeve. An exothermic process whereby molten filler metal, contained by a high strength steel sleeve of larger inside diameter than the bars, is introduced into the annular space between the bars and the sleeve and between the ends of the bars may be used. Provide a splice that is capable of transferring at least 125% of the yield strength of the bars from one bar to the other by the mechanical strength of the splice components.

For splices not on the approved list, before use and as a condition of approval, assemble three test splices in the presence of the Engineer for each size of bar which is proposed for use on the project. Forward the test splices to the Materials and Tests Unit in Raleigh, NC for testing and approval.

1070-10 REJECTION

Reinforcing material that does not meet the *Standard Specifications* is rejected by the Engineer. When required by the Engineer, replace reinforcing material that is bent, deformed, exhibits cracked material or welds, contaminated and when the maximum amount of coating damage exceeds the limits herein or degraded coating is observed and as determined by the Engineer.

SECTION 1072
STRUCTURAL STEEL

1072-1 GENERAL

Furnish and fabricate all structural steel and related incidental materials including sign supports and high mount light standards and use materials in accordance with this section.

(A) Department Steel Bridge Qualification Program

Fabricators furnishing structural steel bridge members for Department projects shall comply with this program. Qualifications shall be submitted to the State Materials and Tests Engineer prior to project letting.

(B) Fabricator Qualification

Use steel fabricators on the Department's Approved Structural Steel Fabricators List that have undergone and successfully completed the Department's audit process for the type work being performed as outlined below. The list is available from the Materials and Tests Unit or on the Department's website.

Fabricators shall possess an AISC Bridge Quality Management Systems (QMS) certification. Employ fabricators that possess an AISC Bridge Component Quality Management Systems (QMS) Certified Component Manufacturer Certification (CPT) for the following:

(1) High mount light standards in excess of 80 feet in length

(2) Structural steel components of fender systems,

(3) Solar array platforms

(4) Retaining walls and noise walls

(5) Sign supports and sign structures

(6) Expansion joints (except modular joints)

Employ fabricators that possess an AISC certification category of Simple Bridge Requirement (SBR) for the following:

(1) Pot and expansion bearings

(2) Simple span rolled beams (unspliced rolled sections), including those requiring cover plates,

(3) Pedestrian bridge truss sections

(4) Modular expansion joints

Employ fabricators that possess an AISC certification category of Certified Bridge Fabricator - Intermediate (IBR) for the following:

(1) A rolled beam bridge with field or shop splices, either straight or with a radius over 500 feet.

(2) A built-up I-shaped plate girder bridge with constant web depth (except for dapped ends), with or without splices, either straight or with a radius over 500 feet.

(3) A built-up I-shaped plate girder with variable web depth (e.g., haunched), either straight or with a radius over 1,000 feet.

(4) A truss with a length of 200 ft or less that is entirely or substantially preassembled at the certified facility and shipped in no more than three subassemblies.

Employ fabricators that possess an AISC certification category of Certified Bridge

Fabricator – Advanced (ABR) for the following: Rail structures, heat curved rolled beams, rolled beams for continuous spans and plate girders, tub or trapezoidal box girders, closed box girders, large or non-preassembled trusses, arches, bascule bridges, cable-supported bridges, moveable bridges, and bridges with particularly tight curve radius. Employ fabricators that possess an AISC certification category of Fracture Critical Endorsement (FC) for the following: Fracture critical bridge beams and girders. This applies to steel bridge members or components that are designated as "fracture critical".

Fabricators performing shop coating applications shall meet the minimum requirements outlined in Section 442.

When AISC certification is required, submit proof of registration and certification of the plant or shop under the AISC program to the State Materials Engineer before beginning fabrication and on an annual basis. The same requirements apply to fabricators subcontracting work from the fabricator directly employed by the Contractor.

(C) Office

Ensure that fabricators of main structural steel components of bridges provide an office area with an approximate floor space of 100 sf, a desk or drafting table, 2 chairs, telephone, facilities for proper heating and cooling, telephone, internet access and adequate lighting and located at the plant site for the exclusive use of the Engineer or their designee. Ensure fabricators of other structural steel items furnish reasonable work areas for the Engineer.

1072-2 SHAPES, PLATES, BARS AND SHEETS

Use shapes, plates, bars and sheets meeting AASHTO M 270 Grade 36 unless otherwise required by the contract. For painted beams or girders, use sheet material of 1/32 inch in thickness meeting ASTM A1008 or A1011, and sheet material of 1/16 inch through 5/32 inch thickness meeting ASTM A1011 for Grades 36, 40 or 45. For unpainted beams or girders, use sheet material less than 3/16 inch thickness meeting ASTM A606 for Type 4.

1072-3 BEARING PLATE ASSEMBLIES

Unless otherwise shown in the plans, galvanize steel bearing assemblies for both structural steel beams and girders and prestressed concrete girders. Galvanize anchor bolts, nuts and washers in accordance with AASHTO M 232. Cut pipe sleeves and collars from Schedule 40 PVC pipe meeting ASTM D1785.

Except for attachments of bearing plates to beams, fabricate and weld bearing plate assemblies before galvanizing the steel. Seal all joints of welded parts with weld material. After the fabrication of the bearing plate assembly is complete, galvanize the assembly in accordance with AASHTO M 111. For prestressed concrete girders, clean welds made for attaching bearing plates to beams or girders and give them two coats of organic zinc repair paint having a minimum total coating thickness of 3 dry mils. For steel beams and girders, clean and paint in accordance with Article 442-10.

Repair galvanized surfaces that are abraded or damaged at any time after the application of the zinc coating by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which give the cleaned area two coats of organic zinc repair paint having a minimum total coating thickness of 3 dry mils. Use zinc rich paint meeting Article 1080-7.

1072-4 ANCHOR BOLTS

Unless otherwise stated herein, use anchor bolts meeting ASTM A307 for Grade A.

Provide anchor bolts for bearing plate assemblies meeting ASTM A449.

Swedge anchor bolts for a distance equal to the embedment length minus 3 inches measured from the embedded end.

Hot-dip galvanize anchor bolts, nuts and washers in accordance with AASHTO M 232.

1072-5 HIGH STRENGTH BOLTS, NUTS AND WASHERS

(A) General

Furnish all high-strength bolts, nuts and washers, including direct tension indicators (DTI's), in accordance with the appropriate AASHTO or ASTM materials specifications as amended and revised herein.

Furnish the Engineer a copy of the manufacturer's test report for each component. Ensure the report indicates the testing date, the city and state where the components were manufactured, the lot number of the material represented, the rotational capacity tests lot number and the source identification marking used by the manufacturer of each component. On test reports for direct tension indicators, include the tension load at which indicators are tested, gap clearance, nominal size and coating thickness.

Produce each permanent fastener component installed in a structure from domestically processed material containing the grade identification markings required by the applicable reference specification and the manufacturer's source identification marking. A copy of the source identification marking used by each manufacturer is on file with the Department's Materials and Tests Unit.

Obtaining permanent bolts, nuts and washers in any one structure from different manufacturers is allowed provided:

(1) All bolts are produced by only one manufacturer.

(2) All nuts are produced by only one manufacturer.

(3) All washers are produced by only one manufacturer.

Have all fasteners used in a structure furnished by the fabricator of the steel. When required, submit the fasteners for sampling and testing at least five weeks before delivery to the project site. The fabricator shall sample and test each diameter bolt, nut and washer assembly to be used on the project. In accordance with Table 1072-1, a minimum of three assemblies per Lot/Heat number shall be submitted by the fabricator to the Materials and Test Laboratory.

TABLE 1072-1
SAMPLING REQUIREMENTS FOR
HIGH STRENGTH BOLTS, NUTS AND WASHERS TO INCLUDE DTI's

Lot / Heat Number	Number of Samples
0-800	3 Assemblies
801-8000	6 Assemblies
> 8000	9 Assemblies

Ship only those fasteners to the project that are sampled, tested and approved by the Department. Protect the material from moisture during storage such that it does not contain any indication of rust at the time of installation. Ensure that each component contains a thin coat of lubricant at the time of installation.

When galvanized high strength bolts are required, use bolts, nuts and washers meeting Subarticle 1072-5(F).

When corrosion resistant structural steel is required by the plans, provide fasteners with atmospheric corrosion resistance and weathering characteristics comparable to that of the structural steel.

(B) Specifications

Ensure that all bolts meet ASTM F3125.

Ensure that all nuts meet ASTM A194 as applicable or ASTM A563. Completely coat each nut with a wax lubricant.

Ensure that all washers meet ASTM F436.

Ensure that all direct tension indicators meet ASTM F959.

(C) Manufacturing

(1) Bolts

Hardness for bolts shall be in accordance with ASTM F3125.

(2) Nuts

(a) Heat treat galvanized nuts to Grades 2H, DH or DH3.

(b) Use plain (ungalvanized) nuts of Grades 2, C, D or C3 meeting the hardness values in accordance with ASTM A194 or heat treat to Grades 2H, DH or DH3.

(c) Tap oversize galvanized nuts the minimum amount required by ASTM A563. Overtap the nut such that the nut assembles freely on the bolt in the coated condition and meets mechanical requirements of ASTM A563 and the rotational-capacity test herein.

(3) Mark all bolts, nuts and washers in accordance with the appropriate ASTM Specifications.

(4) Direct Tension Indicators

(a) For Type 3 high strength bolts, mechanically galvanize direct tension indicators to ASTM B695, Class 55, and then apply baked epoxy to a thickness of 1 mil minimum. Direct tension indicators need not be mechanically galvanized or epoxy coated if they are made from material conforming to ASTM F3125, Type 3 bolts.

(b) For plain Type 1 high strength bolts, provide direct tension indicators that are plain or mechanically galvanized to ASTM B695, Class 55.

(c) For galvanized Type 1 high strength bolts, mechanically galvanize direct tension indicators to ASTM B695, Class 55.

(D) Testing

(1) Bolts

(a) Proof load tests in accordance with ASTM F606, Method 1, are required at the minimum frequency as specified in ASTM F3125.

(b) Wedge tests on full size bolts in accordance with ASTM F606. If bolts are galvanized, perform the tests after galvanizing. Test at a minimum frequency as specified in ASTM F3125.

(c) If galvanized bolts are supplied, measure the thickness of the zinc coating. Take measurements on the wrench flats or top of bolt head.

(2) Nuts

(a) Proof load tests in accordance with ASTM F606, Paragraph 4.2, are required at the minimum frequency of as specified in ASTM A563 and ASTM A194. If nuts are galvanized, perform the tests after galvanizing, overtapping and lubricating.

(b) If galvanized nuts are supplied, measure the thickness of the zinc coating. Take measurements on the wrench flats.

(3) Washers

(a) If galvanized washers are supplied, perform hardness testing after galvanizing.

(b) Remove the coating before taking hardness measurements.

(c) If galvanized washers are supplied, measure the thickness of the zinc coating.

(d) Test direct tension indicators in accordance with ASTM F959.

(4) Assemblies

Rotational-capacity tests are required to be performed by an AASHTO accredited laboratory. Ensure the manufacturer or distributor perform such tests on all black or galvanized (after galvanizing) bolt, nut and washer assemblies before shipping. Washers are required as part of the test.

The following applies:

(a) Except as modified herein, perform the rotational-capacity test in accordance with ASTM F3125.

(b) Test each combination of bolt production lot, nut lot and washer lot as an assembly. Where washers are not required by the installation procedures, do not include in the lot identification.

(c) Assign a rotational-capacity lot number to each combination of lots tested.

(d) The minimum frequency of testing is two assemblies per rotational-capacity lot.

(e) Assemble the bolt, nut and washer assembly in a Skidmore-Wilhelm Tension Indicating Device (Calibrator) or an acceptable equivalent device (This requirement supersedes the current ASTM F3125 requirement to perform the test in a steel joint). For short bolts that are too short for assembly in the Skidmore-Wilhelm, see Subarticle 1072-5(D)(4)(i).

(f) The minimum rotation, from a snug tight condition (10% of the specified proof load), is: 240° (2/3 turn) for bolt lengths less than 4 diameters; 360° (1 turn) for bolt lengths greater than 4 diameters and less than 8 diameters; 480° (1 1/3 turn) for bolt lengths greater than 8 diameters.

(g) These values differ from ASTM F3125.

(h) Achieve tension at the above rotation equal to or greater than 1.15 times the required installation tension. The installation tension and the tension for the turn test are shown in Table 1072-2.

TABLE 1072-2
BOLT TENSION REQUIREMENTS

Diameter, inch	**1/2"**	**5/8"**	**3/4"**	**7/8"**	**1"**	**1 1/8"**	**1 1/4"**	**1 3/8"**	**1 1/2"**
Req. Installation Tension, kips	12	19	28	39	51	64	81	97	118
Turn Test Tension, kips	14	22	32	45	59	74	94	112	136

(i) After the required installation tension listed in Table 1072-2 is exceeded, one reading of tension and torque is taken and recorded. The torque value shall conform to the following equation:

$$\textbf{Torque} \leq 0.25(P \times D)$$

Where:

Torque = measured torque in foot-lbs.
P = measured bolt tension in lbs.
D = bolt diameter in feet

For bolts that are too short to test in a Skidmore-Wilhelm Calibrator, test in a steel joint. The tension requirement of Subarticle 1072-5(D)(4)(h) is computed using a value of **P** equal to the turn test tension shown in the Table 1072-2.

(5) Reporting

(a) Record the results of all tests, including zinc coating thickness, required herein and in the appropriate specifications.

(b) Report the location where tests are performed and date of tests on the appropriate document.

(6) Witnessing

Witness of the test by an inspection agency is not required; however, ensure the manufacturer or distributor performing the tests certifies that the recorded results are accurate.

(7) Documentation

(a) Mill Test Report(s) (MTR)

(i) Furnish Mill Test Report(s) for all mill steel used in the manufacture of the bolts, nuts or washers.

(ii) Indicate in the Mill Test Report the place where the material was melted and manufactured, the lot number of the material represented and the source identification used by the manufacturer.

(b) Manufacturer Certified Test Report(s) (MCTR)

(i) Have the manufacturer of the bolts, nuts and washers furnish Manufacturer Certified Test Report(s) for the item furnished.

(ii) Include in each Manufacturer Certified Test Report the relevant information required in accordance with Subarticle 1072-5(D)(5).

(iii) Have the manufacturer or distributor performing the rotational-capacity test include on the Manufacturer Certified Test Report:

A) The lot number of each of the items tested.

B) The rotational-capacity lot number as required in Subarticle 1072-5(D)(4)(c).

C) The results of the tests required in Subarticle 1072-5(D)(4).

D) The pertinent information required in Subarticle 1072-5(D)(5)(b).

E) A statement that the Manufacturer Certified Test Report for the items are in conformance to the *Standard Specifications* and the appropriate AASHTO specifications.

F) The location where the bolt assembly components were manufactured.

(c) Distributor Certified Test Report(s) (DCTR)

(i) Ensure that the Distributor Certified Test Report(s) includes Manufacturer Certified Test Reports above for the various bolt assembly components.

(ii) Ensure the rotational-capacity test is performed by a distributor or a manufacturer and reported on the Distributor Certified Test Report.

(iii) Include in the Distributor Certified Test Report the results of the tests required in Subarticle 1072-5(D)(4).

(iv) Include in the Distributor Certified Test Report the pertinent information required in Subarticle 1072-5(D)(5)

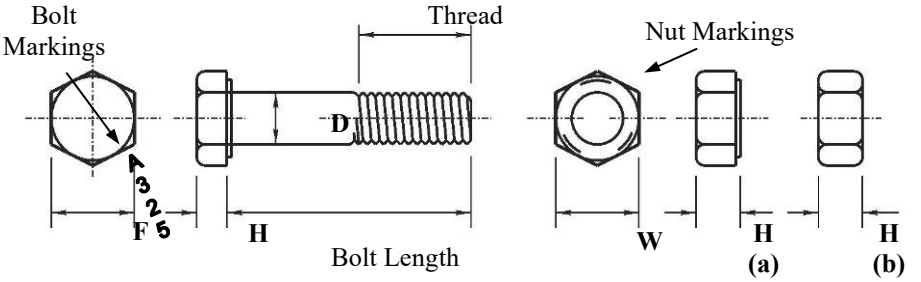
(v) Include in the Distributor Certified Test Report the rotational-capacity lot number as required in Subarticle 1072-5(D)(4)(c).

(vi) Ensure that the Distributor Certified Test Report certifies that the Manufacturer Certified Test Reports are in conformance to this *Standard Specifications* and the appropriate ASTM specifications.

(E) Shipping

(1) Ship bolts, nuts and washers, where required, from each rotational-capacity lot in the same container. If there is only one production lot number for each size of nut and washer, shipping of the nuts and washers in separate containers is allowed. Permanently mark each container on the side with the rotational-capacity lot number such that identification is possible at any stage before installation.

(2) Provide the appropriate MTR and MCTR or DCTR to the contractor or owner as required by the contract.



(3) Figure 1072-1. Bolt and nut description. Bolt and nut marking varies. Refer to Subarticle 1072-5(B). F is the width across the flats of the bolt. H is the height of the bolt or nut. Nuts may be washer facing as in (a) or double chamfered as in (b). D is the bolt diameter and nominal bolt size. W is the width across the flats of the nut.

TABLE 1072-3
HIGH STRENGTH BOLTS
BOLT AND NUT DIMENSIONS

Nominal Bolt Size, inch	Heavy Hexagon Structural Bolt Dimensions, inch			Semi-Finished Heavy Hexagon Nut Dimensions, inch	
	Width Across Flats	Height	Thread Length	Width Across Flats	Height
(D)	*(F)*	*(H)*	*(Thread)*	*(W)*	*(H)*
1/2	7/8	5/16	1	7/8	31/64
5/8	1 1/16	25/64	1 1/4	1 1/16	39/64
3/4	1 1/4	15/32	1 3/8	1 1/4	47/64
7/8	1 7/16	35/64	1 1/2	1 7/16	55/64
1	1 5/8	39/64	1 3/4	1 5/8	63/64
1 1/8	1 13/16	11/16	2	1 13/16	1 7/64
1 1/4	2	25/32	2	2	1 7/32
1 3/8	2 3/16	27/32	2 1/4	2 3/16	1 11/32
1 1/2	2 3/8	15/16	2 1/4	2 3/8	1 15/32

TABLE 1072-4
HIGH STRENGTH BOLTS WASHER DIMENSIONS

Bolt Size D, inch	Circular Washers Dimensions, inch				Square or Rectangular Beveled Washers Dimensions for American Standard Beams and Channels, inch		
	Nominal Outside Diameter	Nominal Diameter of Hole	Thickness Min.	Thickness Max.	Minimum Side Dimension	Mean Thickness	Slope of Taper in Thickness
1/2	1 1/16	17/32	.097	.177	1 3/4	5/16	1:6
5/8	1 5/16	11/16	.122	.177	1 3/4	5/16	1:6
3/4	1 15/32	13/16	.122	.177	1 3/4	5/16	1:6
7/8	1 3/4	15/16	.136	.177	1 3/4	5/16	1:6
1	2	1 1/8	.136	.177	1 3/4	5/16	1:6
1 1/8	2 1/4	1 1/4	.136	.177	2 1/4	5/16	1:6
1 1/4	2 1/2	1 3/8	.136	.177	2 1/4	5/16	1:6
1 3/8	2 3/4	1 1/2	.136	.177	2 1/4	5/16	1:6
1 1/2	3	1 5/8	.136	.177	2 1/4	5/16	1:6
1 3/4	3 3/8	1 7/8	.178[A]	.28[A]	-	-	-
2	3-3/4	2-1/8	.178[A]	.28[A]	-	-	-
Over 2 to 4 Incl.	2**D**-1/2	**D**+1/8	.24[B]	.34[B]	-	-	-

A. 3/16 inch nominal
B. 1/4 inch nominal

(F) Galvanized High Strength Bolts, Nuts and Washers

Use galvanized high strength bolts, nuts and washers meeting all other requirements of this subarticle except as follows:

(1) Use Type 1 bolts.

(2) Quench and temper washers.

(3) Mechanically galvanize in accordance with ASTM B695, Class 55.

(4) Ship galvanized bolts and nuts in the same container.

(5) Use organic zinc repair paint for touch-up of galvanized surfaces meeting Article 1080-7.

(6) Include in manufacturer's test reports results of the zinc coating thickness measurements.

(7) Have each galvanized nut coated with a wax lubricant with a color contrast to that of the zinc coating.

1072-6 WELDED STUD SHEAR CONNECTORS

Use Type B shear studs in accordance with the Bridge Welding Code as defined in Article 1072-18.

Use and install welded stud shear connectors meeting Article 1072-18. Ensure that shear studs and the areas of beams, girders or other structural steel to which the studs are welded are free of rust, rust pits, oil, grease, moisture, paint, galvanizing, loose mill scale or other deleterious matter which adversely affects the welding operation. Shear studs may be applied on steel with tightly adhering mill scale, provided acceptable results are achieved and the installed studs meet the Bridge Welding Code, as determined by the Engineer. Unless otherwise directed by the contract, studs shall be welded with automatically timed stud welding equipment in accordance with AWS D1.5 Bridge Welding Code and manufacture's requirements. Welding voltage,

current, time, and gun settings for lift and plunge should be set at optimum settings based on past practice, recommendations of stud and equipment manufacturer, or both.

1072-7 INSPECTION

(A) General

Give the Materials and Tests Unit 72 hours' notice for in-state producers and 192 hours' notice for producers out-of-state before beginning work in the shop. The "hours' notice" is defined as working hours' Monday thru Friday, 8 AM to 5 PM. Do not manufacture or fabricate any material, other than stock items, before the Materials and Tests Unit is notified and the final shop drawings are reviewed, accepted by the Engineer and returned to the fabricator. The fabricator shall have a stamped approved set of shop drawings assigned to the NCDOT assigned inspection staff and delivered to him upon his/her arrival on site. Shop drawings shall include all current revisions.

The shop inspection performed by the Department or inspection agency hired by the Department is intended as QA to assure to the Department that the fabricator is following all quality control requirements and is providing a product conforming to the Contract requirements. The inspection is not expected to replace the fabricator's quality control. The inspection and acceptance of the work performed by the Department or its representative does not relieve the fabricator of providing materials and finished products as specified.

The Department may reject defective or non-conforming materials at any time. Replace rejected materials promptly at no additional cost to the Department.

The contractor/fabricator shall be responsible for and shall be required to perform all quality control inspections and nondestructive testing in accordance with the Bridge Welding Code as defined in Article 1072-18 and as required by the contract. Perform all quality control inspection and nondestructive testing in the presence of the Department's inspector unless otherwise approved by the Department's inspector. Obtain approval for all quality control inspectors from the Department's inspector and ensure their qualification in accordance with the Bridge Welding Code and these specifications. Maintain all QC reports as required by the Bridge Welding Code, including, but not limited to, visual and nondestructive testing reports and all phases of coating application inspection. Provide copies of all QC reports, including all radiographic films, to the Department inspector upon request. These copies become the property of the Department and shall bear certification (written testimony) signature of the quality control inspector. No separate payment is made for this inspection and testing. The entire cost of this work is included in the unit contract price for the structural steel items involved.

Furnish facilities for the inspection of material and work in the mill and shop, and allow the inspectors unescorted, free access to the necessary parts of the mill or shop. Do not ship any member or component of the structural steel from the shop to the job site before approval by the Department's inspector. Such approval is stamped on the member or appropriate container by the fabricator's quality control and the Department's inspector only after piece mark, quantity, and contract compliance have been verified.

Furnish the Engineer with as many copies of mill orders and shipping statements as directed by the Engineer. The acceptance of any material or finished member by the Department's inspector is not a bar to their subsequent rejection, if found defective. Replace rejected material and correct rejected work promptly and satisfactorily.

(B) Shop and Mill Inspection

Shop inspection is performed on all structural steel used on any project. Mill inspection of structural steel is performed when so noted in the plans or in the specifications. Furnish complete certified Mill Test Reports for all structural steel used except a Type 6 (Supplier Certification) material certification in accordance with Article 106-3 as to the grade of steel

used is acceptable for small amounts of structural steel items which are furnished from the supplier's stock and which are difficult to identify on any Mill Test Report.

Show in the supplier's certification the items fabricated from stock material and the pounds of steel required for each item. A supplier's certification represents only anchor bolts, pipe sleeves, masonry plates, sole plates, diaphragm tees, connector plates and web stiffener plates. Represent all other items required for a structure by certified Mill Test Reports as specified above.

Indicate in the complete certified Mill Test Reports the pounds of steel and the item or items they represent and show heat number of steel, mechanical tests, chemical analyses, Department's project number, station number, the ASTM or AASHTO specification to which the material conforms and a signed statement certifying where the steel was melted and manufactured.

Forward to the Materials and Tests Unit a letter which states by contract number, project number, structure number and station number the items and pounds of steel that are represented by a supplier's certification and those represented by the certified Mill Test Reports identifying the beam and/or plate material for each main member.

The Department reserves the right to select any item for test. Bear any expense of obtaining the sample. The tests are performed at the Department's expense.

(C) Sampling Structural Steel

Furnish samples of structural steel at the beginning of fabrication when random sampling is required.

Furnish one 2 1/2 inch x 26 inch sample for each grade of steel used on a project per 1,000,000 lbs. No more than 2 are required per project.

Take all samples at the location and in the manner directed by an authorized representative of the Engineer. Furnish the necessary personnel and equipment for obtaining samples and be responsible for providing a smooth finish to the areas from which the samples are taken. Fabricator shall be responsible for obtaining representative samples in the presence of the Department's inspector and submitting to the Materials and Test Laboratory.

(D) Charpy V-Notch Tests

Furnish all structural steel for girders, beams and diaphragm components connecting horizontally curved members meeting the longitudinal Charpy V-Notch Tests specified in the supplementary requirements in AASHTO M 270 for Zone 1. Unless otherwise noted in the plans, mark and test the materials as non-fracture critical. Sample and test in accordance with AASHTO T 243 and use the (H) frequency of heat testing. Use the grade or grades of structural steel required in the plans. Obtain and submit certified Mill Test Reports to the Materials and Tests Unit to show the results of each test required by the *Standard Specifications*.

1072-8 WORKING DRAWINGS

Working drawings shall include Contract number, project number, structure number and station number. Submit checked structural steel shop drawings and changes thereto, including shipping diagrams for review, comments, acceptance and distribution as follows:

(A) Submit an electronic set for review, comments and acceptance on all steel structures. After review, comments and acceptance, submit 3 hard copy sets for distribution and an electronic set.

(B) Submit an electronic set for review, comments and acceptance for all bridges carrying railroad traffic, and after acceptance, submit 3 hard copy sets for distribution and an electronic set.

(C) Furnish any additional sets requested by the Engineer or for his use, review, comments, acceptance and/or distribution.

Shop drawings are not checked by the Engineer except to ascertain general compliance with the design and the *Standard Specifications*. Thoroughly check all shop drawings in all respects. Review, comments and acceptance of shop drawings by the Engineer is not considered as relieving the Contractor of his responsibility for the accuracy of his drawings, or for the fit of all shop and field connections and anchors.

Provide prints for shop drawings that are 22 inches x 36 inches, including borders which are at least 1 inch at the left edge of the sheet. Provide shop drawings on any medium provided they are legible and are reproducible. Upon completion of the project, furnish to the Engineer one complete set of reproducible shop drawings that represent the as-built condition of the structural steel including all approved changes if any. Supply drawings that are 22 inches x 36 inches. These drawings will become the property of the Department.

Changes on shop drawings after acceptance or distribution are subject to the approval of the Engineer. Furnish a record of such changes.

Make substitution of sections different from those on the structure plans only when approved in writing by the Engineer.

1072-9 HANDLING AND STORING MATERIALS

Load, transport, unload and store structural material so the metal is kept clean and free from damage. Repair any coating damage per Section 442. Do not use chains, cables or hooks without softeners that could result in damage or scarring of the material. Repair all materials which are scarred or damaged and inspect at the fabricators expense as deemed necessary by the Engineer.

Use lifting equipment and rigging equipment with adequate capacity to handle the material at all times. Do not bend, twist, damage or excessively stress any materials. Do not perform hammering which injures or distorts the members. In the event that damage or overstressing does occur, prepare and submit an inspection and testing verification plan to the Engineer for approval. Operate and maintain all lifting equipment in a safe manner and in accordance with the manufacturer's directions.

When lifting main structural steel members, use spreader bars. Do not use one point pick-ups on members over 50 feet in length. Use two point pick-ups so the amount of overhang and the distance between hooks does not exceed the distances as noted in Table 1072-5.

TABLE 1072-5
SPREADER BAR PICKUP REQUIREMENTS

Property	Beam Size			
	30" or Less	33" WF	36" WF	Plate Girders
Maximum Distance Between Hooks	74 lf	80 lf	85 lf	100 lf
Maximum Overhang	25 lf	28 lf	30 lf	35 lf

Store structural material, either plain or fabricated, above the ground upon platforms, skids or other supports. Keep free from blast media, dirt, grease, vegetation and other foreign matter, and protect from corrosion.

Keep material clean and properly drained. Transport and store girders and beams with the web in the vertical plane and the top flange up. Request permission in writing and await approval to invert haunched girders and beams for transport for safety reasons. Use extreme care in turn-over operations to prevent excessive bending stresses in the edge of flanges. Support long members on blocking placed near enough together to prevent damage from deflection.

Do not use any beam, girder, diaphragm, cross frame or other material, in any stage of fabrication that will be permanently incorporated into the finished structure as a workbench, lifting device or dunnage for any purpose for which it was not specifically intended.

1072-10 STRAIGHTNESS, CAMBER AND DIMENSIONAL TOLERANCES

(A) General

Ensure that rolled material, before being laid out or fabricated, is straight. If straightening is necessary, use methods that do not damage the metal. Kinks or sharp bends are cause for rejection of the material.

Ensure that heat straightened parts are substantially free from external forces, except those resulting from mechanical means used in conjunction with the application of heat.

Heat curving and heat cambering shall be completely free from any external forces. Any heating operation to address straightening, cambering, or curving shall be monitored by the Fabricator's QC department. Personnel performing heating operations shall have adequate training (documented), shall possess proper temperature indicating devices and shall have received instructions for appropriate use.

After heating, allow the metal to cool, without artificial cooling, down to 600°F. Below 600°F, only dry compressed air is permitted to artificially cool steels having minimum yield strength greater than 36,000 psi as indicated by a Type 1 (Certified Mill Test Report) material certification in accordance with Article 106-3.

(B) Straightening

Straighten distorted members and bent material by mechanical means or, if approved the Engineer, by the carefully planned and supervised application of a limited amount of localized heat. Do not allow the temperature of the heated area to exceed 1,150°F as controlled by temperature indicating crayons or other approved methods.

Following the straightening of a bend or buckle, verify the surface is free of evidence of fracture as indicated by visual inspection or, if directed by the Engineer, by appropriate nondestructive testing.

Shop straighten the bottom flanges of steel beams or girders at bearings as necessary to provide uniform contact between the flanges and the bearings. If bearings are to be field installed, the Fabricator shall demonstrate appropriate bearing contact surfaces as defined by the AWS Bridge Welding Code prior to shipping.

(C) Camber

Show the required camber on the drawings.

Make adequate provision in the fabrication of structural members to compensate for change of camber due to welding of the shear connectors and other fabrication work.

Fabricate camber into the members on built-up plate girders and trusses. Where camber is required on rolled sections, induce it by heat cambering, except that for rolled sections within the depth, length and camber ordinate range shown in Table 1072-6, induce camber by cold cambering or "gagging" at the mill or in the shop provided approval procedures for cold cambering are employed.

Where reverse curvature is required in a single rolled shape, induce it by heat cambering.

Show camber diagrams showing the required offset at each tenth point of the span and at any web splice or field splice location and blocking diagrams on the shop drawings. Show additional points if desired by the fabricator. Ensure that the beams, girders or other members with field splices meet all of the blocking ordinates without inducing stress into the members.

Following cambering or camber correction, correct evidence of fracture indicated by visual inspection or, if directed by the Engineer, by appropriate nondestructive testing.

Show camber and blocking diagrams on the shop drawings. Shop assemble continuous beams meeting all the blocking ordinates without inducing stress into the members.

TABLE 1072-6 ACCEPTABLE COLD CAMBER FOR ROLLED SECTIONS		
Beam Length, feet	**Section Designation and Nominal Depth**	
	W-Shapes 14" to 21" Inclusive S-Shapes 12" and Over	**W-Shapes 24" and Over**
Over 30 through 42	3/4" to 2 1/2" inclusive	1" to 2" inclusive
Over 42 through 52	1" to 3" inclusive	1" to 3" inclusive
Over 52 through 65	2" to 4" inclusive	2" to 4" inclusive
Over 65 through 85	2 1/2" to 5" inclusive	3" to 5" inclusive
Over 85 through 100	As directed by the Engineer	3" to 6" inclusive

(D) Heat Cambering of Rolled Beams and Welded Plate Girders

(1) General

Where heat cambering is used, only V-type heating is permitted. Perform V-type heating by the carefully planned and supervised application of a limited amount of localized heat.

When minor corrections in camber are required, use small, localized heats limited to the flange material. Perform major corrections in camber by V-type heating to prevent web distortion.

Begin heating at the apex of the heating pattern and progress slowly towards the base of the pattern as each area is brought up to temperature as stated in Subarticle 1072-10(D)(5). Do not progress the heating torches toward the base of the heating pattern until the apex of the pattern is brought up to the specified temperature. Do not return the heating torch toward the apex of the heating triangle after heating has progressed towards the base. Continue heating to successive areas until the base of the triangular heating pattern is brought up to the required temperature across the full width of the flange.

(2) Heat Cambering of Rolled Beams

Heat cambering of rolled beams is allowed to provide the required vertical curvature. Space triangular heating patterns throughout the length of the member to provide the required curvature. Locate the apex of the heating triangle at a point not less than 75% of the depth of the member measured from the flange that is concave after cambering. Limit the total included angle of the heating pattern to 20°.

Weld all detail material such as connection plates, bearing stiffeners and gusset plates attached to the member to the rolled beam after the beam is cambered as required.

(3) Heat Cambering of Welded Plate Girders

Heat cambering of welded plate girders is only permitted when approved in writing by the Engineer as a necessary repair procedure for plate girders rejected for camber deviation.

When it is necessary to correct camber deviation in welded plate girders, heating is permitted in V-type heating patterns centered on intermediate stiffeners and connection plates. Where necessary, add stiffeners for this purpose if approved by the Engineer. Locate the apex of the heating pattern not less than 3/4 of the depth of the member from the flange that is shortened after cooling. The maximum included angle of the heating pattern is 10°. The maximum width of the base of the heating pattern is 10 inches. Where shallow members or thin webs prescribe heating patterns with a width substantially less than 10 inches at the junction of the web to flange, extend the heating pattern in the flange at that location beyond the limits of the heating pattern in

the web by no more than 1 inch provided the total width of pattern in the flange does not exceed the 10 inch limit stated above.

(4) Support of Members for Heat Cambering

Heat camber members with the web vertical and supports spaced to take the maximum advantage of dead load in the member before applying heat. Ensure all supports are approved by the Department's Inspector before beginning work.

Do not place any combination of support system or external load on the member that causes a compressive stress in the flange to exceed 20,000 psi before heating for AASHTO M 270 Grades 36, 50 and 50W steels.

(5) Heating Process and Equipment

Confine heating to the patterns described herein and conduct to bring the steel within the planned pattern to a temperature between 1,100°F and 1,150°F as rapidly as possible without overheating the steel.

Any heating procedure which causes a portion of the steel to exceed a temperature greater than 1,150°F is destructive heating and is automatically cause for rejection of the steel. Steel rejected for destructive heating is investigated for reacceptance, repair or replacement if allowed by the Engineer. Bear the cost of such tests and any necessary repair or replacement.

(6) Heat Measurement

Specified temperatures are checked using portable digital pyrometers or temperature indicating crayon. When using a temperature indicating crayon, the following procedure shall be employed; mark on the surface of metal or sheet with the required crayon. Once the surface reaches the rated temperature of the crayon, the mark will melt and show liquid smear appearance. At this point, the heating operation shall cease to prevent overheating. Exceeding the specified temperature is strictly prohibited.

(E) Heat Curving Girders

(1) Type of Heating

With approval, use continuous or V-type heating methods to curve girders. For the continuous method, simultaneously heat a strip along the edge of the top and bottom flanges that is of sufficient width and temperature to obtain the required curvature. For V-type heating, heat the top and bottom flanges simultaneously in truncated triangular or wedge-shaped areas. Position the areas with their base along the flange edge and spaced at regular intervals along each flange. Set the spacing and temperatures to approximate the required curvature by a series of short chords. Heat along the top and bottom flanges at approximately the same rate.

For V-type heating, terminate the apex of the truncated triangular area applied to the inside flange surface just before the juncture of the web and flange. To avoid web distortion, make certain that heat is not applied directly to the web when heating the inside flange surfaces (the surfaces that intersect the web). Extend the apex of the truncated triangular heating pattern applied to the outside flange surface to the juncture of the flange and web. Use an included angle of approximately 15° to 30° in the truncated triangular pattern, but do not allow the base of the triangle to exceed 10 inches. Vary the patterns prescribed above only with the Engineer's approval.

For both types of heating, heat the flange edges that will be on the inside of the horizontal curve after cooling. Concurrently heat both inside and outside flange surfaces for flange thicknesses of 1.25 inches and greater. Adhere to the temperature requirements presented below.

(2) Temperature

Conduct the heat curving operation so the temperature of the steel never exceeds 1,150°F as measured by temperature indicating crayons or other suitable means. Do not artificially cool the girder until it naturally cools to 600°F. Below 600°F, use dry compressed air to artificially cool the girder.

(3) Position for Heating

Heat-curving the girder with the web in either a vertical or horizontal position is permitted. When curved in the vertical position, brace or support the girder so the tendency of the girder to deflect laterally during the heat-curving process does not cause the girder to overturn.

When curved in the horizontal position, support the girder near its ends and at intermediate points, if required, to obtain a uniform curvature. Do not allow the bending stress in the flanges to exceed 27,000 psi. To prevent a sudden sag due to plastic flange buckling when the girder is positioned horizontally for heating, place intermediate safety catch blocks at the midlength of the girder within 2 inches of the flanges at all times during the heating process.

(4) Sequence of Operations

Conduct the heat-curving operation either before or after completing all the required welding of transverse intermediate stiffeners to the web. However, unless provisions are made for shrinkage, position and attach connection plates and bearing stiffeners after heat-curving. In any event, weld the stiffeners, connection plates, and bearing stiffeners to the girder flanges after the member is curved. If longitudinal stiffeners are required, heat-curve or oxygen-cut these stiffeners separately before welding to the curved girder.

(5) Camber and Curvature

Camber the girders before heat-curving. Cut the web to the prescribed camber allowing for shrinkage due to cutting welding and heat-curving. If approved, a carefully supervised application of heat is permitted to correct moderate deviations from the specified camber.

Horizontal curvature and vertical camber is measured for final acceptance after all welding and heating operations are complete and the flanges have cooled to a uniform temperature. Horizontal curvature is checked with the web in the vertical position by measuring offsets from a string line or wire attached to both flanges or by using other suitable means. Camber is checked with the web in the horizontal position. Camber the girder so it meets the horizontal and vertical curvature ordinates without inducing stress into the girders by mechanical force.

Compensate for loss of camber in the heat-curved girders as residual stresses dissipate during service life of the structure. Compute this anticipated loss of camber in accordance with the *AASHTO LRFD Bridge Design Specifications*.

(6) Procedure Specification and Shop Drawings

Submit structural steel shop drawings, including a detailed written procedure specification for heat curving the girders, supplemented by calculations and sketches, for review, comments and acceptance. On the shop drawings, indicate the type, location and spacing of heat sectors, if used, supports and catch blocking for each field section of girders. Include suitable blocking diagrams for measuring horizontal curvature similar to those usually prepared for camber and vertical curvature.

(F) Camber Measurement

At the time of acceptance at the shop and after erection, ensure that all stringers and girders for bridges meet the required camber values within the tolerances specified in Subarticle 1072-10(G). Follow the procedure for measuring camber as outlined below:

(1) Assemble the member at the shop as specified in Article 1072-19 and measure with the member lying on its side.

(2) Camber repairs are only allowed when approved by the Engineer. Camber deviation is judged irreparable if corrective measures in the shop produce web buckling in excess of the specified tolerance, in which case the member is rejected.

(3) The final camber measurement is made by the Engineer in the field after erection. At the time of this measurement, ensure that the members have all of the specified camber less the dead load deflection of the steel as specified in Subarticle 1072-10(G).

(G) Dimensional Tolerances

Ensure that dimensions of all material covered by Section 1072 conform to ASTM A6 when received at the fabrication shop. Fabricate member dimensions conforming to this subarticle whether designated to be straight, cambered or curved and regardless of whether curvature is heat-induced (when so permitted). Dimensional tolerances not listed in this subarticle shall be as specified by the Bridge Welding Code as defined in Article 1072-18 and applied to rolled shapes where applicable as well as to welded members.

Place welded butt joints no further than 1/2 inch from the point detailed. Intermediate stiffeners varying ± 1/2 inch from the point detailed are allowed. Connector plates for field connections varying ± 1/8 inch from the point detailed are allowed. Ensure that the actual centerline of bearing lies within the thickness of the bearing stiffener.

Members with end milled for bearing and members with faced end connection angles deviating from the detailed length by -0, +1/32 inch are acceptable. All other members varying from detailed length by ± 1/8 inch are acceptable.

Align to within ± 1/8 inch from the location shown on the approved shop drawings all steel requiring shop assembly for reaming, drilling from the solid or weld joint preparation.

Deviation from specified camber of fabricated members as verified during shop assembly and before shipment from the fabrication shop is limited to:

-0;

$$\frac{+3/32\text{" x No. of ft from nearest bearing}}{10}, \quad \text{up to 3/4" maximum.}$$

Deviation from specified camber of erected steel bridge superstructures measured when the steel work is complete and the superstructure is subject to steel dead load stresses only is limited to:

-0;

$$\frac{+1/8\text{" x No. of ft from nearest bearing,}}{10} \quad \text{up to 1" maximum.}$$

If the plans do not require shop induced camber, provide an actual member that is straight or one of the following:

(1) If natural camber "turned up" is required, the maximum plus camber is the algebraic sum of the allowable deviation, dead load deflection, vertical curve ordinate and superelevation ordinate;

(2) If natural camber ‘turned down" is required, the maximum negative camber is equal to the algebraic sum of the dead load deflection, vertical curve ordinate and superelevation ordinate.

Do not exceed 1/8 inch per 10 foot length for the actual deviation from curvature shown in the plans.

1072-11 OXYGEN CUTTING

Oxygen cutting of structural steel is allowed, provided a smooth surface free from cracks and notches is secured and an accurate profile is secured by the use of a mechanical guide. Hand cut only where approved by the Engineer and grind smooth leaving no burnt edges.

In all oxygen cutting, adjust and manipulate the cutting agent to avoid cutting beyond (inside) the prescribed lines. Provide oxygen cut surfaces meeting the ANSI surface roughness rating value of 1,000 except ensure that oxygen cut surfaces of members not subject to calculated stress meet the surface roughness value of 2,000 (AWS C4.1-G Surface Roughness Gauge). Round corners of oxygen cut surfaces of members carrying calculated stress to a 1/16 inch radius, or an equivalent flat surface at a suitable angle, by grinding after oxygen cutting.

Fillet re-entrant cuts to a radius of not less than 1 inch.

Remove surface roughness exceeding the above values and occasional notches and gouges not more than 3/16 inch deep on otherwise satisfactory oxygen cut surfaces by chipping or grinding. Such removal shall be faired to the material edge with a slope not steeper than one in ten and with machine and grinding marks parallel to the surfaces.

Repair occasional gouges of oxygen cut edges more than 3/16 inch deep, but not more than 7/16 inch deep, by welding with low hydrogen electrodes not exceeding 5/32 inch in diameter and with a minimum preheat of 250°F. Grind the completed weld smooth and flush with the adjacent surface. Radiographically test any gouge repaired by welding.

1072-12 EDGE PLANING

Plane sheared edges of plates more than 5/8 inch in thickness that carry calculated stress to a depth of 1/4 inch. Pre-drill re-entrant cuts before cutting. Round all edges of plates and shapes parallel to calculated stress and all free edges of plates and shapes intended for coating or galvanizing to 1/16 inch radius or provide an equivalent flat surface at a suitable angle. Flame cut edges found to have a Rockwell Hardness Value of C 30 or greater will be considered unacceptable. A portable Rockwell Hardness Tester shall be employed by the Quality Control Inspector to determine conformance with these requirements. Unacceptably hard surfaces shall be removed by grinding or machining, or by a heat treating procedure approved by the Engineer. Grind edges of all other plates and shapes to remove burrs, slag or shear lip. The ends of all steel piles, intended for coating or galvanizing, are not required to be radiused, but remove all burrs, slag and shear lip.

1072-13 FACING OR BEARING SURFACES

Provide a surface finish of bearing and base plates and other bearing surfaces that come in contact with each other or with concrete that meet Table 1072-7 following ANSI surface roughness requirements as defined in ASME B46.1.

TABLE 1072-7 SURFACE ROUGHNESS REQUIREMENTS	
Item	**ANSI Surface Roughness**
Steel slabs	ASME 2,000
Heavy plates in contact in shoes to be welded	ASME 1,000
Milled ends of compression members, milled or ground ends of stiffeners and fillers	ASME 500
Bridge rollers and rockers	ASME 250
Pins and pin holes	ASME 125
Sliding bearings	ASME 125

1072-14 ABUTTING JOINTS

Face and bring to an even bearing abutting joints in compression members, girder flanges and tension members where so indicated on the drawings. Where joints are not faced, do not exceed an opening of 1/4 inch.

1072-15 BENT PLATES

Provide cold-bent, load carrying rolled-steel plates conforming to the following:

(A) Take from the stock plates so the bendline is at right angles to the direction of rolling.

(B) Use a radius of bends such that no cracking of the plate occurs. Use minimum bend radii, measured to the concave face of the metal, as shown in Table 1072-8.

If a shorter radius is essential, bend the plates hot at a temperature not greater than 1,200°F and air cool slowly down to a temperature of 600°F. Below 600°F, use only dry compressed air to artificially cool steels having a minimum yield strength greater than 36,000 psi. Use hot bent plates conforming to Subarticle 1072-15(A) above.

(C) Before bending, round the corners of the plates to a radius of 1/16 inch throughout the portion of the plate at which bending occurs.

TABLE 1072-8 MINIMUM BEND RADII	
Plate Thickness (t)	**Minimum Bend Radii, Ratio of Thickness**
Up to 1/2"	2**t**
Over 1/2" to 1"	2 1/2**t**
Over 1" to 1 1/2"	3**t**
Over 1 1/2" to 2 1/2"	3 1/2**t**
Over 2 1/2" to 4"	4**t**

Hot bend low alloy steel in thicknesses over 1/2 inch for small radii, if required.

1072-16 HOLES FOR BOLTS AND OTHER FASTENERS

(A) General

Punch or drill all holes and remove any burrs. Punching material forming parts of a member composed of not more than 5 thickness of metal 1/16 inch larger than the nominal diameter of the fastener is allowed whenever the thickness of the material is not greater than 3/4 inch for structural steel, 5/8 inch for high-strength steel or 1/2 inch for quenched and tempered alloy steel, unless subpunching and reaming is required by Subarticle 1072-16(D).

When there are more than five thicknesses or when any of the main material is thicker than 3/4 inch for structural steel, 5/8 inch for high-strength steel or 1/2 inch for quenched and tempered alloy steel, either subdrill and ream or drill all holes full size.

When required by Subarticle 1072-16(D), subpunch or subdrill all holes (subdrill if thickness limitation governs) 1/4 inch smaller and, after assembling, ream 1/16 inch larger or drill full size to 1/16 inch larger than the nominal diameter of the fastener.

(B) Punched Holes

Do not use a diameter of the die exceeding the diameter of the punch by more than 1/16 inch. If any holes require enlargement to admit the fasteners, ream such holes. Clean cut holes without torn or ragged edges. Poor matching of holes is cause for rejection. Grind all burrs smooth.

(C) Reamed or Drilled Holes

Make reamed or drilled holes cylindrical and perpendicular to the member complying with the size requirements of Subarticle 1072-16(A). Where practicable, direct reamers by mechanical means. Grind all burrs smooth. Poor matching of holes is cause for rejection. Ream and drill with twist drills. If required, take assembled parts apart for removal of burrs caused by drilling. Assemble connecting parts requiring reamed or drilled holes, securely hold while reaming or drilling and match mark before disassembling.

(D) Subpunching and Reaming of Field Connections

Subpunch or subdrill, if required according to Subarticle 1072-16(A), holes in all field connections and field splices of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, and rigid frames. Subsequently ream while assembled as required by Article 1072-19. Subpunch and ream to a steel template or ream while assembled all holes for floor beam and stringer field end connections. Ream or drill full size field connection holes through a steel template after the template is located with utmost care as to position and angle and firmly bolted in place. Use templates for reaming matching members, or the opposite faces of a single member that are exact duplicates. Accurately locate templates used for connections on like parts of members such that the parts or members are duplicates and require no match-marking.

(E) Accuracy of Punched and Subdrilled Holes

Accurately punch or subdrill all holes punched full size, subpunched or subdrilled such that after assembling, and before any reaming is done, a cylindrical pin 1/8 inch smaller in diameter than the nominal size of the hole enters perpendicular to the face of the member, without drifting, in at least 75% of the contiguous holes in the same plane. If the requirement is not fulfilled, the badly punched pieces are rejected. If any hole does not pass a pin 3/16 inch smaller in diameter than the nominal size of the hole, this is cause for rejection.

(F) Accuracy of Reamed and Drilled Holes

When holes are reamed or drilled, ensure that 85% of the holes in any contiguous group, after reaming or drilling, show no offset greater than 1/32 inch between adjacent thicknesses of metal.

Use all steel templates with hardened steel bushings in holes accurately dimensioned from the centerlines of the connection as inscribed on the template. Use the centerlines in locating accurately by the template from the milled or scribed ends of the members.

(G) Alternate Methods

As an option, make the fastener holes by procedures other than those described in Subarticles 1072-16(A) through 1072-16(F) provided that the requirements for quality and for dimensional accuracy are met. Plasma cutting of holes for high strength fasteners is prohibited. Wherever an alternate method is employed, demonstrate the ability of each alternate method to produce holes and connections consistently meeting all requirements for quality and dimensional accuracy for the type of joint fabricated. When such ability of an alternate method is previously demonstrated on similar work for the Department,

continue its use by certifying, on each subsequent project, that the procedure and equipment are the same as the method previously qualified, and that the equipment involved is in good repair and adjustment. Failure of joints to meet the quality and accuracy requirements is cause for rejection. In the case of repeated failures revise and/or requalify the method or discontinue its use.

At the time of qualification of an alternate method, submit for approval a written procedure specification describing the procedures and equipment and giving upper and lower value limits and tolerances for all pertinent variables. Accurately reflect the actual procedures, equipment and values used in the qualification tests. In addition to the certification on each subsequent project, the Engineer may request copies of the approved procedure specification.

(H) Oversize, Short-Slotted, and Long-Slotted Holes

Where shown in the plans or permitted in writing, use oversize, short-slotted and long-slotted holes with high strength bolts 5/8 inch and larger in diameter. Do not allow the distance between edges of adjacent holes or edges of holes and edges of members to be less than permitted under the AASHTO specification. Oversize, short-slotted and long-slotted holes are defined as follows:

(1) Oversize holes are 3/16 inch larger than bolts 7/8 inch and less in diameter, 1/4 inch larger than bolts 1 inch in diameter, and 5/16 inch larger than bolts 1 1/8 inches and greater in diameter. When oversized holes are permitted, they are allowed in any or all plies of friction type connections. Install hardened washers over exposed oversize holes.

(2) Short-slotted holes are 1/16 inch wider than the bolt diameter and have a length that does not exceed the oversize diameter requirements of Subarticle 1072-16(H)(1) by more than 1/16 inch. When short-slotted holes are permitted, they are allowed in any or all plies of friction-type or bearing-type connection. Locate holes without regard to direction of loading in friction-type connections, but orient normal to the direction of the load in bearing-type connections. Install hardened washers over exposed short-slotted holes.

(3) Long-slotted holes are 1/16 inch wider than the bolt diameter and have a length more than allowed in Sub-paragraph 2 but not more than 2 1/2 times the bolt diameter. Structural plate washers or a continuous bar not less than 5/16 inch in thickness are required to cover long slots that are the outer plies of joints. Ensure that these washers have a size sufficient to completely cover the slot after installation. When long-slotted holes are permitted, they are allowed in only one of the connected parts of either a friction-type or bearing-type connection at an individual faying surface.

When used in slip critical connections, locate holes without regard to direction of loading if one-third more bolts are provided than needed to satisfy the allowable unit stresses except as herein restricted.

When used in bearing-type connections, orient the long diameter of the slot normal to the direction of loading. No increase in the number of bolts over those necessary for the allowable unit stress is required.

(I) Misfits

When misfits occur for any reason, enlargement of the holes by reaming is limited to 1/16 inch over the nominal size hole called for unless otherwise permitted in writing.

(J) Erection Bolt Holes

At field welded connections where erection bolts are used, provide holes 3/16 inch larger than the nominal erection bolt diameter.

1072-17 INSTALLING BOLTS

Install high strength bolts in accordance with Article 440-8.

1072-18 WELDING

(A) Definition

The Bridge Welding Code referred to herein is the edition of the ANSI/AWS/AASHTO Bridge Welding Code D1.5 and any applicable interim that is current on the date of advertisement for the project, and as modified by the *Standard Specifications*.

(B) General

Commercially blast clean all steel used in girders, beams and connecting members to SSPC-SP 6 before welding. With the exception of rolled beams, the Contractor at their option may submit to the Department for review, an alternate cleaning method for main member material exposed to welding.

Weld all steel in the shop or in the field for bridges, whether permanent or temporary, and perform all other work related to welding including, but not limited to, testing and inspection of welds, preparation of material, oxygen cutting, electrodes, shielding and shear studs, meeting the Bridge Welding Code. Weld other steel items not covered under the Bridge Welding Code in accordance with the applicable AWS Welding Code. Some examples may include but not limited to; Structural Welding Code-Steel (AWS D1.1), Structural Welding Code-Aluminum (AWS D1.2), Structural Welding Code-Sheet Steel (AWS D1.3), Structural Welding Code-Steel Reinforcing Bars (AWS D1.4) and Structural Welding Code-Stainless Steel (AWS D1.6).

Weld only where shown in the plans or where called for in the *Standard Specifications* unless requesting and receiving written approval from the Department for additional welding.

Show all permanent and all temporary welds on the shop drawings. For groove welds, indicate on the shop drawings the particular detail and process to be employed in production of the work. For prequalified joints, use of the Bridge Welding Code letter classification designation of the joint (B-L2b-S etc.) along with the appropriate symbol satisfies this requirement. Tack welds that become part of a permanent weld are not required on the shop drawings.

Provide fillet welds, including seal welds, at least the minimum size allowed by the Bridge Welding Code for the thickness of material welded or the size called for in the plans, whichever is larger. For exposed, bare, unpainted applications of steel, the basic requirements for weld filler metal with atmospheric corrosion resistance and coloring characteristics similar to that of the base metal are mandatory. The variations from these basic requirements listed in the Bridge Welding Code for single pass welds are not permitted.

All welds designated as Fracture Critical (FC) and subject to tension shall be so designated on the shop drawings. Unless otherwise directed by the Engineer, any flange to web (FC) complete joint penetration (CJP) groove weld subjected to calculated tensile stress normal to the weld axis, shall be so designated on the design and shop drawings.

(C) Qualification of Personnel

Ensure that each welder, welding operator and tacker is qualified in accordance with the Bridge Welding Code or other applicable AWS Welding Code as determined by the Engineer. For field applications, employ welders that are qualified by the Department. Welders shall be requalified by the Department every 5 years. Contact the Materials and Tests Unit to schedule qualification tests.

Permanent in-shop welders employed by a fabricator who passed the appropriate welding tests and whose weldments are radiographically tested with regularly acceptable results are exempt from additional testing when approved by the Engineer. Welder qualification testing shall be administered and witnessed by a current AWS Certified Welding Inspector (CWI). Ensure all welder qualification testing is witnessed by an independent testing agency approved by the Department. As evidence of such qualification, furnish a satisfactory certificate, or a copy thereof, issued by a fabricator or Department approved testing agency as applicable. Submit certification for each welder, welding operator or tacker, and for each project, stating the name and identification number of the welder, welding operator or tacker; the name and title of the person who conducted the examination; the kind of specimens; the position of welds; the AWS electrode classification used; the results of the tests; the date of the examination and witness thereof. Such certifications are required for all persons performing shop or field welds of any kind on the work, whether permanent or temporary. Ensure each welder provides a picture ID upon request or other form of positive identification as required by the Engineer.

(D) Qualification of Welds and Procedures

For shop employed welded construction, submit to the Department all welding procedures, prequalified or qualified by test 30 days in advance before performing any welding. All welding shall comply with the applicable AWS designed code of construction.

For field weld applications, submit prequalified Welding Procedure Specifications (WPS) for each joint configuration for approval at least 30 days before performing any welding. In lieu of the aforementioned,, use the WPS provided and preapproved by the Department. Field welding operations are limited to using SMAW welding process. These preapproved WPS are available from the Materials and Tests Unit. Use non-prequalified welding procedures that have been submitted and approved by the Engineer. At no cost to the Department, demonstrate their adequacy in accordance with the applicable AWS Welding Code.

On all welding, include in the welding procedure continuous visual inspection by welders, welding operator, tackers, welding supervisors and all personnel involved in preparation of the material for welding.

Approval by the Engineer of the procedure specifications does not relieve the Contractor of his responsibility to develop a welding procedure that produces weldments meeting the required quality and dimensions.

If non-prequalified joints procedures are previously found acceptable to the Engineer on another project, furnish the inspector with a copy of the joint details and procedure specification approved at the time of qualification. Such documentation is required from each fabricator employing a non-prequalified joint or procedure on the work. Failure to produce such documentation results in the fabricator being required to requalify the joint or procedure or to use prequalified joints, procedures, and procedure specifications.

On weldments where geometric shape prevents compliance with requirements to weld a particular position, alternate procedures are considered for approval. Previously qualified alternate procedures are considered for approval without further procedure qualification tests. No separate payment is made for developing, demonstrating and documenting for future use such alternate procedures, as such work is incidental to the work of welding.

(E) Requirements for Testing and Inspection

Require the fabricator to make provisions for convenient access to the work for inspection and cooperate with the inspector during the required inspection and testing.

Visual welding inspection shall be performed by an inspector qualified in accordance with AWS QC-1. Inspect welds in the presence of the Department’s inspector unless otherwise approved by the Department’s inspector, using visual inspection and the nondestructive

tests herein prescribed in addition to the test requirements of the Bridge Welding Code and the contract. Employ quality control inspectors and NDT technicians qualified in accordance with the Bridge Welding Code and preapproved by the Engineer before the start of any fabrication. Supply the appropriate certifications as required by the Bridge Welding Code to the Department's inspector for all inspectors. Individuals assigned to production welding activities or processes and their supervisors are not acceptable for performing quality control testing. Ensure a qualified quality control welding inspector (CWI) is present any time welding is in progress. No separate payment is made for inspection and testing.

Retest welds requiring repairs or replacement in the presence of the Department's inspector after the repairs or replacements are made. Approval of the Engineer is required for any repair exceeding three attempts to correct.

If the Engineer finds that acceptable repair to defective work is not feasible; the entire piece is rejected.

Payment at the contract prices for the various items in the contract which include the work of welding is full compensation for all costs resulting from the required nondestructive testing of welds and from the required inspection of welds.

(F) Nondestructive Test Required

Personnel performing Nondestructive Testing (NDT) other than visual examination shall be certified in conformance with the American Society for Nondestructive Testing's (ASNT) recommended practice number (SNT-TC-1A). The Employer's program shall meet all established guidelines of SNT-TC-1A for the qualification of NDT personnel. In addition, all personnel performing NDT for final weld acceptance shall be subject to the Department's practical proficiency test.

The extent of nondestructive testing required for main members is as prescribed in the Bridge Welding Code and by the contract except that all flange splices shall be radiographed for their full length. The term "main members" in this regard means girders, diaphragms for curved girders, beams, floor beams, stringers, truss members, high strength bolts, columns, bearing stiffeners, bearing shoes, high mount light standards and components of main member carrying stress, including the end connections for such members. Nondestructive testing of other complete welds or weld passes is required when so noted in the plans or deemed necessary by the Engineer. For bridge applications involving tubular structures that may be subject to the AWS D1.1 welding code, the extent of NDT shall be as specified above for main members. Tests other than those prescribed are also required when deemed necessary by the Engineer. Perform all radiographic testing in accordance with procedures established by the Engineer. Copies of these procedures are available from the State Materials Engineer.

High mount light standards shall be examined in accordance with Section 1401-2. Other nondestructive test methods are sometimes deemed necessary by the Engineer to determine the quality of the welds. No separate payment is made for inspection and testing.

Any NDT not identified above shall be examined as directed by the Engineer.

The entire cost of this work is included in the unit contract price for the structural steel items involved.

(G) Welded Structural Shapes

Produce butt welds of flanges and webs, and fillet welds of web to flanges of plate girders and haunched beams using the submerged arc process. Produce other structural shapes built up from plates and bars using the submerged arc process unless another process is qualified for these joints in accordance with the Bridge Welding Code and is subject to the approval of the Engineer.

After all shop welded splices in the flanges and webs for the full length of the field section are made, tested and approved, fit the flange plates tight and square against the web to leave no gap and to not bow the web. Brace one side of each flange against the web with gussets or struts and tack weld securely to the web at the stiffener locations. Upon removal of the welds, grind any nicks or gouges, preheat, weld and test or incorporate into the stiffener fillet weld.

Connect the flanges to the web by starting the fillet weld at one end of the girder and proceeding to the other ends.

As an option, make adjacent welds simultaneously.

The sequence for making the flange to web fillet welds is subject only to the provisions for control of shrinkage and distortion and to the position requirements of the Bridge Welding Code.

After flange to web welds are complete, shift bracing gussets or struts if necessary, then remove all temporary gussets or struts. Remove tack welds by grinding flush with parent metal.

Straighten any transverse warpage of the flanges if necessary by heating along the centerline of the outside face.

Fit tight, square and tack weld stiffeners securely to the web. With the girder in the flat position (web horizontal), weld the stiffeners to the web. Do not weld or tack weld stiffeners to the flanges except where noted in the plans. Stiffeners are not to be used to correct tilt of flange due to distortion associated to welding.

After all parts are welded into place, trim the girder to detail length with adjustments for slope and end rotation exceeding 1/4 inch net.

1072-19 SHOP ASSEMBLING

(A) General

Assemble the field connections of main members of continuous beam spans, plate girders and rigid frames in the shop with milled ends of compression members in full bearing, and then ream their sub-size holes to specified size while the connections are assembled. Assembly shall be either Full Girder Assembly or Progressive Girder Assembly unless Full Girder Assembly or Special Complete Structure Assembly is required by the contract.

Furnish a camber diagram to the Engineer showing the camber at each panel point of each continuous beam line, plate girder or rigid frame. When the shop assembly is Full Girder Assembly or Special Complete Structure Assembly, ensure the camber diagram shows the camber measured in assembly. When any of the other methods of shop assembly is used, show the calculated camber in the camber design.

Clean surfaces of metal in contact before assembling. Assemble the parts of a member, pin well and firmly draw together with bolts before reaming. Take assembled pieces apart, if necessary, for removal of burrs and shavings produced by the reaming operation. Ensure that the member is free from twists, bends and other deformation.

Drift during assembling only to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes are enlarged to admit the fasteners, ream them.

Match-mark those connecting parts assembled in the shop for the purpose of reaming holes in field connections and provide a diagram showing marks furnished by the Engineer.

(B) Full Girder Assembly

Full Girder Assembly consists of assembling all members of each continuous beam line, plate girder or rigid frame at one time.

(C) Progressive Girder Assembly

Progressive Girder Assembly consists of assembling initially for each continuous beam line or plate girder at least two contiguous shop sections or all members in at least two contiguous shop panels but not less than the number of panels associated with three contiguous section lengths (i.e., length between field splices) and not less than 150 feet in the case of structures longer than 150 feet. Add at least one shop section at the advancing end of the assembly before removing any member from the rearward end, so the assembled portion of the structure is never less than the specified above.

(D) Special Complete Structure Assembly

Special Complete Structure Assembly consists of assembling the entire structure, including the floor system.

Ensure each assembly, including camber, alignment, accuracy of holes and fit of milled joints, is approved by the Engineer before reaming.

1072-20 PAINTING AND OTHER PROTECTIVE COATINGS

Shop paint in accordance with Section 442.

Repair galvanized surfaces that are abraded or damaged in accordance with Article 1076-7.

1072-21 MARKING AND SHIPPING

Paint or mark each member with an erection mark for identification and furnish an erection diagram with erection marks shown thereon. Notification of shipping shall be provided to the Department in writing as soon as practical but in no case less than 24 hours for in-state producers and 72 hours for out of state producers. Hours are as defined in Subarticle 1072-7(A).

Prior to loading, the Fabricator's quality control (QC) shall make certain (QC stamped approved) that all material meets the contract and has been presented to the Department for final inspection.

Furnish to the Engineer as many copies of material orders, shipping statements and erection diagrams as the Engineer directs. Show the weights of the individual members on the statement. Mark the weights on members weighing more than 3 tons. Load structural members on trucks or cars in such a manner that they are transported, unloaded and stored at their destination without being excessively stressed, deformed or otherwise damaged.

Load and ship steel beams and girders in accordance with the Figures 1072-2 and 1072-3 and Table 1072-9 for all types of transportation. When the contractor wishes to place members on trucks not in accordance with these limits, to ship by rail, to attach shipping restraints to the members, to ship horizontally curved steel members, or to invert members, he shall submit a shipping plan before shipping. Refer to Article 1072-9.

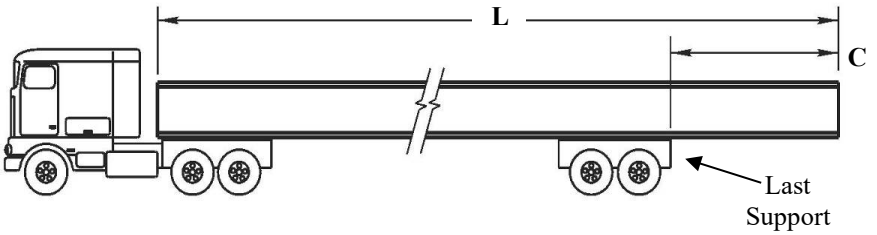


Figure 1072-2. Truck loading diagram for when the length past the last support, **C**, is 15 ft or less.

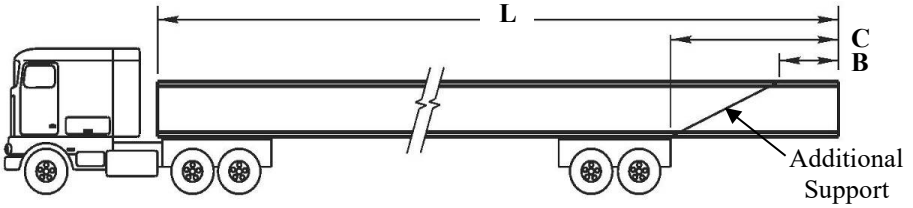


Figure 1072-3. Truck loading diagram for when the length past the last support, **C**, is between 15 feet and 30 feet.

For truck loading with the length of the last support between 15 feet and 30 feet in Figure 1072-3, use the following formulas to calculate truck loading limits or use the values given in Table 1072-9:

$$\mathbf{B} = 0.4C$$

$$\mathbf{C} = 0.2L \text{ to } 0.3L\text{, up to 30 ft}$$

Where **B** is the length of the member past a required additional restraint, **C** is the length of the member extending past the last support and **L** is the length of the member.

TABLE 1072-9 LIMITS FOR PLACEMENT OF STEEL BEAMS AND GIRDERS DURING SHIPMENT			
Length of Member, feet	**Minimum Length Past Last Support, feet**	**Maximum Length Past Last Support, feet**	**Maximum Length Past Additional Restraint, feet**
(L)	*(C)*	*(C)*	*(B)*
75	15	22.5	9
80	16	24	9.6
85	17	25.5	10.2
90	18	27	10.8
95	19	28.5	11.4
100	20	30	12
105	21	30	12
110	22	30	12
115	23	30	12
120	24	30	12
125	25	30	12
130	26	30	12
135	27	30	12

Restrain overhanging ends of beams or girders both vertically and horizontally to prevent excess movement. Chains are permitted to secure beams and girders during shipping only when adequate measures are taken to prevent damage to the material by the use of approved protective material. If necessary, use adequate bracing to prevent bending of the top flange.

Pack bolts of one length and diameter and loose nuts or washers of each size separately. Ship pins, small parts and packages of bolts, washers and nuts in boxes, crates, kegs or barrels, but do not allow the gross weight of any package to exceed 300 lbs. Plainly mark a list and description of the contained material on the outside of each shipping container.

Steel die stamped fabricator's identity, station number, girder number and span number of main members into an unpainted area (if available) near the end of the member. Die stamp members with painted ends outside the painted area but as close to the end as possible.

Ship anchor bolts, washers and other anchorage or grillage materials, in time to be incorporated into the masonry portion of the structure.

SECTION 1074
MISCELLANEOUS METALS AND HARDWARE

1074-1 WELDING

Any facility performing welding operations shall be approved by NCDOT Materials and Tests Unit. Weld other steel items not covered under the Bridge Welding Code in accordance with the applicable AWS Welding Code. Some examples may include but not limited to; Structural Welding Code-Steel (AWS D1.1), Structural Welding Code-Aluminum (AWS D1.2), Structural Welding Code-Sheet Steel (AWS D1.3), Structural Welding Code- Steel Reinforcing Bars (AWS D1.4) and Structural Welding Code-Stainless Steel (AWS D1.6). Certify all welders performing any welding on any metals in accordance with the applicable AWS welding code in the position and process required as approved by the Engineer.

1074-2 EXPANSION ANCHORS

Unless otherwise shown in the plans, provide expansion anchors consisting of two or more units with a minimum of two hard metal conical ring wedges and two expandable lead sleeves of an equally effective design that is approved by the Engineer. Use anchors providing a minimum safe holding power of 3,000 lbs. for 3/4 inch bolts and 2,000 lbs. for 5/8 inch bolts, based upon

1/4 of the actual holding power of the anchor in 3,000 psi concrete. Furnish satisfactory evidence, based upon actual tests performed by a commercial testing laboratory, which indicate that the anchors develop the minimum required safe holding power.

When it is proposed to use anchors that are previously accepted as meeting the above requirements, the anchors are accepted on the basis of a certified statement indicating the prior acceptance of the furnished anchors.

1074-3 PLAIN STEEL BARS WITH THREADED ENDS

Provide plain steel bars with threaded ends meeting ASTM A307, Grade A.

1074-4 HARDWARE FOR TIMBER STRUCTURES

Use machine bolts, drift-bolts and dowels that are either wrought iron or medium steel. Use washers that are cast iron ogee, malleable iron castings or cut from medium steel or wrought iron plate.

Use machine bolts with square heads and nuts. Use nails that are cut or round wire of standard form. Use spikes that are cut, wire spikes or boat spikes.

Use black or galvanized nails, spikes, bolts, dowels, washers and lag screws for untreated timber.

Galvanize or cadmium plate all hardware for treated timber bridges, except malleable iron connectors.

1074-5 METAL BRIDGE RAILING

(A) General

As an option, use either aluminum or galvanized steel metal rail, provided that the same material is used on all structures on the project.

Certified Mill Test Reports are required for rails and posts.

Place a permanent identifying mark that identifies the fabricator on each post. Use a method and location of the identifying mark such that it does not detract from the appearance of the post.

Where it is necessary for rails to be curved, form the curvature in the shop or in the field. Uniformly curve the rail without buckling or kinking. Perform all welding in accordance with AWS D1.1 for steel railing and AWS D1.2 for aluminum railing.

Provide an anchor unit of sufficient strength to ensure load anchoring capacity as specified for rail loading in the *AASHTO LRFD Bridge Design Specifications*.

(B) Aluminum Rail

Supply material for posts, post bases, rails, expansion bars and clamp bars meeting ASTM B221 for Alloy 6061 T6, materials will be mill finished.

Use material for rivets meeting ASTM B316 for Alloy 6061 T6. Use rivets that are standard button head and cone point cold driven.

Use material for nuts meeting ASTM B211 for Alloy 6061 T6.

Provide material for washers meeting ASTM B209 for Alloy Alclad 2024 T3.

Supply material for shims meeting ASTM B209 for Alloy 6061 T6.

Ensure that the handrails meet the dimensional tolerance requirements of ANSI H35.2.

(C) Galvanized Steel Rail

Use posts, post bases, rails, expansion bars and clamp bars meeting ASTM A36 and galvanize in accordance with ASTM A123. Grind the cut ends of rail smooth and give

them 2 coats of organic zinc repair paint. Galvanize the posts and post bases after they are riveted together.

Use rivets meeting ASTM A502 for Grade 1 rivets.

Use bolts meeting ASTM F593 Alloy 304.

Use nuts meeting ASTM F594 Alloy 304.

Use washers meeting ASTM F844 except made from Alloy 304 stainless steel.

Use materials for shims meeting ASTM A1011 for Grades 36, 40 or 45, or ASTM A1008 for Grade C, and galvanized in accordance with ASTM A123.

1074-6 STEEL PIPE

Steel pipe bent or welded in fabricating shall meet ASTM A53 for standard weight pipe. Use galvanized pipe unless otherwise shown in the plans.

1074-7 IRON CASTINGS

(A) General

Comply with the Department's Iron Casting QA/QC program. Producers and suppliers furnishing iron castings for Department projects shall comply with this program. The program details are available on the Materials and Tests website.

Boldly fillet castings at angles, and provide arises that are sharp and precise. No sharp, unfilleted angles or corners are permitted. Provide castings that are true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects affecting their strength and value for the service intended. Sand blast or otherwise effectively clean of scale and sand all castings to present a smooth, clean, and uniform surface. Welding is not allowed for the purpose of making a casting structurally sound. Welding for cosmetic or other purposes is not allowed without approval of the Engineer.

(B) Gray Iron Castings

Supply gray iron castings meeting all facets of AASHTO M 306 excluding proof load. Proof load testing will only be required for new casting designs during the design process, and conformance to AASHTO M 306 loading (40,000 lbs.) will be required only when noted on the design documents. Acceptance of production castings will be based on test bars. Cast test bars, of size "B", attached to an integral with the castings. Instead of this, cast test bars separate from the castings when approved in writing by the Engineer. The Engineer reserves the right to require that a test bar be machined from an actual casting if deemed necessary. Unless otherwise specified, do not coat gray iron castings. Do not perform any welding on castings for any reason without prior approval from the Engineer. Mark castings with the NCDOT Standard Number of the casting design, the fabricator's ID and the day, month and year of production.

1074-8 STEPS

Fabricate steps for minor drainage structures from deformed reinforcing bars, use gray iron castings meeting Subarticle 1074-7(B) or use composite plastic-steel construction as shown in the plans.

The use of steps differing in dimension, configuration or materials from those shown in the plans is allowed by furnishing the Engineer with details of the proposed steps and obtaining written approval for the use of such steps.

1074-9 FABRICATED STEEL GRATES

Use fabricated steel grates made from bars that meet ASTM A36. Galvanize the grates after fabrication in accordance with AASHTO M 111. Mark items with fabricators ID, month and year of production.

1074-10 PINS

Supply pins for bearing assemblies meeting either ASTM A36 or ASTM A108 for Grades 1016 through 1030, unless otherwise required by the plans or specifications.

1074-11 WASHERS

Provide washers for use with fasteners meeting ASTM F436. Provide washers for high strength bolts meeting Article 1072-5.

Ensure that the size and finish (plain, weathering or galvanized) of washers is compatible with the fastener.

1074-12 METAL STAY-IN-PLACE FORMS

Provide metal stay-in-place forms for concrete floor slabs of zinc-coated (galvanized) steel sheet conforming to ASTM A653, Structural Steel (SS) Grades 33 through 80 and Coating Class G165 meeting all requirements relevant to steel stay-in-place forms as noted on the contract plans. Do not use material thinner than 20 gauge.

1074-13 STEEL GRID FLOORING

Steel grid flooring shall conform to the requirements of *AASHTO LRFD Bridge Construction Specifications*, Section 12 and these *Standard Specifications*.

SECTION 1076
GALVANIZING

1076-1 GALVANIZING

Wherever galvanizing is required, perform the galvanizing in accordance with this section except where other requirements for galvanizing are included in other sections of these *Standard Specifications*.

Allow the Engineer to obtain samples of molten zinc directly from the galvanizing vat upon request.

1076-2 INSPECTION NOTIFICATION

Coordinate galvanizing inspection with the Materials and Tests Unit in accordance with Subarticle 1072-7(A). Before inspection, the galvanizer/supplier shall provide the Department's inspector with NCDOT approved drawing/purchase order, stating contract number, location of project, quantity/type of material being galvanized and Mill Test Report(s) for respective material.

1076-3 FABRICATED PRODUCTS

Galvanize products fabricated from rolled, pressed and forged steel shapes, plates, bars and strips 1/8 inch thick and heavier in accordance with AASHTO M 111. Fabricate products into the largest unit that is practicable to galvanize before the galvanizing is done. Fabrication includes all operations necessary to complete the unit such as shearing, cutting, punching, forming, drilling, milling, bending, welding and riveting. Galvanize components of bolted or riveted assemblies separately before assembly. When it is necessary to straighten any sections after galvanizing, perform such work without damage to the zinc coating.

Completely seal all edges of tightly contacting surfaces by welding and commercial blast clean to SSPC-SP 6 before galvanizing.

Commercial blast clean components with partial surface finishes in accordance with Subarticle 442-7(A) before pickling.

1076-4 HARDWARE

Galvanize iron and steel hardware in accordance with AASHTO M 232.

1076-5 ASSEMBLED PRODUCTS

Completely seal all edges of tightly contacting surfaces by welding before galvanizing. Galvanize assembled steel products in accordance with AASHTO M 111.

1076-6 SHEETS

Galvanize iron or steel sheets in accordance with ASTM A653.

1076-7 REPAIR OF GALVANIZING

Repair galvanized surfaces that are abraded or damaged at any time after the application of zinc coating. Surfaces to be repaired shall be clean, dry and free of oil, grease, pre-existing paint, corrosion and rust. Surface to be repaired shall be blast-cleaned to SSPC-SP 10 (Near-White Metal).

Where circumstances do not allow blast or power tool cleaning to be used, then hand tools may be used. Cleaning shall meet SSPC-SP 2, the removal of loose rust, mil scale or paint to the degree specified, by hand chipping, scrapping, sanding and wire-brushing. Surface preparation shall extend into the undamaged galvanized coating. Spray using a non-aerosol spray, or brush-apply the paint to the cleaned areas with 2 coats of organic zinc repair paint meeting Article 1080-7. Ensure that the total thickness of the 2 coats is not less than 3 dry mils. Allow adequate curing time before subjecting repaired items to service conditions in accordance with the manufacturer's printed instructions.

Application conditions shall be 40°F Air/Steel temperature and rising, steel temperature shall be 5°F above the dew point and relative humidity shall be 85% or less. Follow paint manufacturers recommendation if more restrictive than above requirements.

Follow paint manufacturers written instructions on storage temperatures, mixing application, continuous agitation and pot life. No thinners are to be used when applying organic zinc repair paint by brush or roller.

Instead of repairing by painting with organic zinc repair paint, other methods of repairing galvanized surfaces that are abraded or damaged are allowed provided the proposed method is acceptable to the Engineer.

Excessive damage to galvanized surfaces as determined by the Engineer is cause for rejection. Replace or re-galvanize rejected galvanized material.

SECTION 1077
PRECAST CONCRETE UNITS

1077-1 GENERAL

Use precast concrete units that is NCDOT approved as found on the Department's approved producer/supplier list. The Department will remove a manufacturer of precast concrete units from this producer/supplier list if the monitoring efforts indicated that non-specification material is being provided or test procedures are not being followed.

This section covers the materials for and the production of precast reinforced concrete units produced in accordance with the contract. Where precast reinforced concrete circular manhole sections are used, they shall meet AASHTO M 199.

(A) Producer Qualification

Producers of precast concrete members are required to establish proof of their competency and responsibility in accordance with the National Precast Concrete Association (NPCA) or American Concrete Pipe Association (ACPA) Certification Programs to perform work for the NCDOT. Certification of the manufacturing plant under either NPCA or ACPA program and submission of proof of certification to the State Materials Engineer is required before beginning fabrication. Maintain certification at all times while work is being performed for the Department. Submit proof of certification following each NCPA or

ACPA audit to the State Materials Engineer for continued qualification. These same requirements apply to producers subcontracting work from the producer directly employed by the Contractor. All producers shall be listed as an approved producer/supplier before beginning any work for the Department.

1077-2 PLAN REQUIREMENTS

The plans for precast units will be furnished by the Department in the *Roadway Standard Drawings* or details shown in the project plans.

When the Department does not make precast plans available and the Contractor chooses to precast, submit drawings to the Engineer for the items proposed to precast. Submit one complete set of drawings for review, at least 40 calendar days before beginning production. After acceptance, submit a complete set of drawings. Acceptance by the Engineer of contractor drawings will not be considered as relieving the Contractor of any responsibility for precast units. When precast units are load bearing and require structure design, have the plans prepared and certified by an engineer licensed by the State of North Carolina. Contractor furnished drawings shall show complete design, installation and construction information in such detail as to enable the Engineer to determine the adequacy of the proposed units for the intended use. Contractor drawings shall include details of steel reinforcement size, weight and placement and a schedule that lists the size and type of precast units at each location where the precast units are to be used. Produce precast units in accordance with the approved drawings.

1077-3 MATERIALS

Refer to Division 10.

Item	Section
Air Entraining Agent	1024-3
Chemical Admixtures	1024-3
Coarse Aggregate	1014-2
Curing Materials	1026
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6
Miscellaneous Metals	1074
Portland Cement	1024-1
Reinforcing Steel	1070
Silica Fume	1024-7
Blended Cement	1024-1
Water	1024-4

1077-4 INSPECTION

The Department reserves the right to place a duly authorized inspector in the plant at any time work related to the production of units for the Department is being performed. Notify the Engineer at least 15 business days in advance when such work is scheduled to begin.

Provide an office area for the inspector of at least 50 sf with desk, chair, telephone, facilities for proper heating and cooling, adequate lightning, electrical outlets and internet access.

Acceptance of precast units will be on the basis of tests of materials, compression tests on concrete cylinders and inspection of the finished units, including amount and placement of steel reinforcement, to determine their conformance with the approved dimensions and design and their freedom from defect. The inspector will have the authority to reject any or all units not manufactured in accordance with these specifications. Any unit found to be defective in any manner at any time will be rejected and replaced by an acceptable unit or repaired in a manner approved by the Engineer.

(A) Storage

Store all Department units in a separate area on the yard. Store all units on a solid, unyielding foundation free of standing water or in a manner directed by the Engineer. Do not stack units before inspection. Provide access to all surfaces of units so the plant inspector has the opportunity to properly inspect the units before approval. The provided access should allow room for inspection personnel to safely and freely move between and around units. Do not stack above 6 feet off the ground.

(B) Transporting

Do not transport units away from the casting yard until the concrete has reached the minimum required 28 day compressive strength and a period of at least 5 days elapses after casting, unless otherwise permitted by the Engineer.

Do not transport any unit from the plant to the job site before the approval of that unit by the plant inspector. Such approval will be indicated by the compliance with the Department's RFID tag/label tagging policy in accordance with Section 1030 and verified product approval as noted by an authorized Field Inspection Report (FIR) or NCDOT alternate ID.

1077-5 PORTLAND CEMENT CONCRETE

(A) Composition and Design

Portland cement concrete is composed of Portland cement, coarse aggregate (#67 or 78M), fine aggregate, water and unless otherwise permitted by the Engineer, an air entraining agent. If other cementitious materials and/or chemical admixtures are used, use these materials in the proper proportions to obtain the optimum effect. Do not use calcium chloride or other admixtures containing calcium chloride.

Supply concrete that develops a minimum compressive strength as shown in Table 1077-1 unless other strengths are designated on the approved drawings. When required, air entrain concrete to provide an air content of 5% ± 2%. Supply concrete with a maximum slump of 3.5 inches unless a high range water reducer (super plasticizer) is approved by the Engineer. Supply concrete with a maximum slump of 3.5 inches. A slump of 8 inches is permitted only when obtained with the use of an approved high range water reducer. As an option, reduce the cement content of the mix design by up to 30% and replace with fly ash at a rate of 1 lb. of fly ash for each pound of cement replaced or reduce the cement content up to 50% and replace with blast furnace slag on a pound for pound basis.

Submit proposed concrete mix designs in terms of saturated surface dry weights on *Materials and Tests Form 312U* at least 35 days before proposed use. Adjust batch proportions to compensate for surface moisture contained in the aggregates at the time of batching. Changes in the saturated surface dry mix proportions will not be permitted unless revised mix designs have been submitted to the Engineer and approved. Laboratory trial batches shall be created to confirm the proposed mix design meets the requirements of the plastic and hardened concrete.

Accompany *Materials and Tests Form 312U* with a listing of laboratory test results of aggregate gradation, air content, slump and compressive strength from a certified laboratory. List the compressive strength of at least three 6 inch x 12 inch or 4 inch x 8 inch cylinders at the age of 7 and 28 days.

Perform laboratory tests in accordance with the following test procedures:

Property	Test Method
Aggregate Gradation	AASHTO T 27
Air Content	AASHTO T 152
Slump	AASHTO T 119
Compressive Strength	AASHTO T 22 and R100

The Engineer will review the mix design for compliance with the Specifications and notify the Contractor as to its acceptability. Do not use a mix until written notice has been received. Acceptance of the mix design does not relieve the Contractor of his responsibility to furnish a product that meets the contract.

(B) Self-Consolidating Concrete (SCC) and Intermediate Flow Concrete

When a flowable concrete consistency is required, the use of an SCC or Intermediate Flow concrete is permitted with an approved concrete mix design.

SCC is a specialized concrete mix that utilizes various admixtures to obtain a fluid consistency without negatively impacting the strength or homogeneity of the mix. SCC is designed to flow under its own weight and completely fill the formwork completely, even in the presence of dense reinforcement and without the need for consolidation. SCC is characterized by a plastic concrete mixture with a flow that achieves a spread of 22-30 inches, when tested in accordance with ASTM C1611.

Intermediate Flow Concrete is a concrete mix that exceeds the slump of standard concrete but does not have the same high flow characteristics of an SCC concrete mix.. Intermediate Flow Concrete is characterized by a plastic concrete mixture with a flow that achieves a spread of 16-22 inches, when tested in accordance with ASTM C1611.

When submitting a proposed SCC or Intermediate Flow concrete mix design on a *Materials and Tests Form 312U*, include the test results obtained using the following test procedures:

Property	Test Method
Aggregate Gradation	AASHTO T 27
Air Content	AASHTO T 152
Slump Flow	ASTM C1611
Visual Stability Index (VSI)	ASTM C1611
Passing Ability	ASTMC1621 (Filling Procedure B)
Segregation	ASTM C1610
Compressive Strength	AASHTO T 22 and R100

Supply concrete that develops a minimum compressive strength as shown in Table 1077-1 unless other strengths are designated on the approved drawings. When required, air entrain concrete to provide an air content of 5 ± 2%. SCC and Intermediate Flow mixes shall have a difference in slump flow and passing ability not to exceed 2 inches, a Visual Stability Index no greater than 1, and a static segregation limit of 15%.

TABLE 1077-1 PRECAST CONCRETE STRENGTH REQUIREMENTS AT AN AGE OF 28 DAYS		
Precast Units	**Requirement**	**Specification Reference**
BARRIER:		
Portable	4,500 psi	Section 854, 1090 and 1170
Permanent	4,500 psi	Section 854, 857 and 1090
CULVERTS:		
Circular Pipe	4,000 psi	Section 310, 1032, 1034, 1520 and AASHTO M 170
Single Cell Box Sections	5,000 psi	Contract and AASHTO M 259
Pipe Tees	4,000 psi	Section 310, 1032 and AASHTO M 170
Pipe Elbows	4,000 psi	Section 310, 1032 and AASHTO M 170
Cross & Parallel Special End Sections	3,500 psi	Section 310 and 1032
DRAINAGE STRUCTURES:		
Boxes (Solid & Waffle)	4,000 psi	Section 840 and ASTM C913
CIRCULAR MANHOLES:		
Base	4,000 psi	Section 1525 and AASHTO M 199
Riser Section	4,000 psi	Section 1525 and AASHTO M 199
Top Section	4,000 psi	Section 1525 and AASHTO M 199
Grade Ring	4,000 psi	Section 858 and AASHTO M 199
WALLS AND PANELS:		
Wing, Head & End Walls	4,000 psi	AASHTO T 23
Precast Retaining Wall (PRW) Units	4,000 psi	Section 455
Precast Coping	3,000 psi	Contract
Retaining Wall Panels	4,000 psi	Contract
Sound Barrier Wall Panels	4,500 psi	Contract
INCIDENTAL PRECAST ITEMS:		
Concrete Pads For Outlet Pipe, Controller Base Cabinets	2,500 psi	Section 815, 816 and 825
Right-of-Way Markers	2,500 psi	Section 806 and 1054
Concrete Anchor For Cable Guardrail	3,000 psi	Section 1046
Picnic Tables	2,500 psi	Contract
Waste Containers	2,500 psi	Contract

Submit a proposed concrete mix design for the precast units to the Engineer. Determine quantities of fine and coarse aggregates necessary to provide concrete in accordance with this section by the method described in ACI 211 using the absolute volume method.

The Engineer will review the mix design only to ascertain general compliance with the *Standard Specifications*. Do not use a mix until notified that the mix is acceptable.

Acceptance of the mix design does not relieve the Contractor of his responsibility to furnish an end product meeting the *Standard Specifications*.

(C) Testing

Make all representative concrete test cylinders and all testing required herein in the presence of the plant inspector for items with strength requirements greater than 2,500 psi in Table 1077-1, unless otherwise approved by the Engineer. For incidental precast items listed in Table 1077-1, furnish a Type 3 material certification in accordance with Article 106-3 certifying that the item meets this Specification.

Before the first load is placed, determine the air content by AASHTO T 152, T196 or T121. If the air content does not meet the *Standard Specifications*, a second test on the same load is conducted using AASHTO T 152, T196 or T121. Acceptance or rejection of the load is based on the results of this test.

Perform temperature, air, and slump or spread tests whenever cylinders are cast.

Determine slump in accordance with AASHTO T 119 and ensure that slump meets the specifications as stated on Materials and Tests Form 312U approved mix design.

For the purpose of testing for the required 28 day compressive strength, furnish, at no cost to the Department, at least four concrete cylinders for each class of concrete, each structure and each day that precast units are produced for the Department. If the contractor anticipates an early break request, furnish the Department with two concrete cylinders for each early break request. These cylinders are in addition to the four concrete cylinders required for each day of production. Make and cure cylinders in accordance with AASHTO R 100 unless, by permission of the Engineer, the units are cured by one of the methods in Article 1077-9 for the full time required to meet the specified compressive strength requirements. In such case, cure the cylinders with the members and in the same manner as the members. Test cylinders in accordance with AASHTO T 22. If the average of two cylinders tested to determine compressive strength at the age of 28 days fails to indicate a compressive strength as shown in Table 1077-1, or such compressive strength as is required by the approved drawings, such failure is cause for the rejection of the members represented.

(D) Temperature Requirements

Maintain the concrete temperature at the time of placing in the forms not less than 50°F nor more than 95°F unless otherwise directed by the Engineer.

Place concrete in cold weather in accordance with Article 420-7.

(E) Use of Water Reducing Admixtures

Use water reducing admixtures in accordance with Subarticle 1000-3(G). Use high range water reducers (super plasticizers), if approved by the Engineer.

1077-6 FORMS

Use forms of sturdy construction and in good working order which are capable of consistently providing straight lines and uniform dimensions in the finished product. Use metal forms except where other materials are approved by the Engineer. Provide an identifying number on each form, and mark each precast unit with the same identifying number as the form used to cast unit. Forms not meeting these requirements are subject to rejection by the Engineer. Provide joints in forms that are smooth and tight enough to prevent leakage of mortar. Provide inside surfaces of forms that are accessible for cleaning. After each use, clean the forms thoroughly and inspect for damage. Repair or replace damaged forms that will not allow for proper casting or cause defects in the finished product. Before casting, free the inside surfaces of the forms from rust, grease or other foreign matter. Do not allow coatings used for release of members to build up and in no case allow liquid or powder from coating materials to come in contact with the reinforcement steel.

1077-7 REINFORCEMENT

(A) Steel Reinforcement

Furnish steel reinforcement and place as shown in the plans and in accordance with Section 1070.

(B) Macro Synthetic Fiber Reinforcement

Substitute as an option, macro-synthetic fibers instead of 4 inches x 4 inches W1.4 x W1.4 welded wire reinforcement for selected precast concrete products in accordance with the following requirements.

(1) Materials

Refer to Division 10.

Item	Section
Portland Cement Concrete	1077-5

Substitute macro-synthetic fibers only for steel reinforcement with an area of steel of 0.12 sq.in./ft or less in the following items:

(a) Precast drainage structure units in accordance with *Roadway Standard Drawings* No. 840.45.

(b) Precast manhole 4.0 feet riser sections in accordance with *Roadway Standard Drawings* No. 840.52.

All other requirements, including reinforcement for these precast concrete items will remain the same.

(2) Submittal

Submit to the Department for approval by the precast producer and fiber manufacturer, independently performed test results certifying the macro-synthetic fibers and the precast concrete products meet the requirements listed herein.

(3) Macro-Synthetic Fibers

Manufacture from virgin polyolefins (polypropylene and polyethylene) and comply with ASTM D7508. When using fibers manufactured from materials other than polyolefins, submit test results complying with ASTM D7508 certifying resistance to long-term deterioration when in contact with the moisture and alkalies present in cement paste and/or the substances present in air-entraining and chemical admixtures.

Fiber length shall be no less than 1.5 inches. Use macro-synthetic fibers with an aspect ratio (length divided by the equivalent diameter of the fiber) between 45 and 150, a minimum tensile strength of 40 ksi when tested in accordance with ASTM D3822 and a minimum modulus of elasticity of 400 ksi when tested in accordance with ASTM D3822.

(4) Fiber Reinforced Concrete

Approved structural fibers may be used as a replacement of steel reinforcement in allowable structures of *Roadway Standard Drawings* Nos. 840.45 and 840.52. The dosage rate, in pounds of fibers per cubic yard, shall be as recommended by the fiber manufacturer to provide a minimum average residual strength of concrete, tested in accordance with ASTM C1399, of no less than that of the concrete with the steel reinforcement that is being replaced and no less than 5 lb/cy. Submit the recommendations of the manufacturer that correlate the toughness of steel-reinforced concrete with that of the recommended dosage rate for the fiber-reinforced concrete.

Use fiber reinforced concrete with a 5% ± 2% air content and a compressive strength of at least 4,000 psi in 28 days.

Assure the fibers are well dispersed and prevent fiber balling during production. After introduction of all other ingredients, add the plastic concrete and mix the plastic concrete for at least 4 minutes or for 50 revolutions at standard mixing speed.

1077-8 PLACING CONCRETE

Use the procedures and equipment for handling, placing and consolidating the concrete such that a uniformly dense and high grade concrete is obtained in all parts of the unit under all working and weather conditions. Do not mix, handle, deliver, place or finish concrete using devices made of aluminum or containing aluminum.

Placing concrete for precast members in cold weather shall be in accordance with Article 1078-10.

Internal, external or a combination of internal and external vibration is required as necessary to produce uniformly dense concrete without honeycomb.

1077-9 CURING CONCRETE

(A) General

Precast units are subjected to one of the methods of curing described below or to other methods or combinations of methods approved by the Engineer. Cure the precast units for a sufficient length of time so the concrete develops the specified compressive strength at 28 days or less. Do not strip forms until at least 24 hours after the concrete attains initial set. For this purpose, initial set is defined as at least 500 psi resistance to a standard penetrometer. The option to strip forms earlier is available provided concrete cylinders indicate a strength of at least 75% of the 28 day compressive strength is attained before release for each day's production. Do not deface or injure the units.

(B) Curing at Elevated Temperatures

Cure at elevated temperatures in accordance with Subarticle 1078-11(B). The temperature within the curing enclosure shall not exceed 160°F. Place recording thermometers within each enclosure. Calibrate recording thermometers at intervals not to exceed 6 months. Submit complete temperature records to the Engineer for all cures before final approval of the members.

(C) Water Curing

Water curing of precast units is allowed as described in Subarticle 420-15(B), by covering with water saturated material, or by a system of perforated pipes, mechanical sprinklers, porous hoses or by any other method that keeps the units moist during the specified curing period. Do not use methods that deface or injure the precast units.

(D) Curing Compound

Application of a curing compound is allowed provided it is left intact until the specified compressive strength is met. Keep all surfaces moist before the application of the compound and damp when the compound is applied. Seal the surface with a single uniform coating at the rate of coverage recommended by the curing compound manufacturer, or as directed by the Engineer, but not less than 1 gal per 150 sf of area.

1077-10 LIFT HOLES, HANDLING

Do not cast or drill more than 4 holes in each unit for the purpose of handling or placing unless otherwise approved by the Engineer. Locate all lift holes and handling devices in accordance with plan and design requirements. Units damaged while being handled or transported are rejected or require repair in a manner approved by the Engineer.

1077-11 FINAL FINISH

Unless otherwise required by the contract, finish all concrete in accordance with Subarticle 420-17(B) except as noted within Article 1077-16.

Do not repair units with honeycomb, cracks, or spalls until inspected by the Engineer. Use repair methods that are approved by the Engineer before their use. Any appreciable impairment of structural adequacy is cause for rejection.

1077-12 EXPOSED AGGREGATE FINISH FOR PRECAST CONCRETE PANELS

When required, provide an exposed aggregate finish for front faces of panels with a depth of exposure ranging from 0 to 1/4 inch. Before beginning production, furnish three 12 inch x 12 inch sample panels to establish acceptable variations in color, texture and uniformity of the finish. After the sample panels are accepted by the Engineer and within 30 days of beginning production, produce a reinforced test panel of the largest size that will be used for the project with the accepted exposed aggregate finish. Acceptance of the appearance of panels during production will be based on the test panel and accepted sample panels.

Use aggregate and cement from the same source as was used for the test panel and accepted sample panels to produce panels with an exposed aggregate finish. Provide access to visually inspect the entire finish of each completed panel and compare it to the test panel appearance before stacking panels. Replace the test panel with a new test panel every three months during production or when fly ash or cement source changes.

1077-13 STEPS FOR PRECAST DRAINAGE STRUCTURES

Supply steps meeting AASHTO M 199 for design, materials and dimensions. Incorporate steps in all drainage structures 3.5 feet or greater in height. Do not detail the lowest step more than 16 inches from the bottom.

1077-14 MARKING

Clearly mark the following information on each precast member:

(A) Date of manufacture,

(B) Name of the manufacturer,

(C) Piece mark designations where such designations are shown in the plans, and

Clearly apply a Department approved self-adhesive RFID tag/label tagged in accordance with Section 1030 applied in accordance with Subarticle 1030-2(F). When precast products have been inspected the Department will update the RFID tag/label record as found in the Field Inspection Report (FIR) or NCDOT alternate ID. RFID tag/labels are allowed but not required for incidental precast items.

1077-15 DIMENSIONS

Ensure that all dimensions allow assembly of the units in place without objectionable deviation from the lines shown in the plans. If requested by the Engineer, assemble the precast members to ensure a quality fit before shipment of the precast members.

1077-16 INCIDENTAL PRECAST ITEMS

Furnish a Type 3 materials certification in accordance with Article 106-3 for incidental precast items in Table 1077-1.

1077-17 SOUND AND NOISE WALL PANELS AND NOISE WALL POSTS

Wall panels will be required to be placed in a rack system for inspection. Double faced wall panels will require access to both faces for proper inspection. After sound wall panels have been inspected and approved they shall be stored in a manner that will not cause damage prior to delivery to the project.

Manufacture sound wall post within the tolerances indicated in Table 1078-2 and Figure 1078-1.

SECTION 1078
PRESTRESSED CONCRETE MEMBERS

1078-1 GENERAL

This section covers the materials for and the production of precast, prestressed concrete members produced in accordance with the contract.

Use prestressing of the pretensioning type in which steel prestressing strands are initially stressed and anchored; the concrete is then placed, vibrated and cured; and when the concrete reaches the required strength, the load is transferred from the anchorages to the concrete.

The intent of this section is to require the producer to provide prestressed concrete members that meet the *Standard Specifications* and exhibit characteristics that are not objectionable to the Department.

(A) Producer Qualification

Producers of precast, prestressed concrete members are required to establish proof of their competency and responsibility in accordance with the Precast/Prestressed Concrete Institute's (PCI) Plant Certification Program to perform work for the project. Certification of the manufacturing plant under the PCI program and submission of proof of certification to the State Materials Engineer is required before beginning fabrication. Maintain certification at all times while work is being performed for the Department. Submit proof of certification following each PCI audit to the State Materials Engineer for continued qualification. These same requirements apply to producers subcontracting work from the producer directly employed by the Contractor.

Employ producers PCI certified in Product Group B, Bridge Products and in one of the appropriate categories as listed below:

(1) B2 Prestressed Miscellaneous Bridge Products includes solid piles, sheet piles and bent caps;

(2) B3 Prestressed Straight-Strand Bridge Members includes all box beams, cored slabs, straight-strand girders and bulb-tees, bridge deck panels, hollow piles, prestressed culverts and straight strand segmental components; or

(3) B4 Prestressed Deflected-Strand Bridge Members includes deflected strand girders and bulb-tees, haunched girders, deflected strand segmental superstructure components and other post-tensioned elements.

Categories for elements not listed above will be as required by the project special provision or plans.

(B) Working Drawing Submittals

Before casting members, submit complete working drawings to the Engineer for approval. The working drawings shall detail the exact location and description of all casting holes, attachments and inserts cast in the member for both temporary and permanent applications. The casting holes, attachments and inserts are in association with, but not limited to: fall protection, overhang falsework, metal stay-in-place forms, solar platforms, temporary girder bracing, transit, erection, lifting and handling. If the plan notes indicate that the structure contains the necessary corrosion protection required for a corrosive site, epoxy coat, galvanize or metalize all metallic components except stainless steel and malleable iron components. Electroplating will not be allowed.

1078-2 MATERIALS

Refer to Division 10.

Item	Section
Air Entraining Agent	1024-3
Chemical Admixtures	1024-3
Coarse Aggregate	1014-2
Epoxy Protective Coating	1081-1
Fine Aggregate	1014-1
Fly Ash	1024-5
Ground Granulated Blast Furnace Slag	1024-6
Miscellaneous Metals	1074
Portland Cement	1024-1
Prestressing Strand	1070-5
Reinforcing Steel	1070
Blended Cement	1024-1
Silica Fume	1024-7
Structural Steel	1072
Water	1024-4

Do not make changes in the source of aggregates, cements or admixtures during the casting of members in any one span or substructure unit unless approved by the Engineer.

1078-3 INSPECTION

The Department reserves the right to place a duly authorized inspector in the plant at any or all times work related to the production of members for the Department is performed. Notify the Engineer at least 15 business days in advance when such work is scheduled. Provide an office area with an approximate floor space of 100 sf, a desk or drafting table, two chairs, telephone, separate dial-up or faster internet access, facilities for proper heating and cooling and adequate lighting at the plant for the exclusive use of the inspector. The Inspector has the authority to reject any or all members not manufactured in accordance with these specifications. Approval of any member by the inspector at the plant is in no way final, and further inspection is made at the structure site both before and after the member is placed in the final position. Any member found to be defective in any manner at any time is rejected and requires replacement by an acceptable member or repair in a manner approved by the Engineer.

Do not transport any member from the plant to the job site before approval of that member by the plant inspector. Provide access to all surfaces of the member so the plant inspector has the opportunity to properly inspect the member before approval. Such approval will be indicated by the compliance with the Department's RFID tag/label tagging policy in accordance with Section 1030 and verified product approval as noted by an authorized Field Inspection Report (FIR) or NCDOT alternate ID.

1078-4 PORTLAND CEMENT CONCRETE

(A) Composition and Design

Supply Portland cement concrete composed of Portland cement, coarse aggregate, fine aggregate, water and an approved air-entraining agent. Add other cementitious materials and/or chemical admixtures if approved by the Engineer. When admixtures are used, use them in the proper proportions to obtain the optimum effect. Do not use set accelerating admixtures, calcium chloride or admixtures containing calcium chloride. If approved by the Engineer, high range water reducer may be used at a rate not to exceed the manufacturer's recommended dosage.

Supply concrete with a minimum compressive strength of 5,000 psi at the age of 28 days, unless otherwise required by the plans or *Standard Specifications*. Ensure that all coarse aggregate used in prestressed concrete passes a 1 inch sieve. Maintain a cement content of at least 564 lbs. per cubic yard. Air entrain concrete to provide an air content of 5 ± 2%. Supply concrete with a maximum slump of 3.5 inches. A slump of 8 inches is permitted only when obtained with the use of an approved high range water reducer. As an option, reduce the cement content of the mix design and replace with fly ash or ground granulated blast furnace slag in accordance with Article 1024-1. For concrete with a 28 day design strength greater than 6,000 psi, if approved by the Engineer, substitute microsilica for cement, in conformance with Article 1024-1.

Submit to the Engineer proposed concrete mix designs for each strength of concrete used in the work. Determine quantities of fine and coarse aggregates necessary to provide concrete in accordance with the *Standard Specifications* by the method described in ACI 211 using the absolute volume basis.

Submit mix designs, stated in terms of saturated surface dry weights, on *Materials and Tests Form 312U* at least 35 days before using the proposed mix. Adjust batch proportions to compensate for surface moisture contained in the aggregates at the time of batching. Changes in the saturated dry mix proportions are not permitted unless revised mix designs are submitted to the Engineer and are determined to be acceptable for use. Create laboratory trial batches to confirm the proposed mix design meets the requirements of the plastic and hardened concrete.

Provide with *Materials and Tests Form 312U* a listing of laboratory test results of aggregate gradation, air content, slump and compressive strength. List the compressive strength of at least three 6 inches x 12 inches or 4 inches x 8 inches cylinders. Show the age of the cylinders at the time of testing and a detailed description of the curing procedure. Perform laboratory tests in accordance with the following test procedures:

Property	**Test Method**
Aggregate Gradation	AASHTO T 27
Air Content	AASHTO T 152
Slump	AASHTO T 119
Compressive Strength	AASHTO T 22 and R100

If the design 28 day compressive strength is greater than 6,000 psi, submit the compressive strength of at least six cylinders. Ensure that the average strength of the six cylinders is at least 1,500 psi above the minimum 28 day compressive strength required by the plans.

The Engineer will review the mix design for compliance with the specifications and notify the Contractor as to its acceptability. Do not use a mix until written notified has been received. Acceptance of the mix design does not relieve the Contractor of his responsibility to furnish a product that meets the contract.

(B) Self-Consolidating Concrete (SCC) and Intermediate Flow Concrete

When a flowable concrete consistency is required, the use of an SCC or Intermediate Flow concrete is permitted with an approved concrete mix design. SCC is a specialized concrete mix that utilizes various admixtures to obtain a fluid consistency without negatively impacting the strength or homogeneity of the mix. SCC is designed to flow under its own weight and fill the formwork completely, even in the presence of dense reinforcement and without the need for consolidation. SCC is characterized by a plastic concrete mixture with a flow that achieves a spread of 22-30 inches, when tested in accordance with ASTM C1611.

Intermediate Flow Concrete is a concrete mix that exceeds the slump of standard concrete but does not have the same high flow characteristics of an SCC concrete mix. Intermediate Flow Concrete is characterized by a plastic concrete mixture with a flow that achieves a spread of 16-22 inches, when tested in accordance with ASTM C1611.

When submitting a proposed SCC or Intermediate Flow concrete mix design on a Materials and Tests Form 312U, include the test results obtained using the following test procedures:

Property	Test Method
Aggregate Gradation	AASHTO T 27
Air Content	AASHTO T 152
Slump Flow	ASTM C1611
Visual Stability Index (VSI)	ASTM C1611
Passing Ability	ASTM C1621 (Filling Procedure B)
Segregation	ASTM C1610
Compressive Strength	AASHTO T 22 and R100

Supply concrete that develops a minimum compressive strength of 5,000 psi at the age of 28 days, unless otherwise required by the plans or *Standard Specifications*. SCC and Intermediate Flow mixes shall have a difference in slump flow and passing ability not to exceed 2 inches, a Visual Stability Index no greater than 1, and a static segregation limit of 15%.

(C) Testing

Employ a certified concrete technician to perform all testing required by this subarticle at the bed site in the presence of the plant inspector unless otherwise approved by the Engineer. Certification of technicians is awarded upon satisfactory completion of examinations prepared and administered by the Department or other approved agency.

(1) Air Content

Before allowing placement of the first load in a bed, determine the air content by AASHTO T 152, T196 or T121. During the placement of the first load, determine the air content by AASHTO T 152, T 196 or T 121. Determine the air content in each subsequent 10 cubic yards by AASHTO T 152, T196 or T121 before allowing placement. Determine the air content by AASHTO T 152, T196 or T121 from all loads from which cylinders are made. If the air content does not meet the *Standard Specifications*, a second test on the same load is conducted using AASHTO T 152, T196 or T121. Acceptance or rejection of the load is based on the results of this test.

(2) Slump

Determine slump in accordance with AASHTO T 119.

(3) Spread

Determine spread on SCC and intermediate flow concrete in accordance with ASTM C1611 or AASHTO T 347.

(4) Strength

For the purpose of testing for the required 28 day compressive strength and also for the required compressive strength for the transfer of load, furnish, at no cost to the Department, cylinders made from a sample of concrete placed near the live end of the bed and additional cylinders made from a sample of concrete placed near the dead end of the bed. Make cylinders in accordance with AASHTO R 100, except cure the cylinders in the same manner as the members represented until the strands are released. Place cylinders in clusters at random points along the casting bed. After the strands are released, air cure the cylinders in an approved common area near the testing apparatus for the remainder of the 28 day curing period. Test the cylinders in accordance with AASHTO T 22. Provide approved apparatus for testing the transfer strength of the cylinders. Maintain this apparatus to within 1.0% accuracy and calibrate at intervals not to exceed 12 months by an approved testing company at no cost to the Department. The Engineer reserves the right to require verification

immediately after a testing machine is relocated and whenever there is reason to doubt the accuracy of the indicated load, regardless of the time interval since the last verification.

The testing requirements for the 28 day compressive strength for all prestress members required by the plans are as follows:

(a) Release Strength

Test four cylinders, two sets of two cylinders from each end of the bed, for the purpose of determining whether the concrete has reached the required strength for transfer of load. The strengths from the dead end cylinders are averaged and the strengths from the live end cylinders are averaged. Ensure that both of these averages meet or exceed the required release strength and the lowest cylinder is not more than 200 psi below the required strength.

(b) Acceptance Strength

Test a set of three cylinders from each end to determine the 28 day compressive strength. The strengths from the dead end cylinders are averaged and the strengths from the live end cylinders are averaged. Ensure that both of these averages meet or exceed the 28 day compressive strength. Ensure that no cylinder indicates a compressive strength less than 400 psi less than the required 28 day compressive strength. Failure to meet the above requirements is cause for rejection of the members represented.

(D) Temperature Requirements

Maintain a concrete temperature at the time of placing in the forms between 50°F and 95°F.

Place concrete when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is a minimum of 35°F and rising.

Place concrete when the form temperature is between 35°F and 110°F.

(E) Elapsed Time for Placing Concrete

Ensure that the elapsed time for placing concrete is in accordance with Subarticle 1000-3(E). The requirements of Subarticle 1000-3(E) pertaining to Class AA concrete apply to prestressed concrete.

(F) Use of Set Retarding Admixtures

By permission of the Engineer, use an approved set retarding admixture if choosing to take advantage of the extended time interval between adding mixing water and placing the concrete.

Use a quantity of set retarding admixture per 100 lbs. of cement within the range recommended on the current list of approved set retarding admixtures issued by the Materials and Tests Unit.

(G) Use of Water Reducing Admixtures

Use water-reducing admixtures in accordance with Subarticle 1000-3(G).

(H) Use of Calcium Nitrite Corrosion Inhibitor

Add an approved calcium nitrite corrosion inhibitor (30% solids) to the concrete mix at the batch plant for the bridge elements identified by the plan notes. Clearly mark the prestressed concrete members that contain calcium nitrite.

Use the inhibitor at a minimum rate of 3.0 gal/cy. Ensure that the hardened concrete contains at least 5.8 lbs/cy Nitrite (NO_2) when tested in accordance with Materials and Tests Method Chem. C-20.0 with the exception of concrete used in prestressed members. Test prestressed members as follows:

The Department will perform the complete C-21.0 Field Test Procedure for the Nitrite Ion in Plastic Concrete on plastic concrete samples obtained randomly from a truck used to pour concrete near each end (live end and dead end) of a prestressed concrete casting. Powder samples will be taken from hardened cylinders made at the time C-21.0 is run for any concrete that fails the C-21.0 (plastic test) method. The Chemical Testing Laboratory will test the powder using method C-20.0 Determination of Nitrite in Hardened Concrete. Acceptance of the concrete is dependent in the results of method C-20.0 (hardened test) when any sample fails the C-21.0 (plastic test method).

The Department will perform a qualitative nitrite ion check by method C-22.0 (Field Spot Test) on each load of concrete batched for a prestressed concrete casting bed. Acceptance of the concrete is dependent on the results of method C-20.0 (hardened test) when any sample fails the C-22.0 (Field Spot Test). The producer may elect to not incorporate concrete that fails Method C-22.0 (Field Spot Test) instead of waiting for C-20.0 (hardened test) test results to determine the acceptability of the member. Once per each week's production of prestressed concrete with corrosion inhibitor, random samples of hardened concrete powder will be taken from cylinders used for method C-21.0 (plastic test). These samples will be submitted to the Chemical Testing Laboratory for analysis using method C-20.0 (hardened test).

Units with calcium nitrite in a quantity less than specified are subject to rejection. Furnish powder drilled from concrete cylinders to the Engineer, in a quantity to be specified, to verify the concentrations of calcium nitrite in hardened concrete. Concrete failing to contain calcium nitrite at the required concentrations as tested is subject to rejection.

Use only air-entraining, water-reducing and/or set-controlling admixtures in the production of concrete mixtures that are compatible with calcium nitrite solutions.

Strictly adhere to the manufacturer's written recommendations regarding the use of admixtures including storage, transportation and method of mixing. If preferred, use calcium nitrite, which acts as an accelerator, in conjunction with a retarder to control the set of concrete, as per the manufacturer's recommendation.

(I) Measuring Materials

Measure materials in accordance with Article 1000-9.

(J) Mixers and Agitators

Use mixers and agitators meeting Article 1000-11.

(K) Mixing and Delivery

(1) General

Mix and deliver concrete to the site of the work by one of the following methods, except where other methods are approved by the Engineer. The Engineer approves the mixing of concrete by methods other than those listed below provided the proposed method is capable of satisfying job requirements and there is adequate evidence that the proposed method produces concrete complying with the *Standard Specifications*. Assume responsibility for controlling the materials and operations so as to produce uniform concrete meeting the *Standard Specifications*.

Have present during all batching operations at the concrete plant a certified concrete technician employed by the Contractor, prestressed concrete producer or concrete supplier while concrete is batched and delivered to the site of the work. The sole duty of this employee is to have charge of and exercise close supervision of the production and control of the concrete. Ensure the technician performs moisture tests, adjusts mix proportions of aggregates for free moisture, completes batch tickets on *Materials and Tests Form 903* or approved delivery tickets, signs batch tickets or approved delivery tickets and assures quality control of the batching operations. Delivery tickets are

permitted instead of batch tickets on M&T *Form 903* provided they are reviewed and approved by the Materials and Tests Unit. Certification of technicians is awarded upon satisfactory completion of examinations prepared and administered by the Department or other approved agency.

(a) Central Mixed Concrete

Mix completely in a stationary mixer and transport the mixed concrete to the point of delivery in a truck agitator or in a truck mixer operating at agitating speed or in non-agitating equipment approved by the Engineer. Mix within the capacity and at the mixing speeds recommended by the equipment manufacturer.

(b) Transit Mixed Concrete

Mix completely in a truck mixer while at the batching plant, in transit or at the work site.

(2) Mixing Time for Central Mixed Concrete

The mixing time starts when all the solid materials are in the mixing compartment and ends when any part of the concrete begins to discharge. Charge the ingredients into the mixer such that some of the water enters in advance of cement and aggregate, and substantially all the water is in the drum before 1/3 of the specified mixing time elapses. Transfer time in multiple drum mixers is counted as part of the mixing time.

Establish the minimum mixing time by one of the following:

(a) Mixer performance tests as described herein,

(b) The manufacturer of the equipment, or

(c) The requirement of one minute for mixers of 1.0 cy capacity or less with an increase of 15 seconds for each cubic yard or fraction thereof in increased capacity.

The Engineer reserves the right to require a mixer performance test at any time. The minimum mixing time as determined by the mixer performance test is that which produces concrete in accordance with Table 1078-1.

Sample and test for mixer performance as provided below. Charge the mixer to its rated capacity with the materials and proportions used in the work and mix at the recommended mixing speed to the target time. Stop mixing then and begin discharging. Take two samples of sufficient size to make the required tests after discharge of approximately 15% and 85% of the load by an appropriate method of sampling which provides representative samples of the concrete.

Separately test each of the two samples of concrete for the properties listed in Subarticle 1078-4(A) or 1078-4(B). Conduct tests in accordance with the standard methods shown in Subarticle 1078-4(A) or 1078-4(B) or procedures established by the Materials and Tests Unit.

Perform the mixer performance test described above on at least two batches of concrete. For the performance test to be acceptable, ensure that all tests in each batch meet the requirements listed in Table 1078-1.

The Engineer rechecks mixer performance at any time when in his judgment acceptable mixing is not accomplished.

Where acceptable mixing cannot be accomplished in the established mixing time, the Engineer increases the mixing time or requires that the mixer be repaired or replaced before any further mixing.

TABLE 1078-1
REQUIREMENTS FOR UNIFORMITY OF CONCRETE WITHIN A BATCH

Property	Requirement	Test Method
Difference in Test Samples Air Content, Percent by Volume of Concrete	1.0%	AASHTO T 152
Slump	1.0"	AASHTO T 119
Coarse aggregate content, portion by weight of each sample retained on the No. 4 sieve	6.0%	-
Weight per Cubic Foot (Density)	1.0 lb/cf	AASHTO T 121
Average Compressive Strength at 7 days, Percent of Average	7.5%[A]	AASHTO T 22 and R100

A. Obtain tentative approval pending 7 day compressive strength tests.

(3) Truck Mixers and Truck Agitators

Use truck mixers and truck agitators meeting Subarticle 1000-11(C). For concrete with a design 28 day compressive strength greater than 6,000 psi, load trucks to within 1 cy of rated capacity and mix at a speed of 16 to 18 rpm.

(4) Delivery

For central mixed concrete delivered in truck agitators, truck mixers, or transit mixed concrete, use a ticket system for recording the transportation of batches from the proportioning plant to the site of the work. Fill out the tickets on *Materials and Tests Form 903* or approved delivery tickets in accordance with the instructions issued by the Engineer. Issue the tickets to the truck operator at the proportioning plant for each load and have them signed by the certified concrete technician, which signifies that the concrete in the truck is inspected before departure. Show on each ticket the time batching is complete and if transit mixed, the number of revolutions at mixing speed, if any, at the plant. Deliver the tickets to the inspector at the site of the work. For central mixed concrete delivered in non-agitating equipment, alternate methods of documenting batch proportions are considered by the Engineer. Loads that do not arrive in satisfactory condition within the time limits specified are not acceptable for use in the work.

(L) Ready Mixed Concrete Plant

Ensure ready mixed concrete plants are inspected and approved by the Department before they are used to produce concrete for the project. Ensure that plants meet all applicable requirements of the *Standard Specifications* and in addition have at least two acceptable concrete delivery vehicles that are in working condition. Plants approved by the Department are placed on a list of approved plants that is made available. All plants are subject to reinspection at intervals selected by the Engineer. Reapproval after each inspection is contingent on continuing compliance with the *Standard Specifications*.

1078-5 CASTING BED AND FORMS

Use metal forms, including headers or end forms, except where other materials are approved by the Engineer. Use forms of adequate thickness, braced, stiffened, anchored and aligned adequately to consistently produce members within the limits of dimensional tolerances. Design and align the forms so they do not restrict longitudinal movement of the casting when the prestressing force is transferred. Provide corners and angles that are chamfered or rounded. Provide joints in forms that are smooth and tight enough to prevent leakage of mortar. Plug holes and slots in forms, pallets, headers and bulkheads neatly to prevent leakage of mortar. Make the inside surfaces of forms accessible for cleaning. Thoroughly clean the beds and forms after each use. Before casting, clean the inside surfaces of the forms from rust, grease or other foreign matter. Remove all foreign substances from inside the forms, including any standing water. Do not allow coatings used for release of members to build up. Do not use forms that do not present a smooth surface.

When casting holes through the top flange of girders for overhang or interior bay falsework hanger rods, use rigid PVC conduits with a wall thickness of approximately 1/8 inch. Do not use thin wall material. Secure conduits in the forms so they do not migrate out of the proper location. Other methods of forming holes may be proposed but are subject to the Engineer's approval.

When casting dowel rod holes in cored slab or box beam members, use material that creates round, vertical holes of the specified diameter and in the correct location. Do not use material that deforms, collapses or shifts position during casting of the member.

Apply form release agents to the forms either before or after stringing of strands. If applied before stringing, provide a release agent of a type that dries to a degree so it cannot contaminate any strand that comes in contact with it. If the release agent is applied after stringing, exercise great care and provide a sheet metal or similar type shield for protection of the strands.

1078-6 TENSIONING DEVICES

Use tensioning devices adequate to produce and maintain the required tension in all strands until the concrete reaches the required transfer strength. Equip all jacks with accurate and calibrated gauges for registering jacking loads. Calibrate gauges with the jacks with which they are used. Calibrate all jacks and gauges by an approved testing company at no cost to the Department at intervals not to exceed 12 months. During progress of the work, if gauge readings and elongations indicate materially differing loads, recalibrate as required. Use gauges with a full load capacity of 1 1/2 to 2 times their normal working load, unless otherwise approved by the Engineer. Do not use loads less than one-fourth or more than 3/4 of the total graduated gauge capacity unless calibration data clearly establishes consistent accuracy over a wider range. Use gauges with indicating dials at least 6 inches in diameter and gauge pointers that do not fluctuate, preventing an accurate reading, but remain steady until the jacking load is released. Ensure that all gauges have an accuracy of reading within 2%. Provide means for measuring the elongation of strands within 1/4 inch.

1078-7 PLACING STRANDS, TIES AND REINFORCING STEEL

Position strands, ties, supports, reinforcing bars of the sizes shown in the plans and bearing plates in accordance with the detailed dimensions shown in the plans and effectively secure against displacement from their correct positions. The use of previously tensioned strands is not permitted. For prestressing strands, do not allow deflections or displacements of any kind between the end anchorages unless shown in the plans. Place the steel reinforcing in final position after tensioning of the strands. Bend all tie wires to the inside of the member so the ends are farther from the edge than the material tied. Support bottom strands spacings not to exceed 20 feet by supports meeting Article 1070-4 or by other approved means. Plastic supports may be used when approved by the Engineer.

Strands with kinks, bends, nicks, scale, excessive rust or other defects are not permitted. No more than one broken wire per casting bed is permitted. Slight rusting is not cause for rejection, provided it is not sufficient to cause visible pits. Take precautions to prevent contamination of strands and reinforcing steel. Clean the strands and reinforcing steel to an acceptable condition before pouring concrete. Do not place concrete in the forms until the strand and reinforcement condition and arrangement are inspected by the plant inspector.

Strand splices are only permitted at the end of a reel and when using a single strand jack. Ensure that the strand lengths to be spliced together have the same lay of wire to avoid unraveling and position the splice so it does not fall within a member. Do not torch cut the ends of the spliced strand lengths. Cut by shears, abrasive grinders or other means approved by the Engineer. No more than one strand splice per bed is allowed on an individual strand and the use of previously tensioned strands for splicing is not permitted.

Where debonding of strands is required, accomplish by encasing the strand in a tubular conduit capable of resisting the pressure exerted by the concrete. Do not use slit conduit. Use a conduit of HDPE or polypropylene with a minimum wall thickness of 0.025 inch. Ensure that the inside

diameter of the conduit is of sufficient size to allow free movement of the encased strand but not greater than the diameter of the strand plus 1/8 inch. Secure the conduit so longitudinal movement along the strand is prevented, and bonding of the strand is prevented at the required location ± 1 inch. When conduit is added after initial tensioning, prevent concrete from entering the conduit by taping all joints and cuts along the length of the conduit. Use tape manufactured from a non-corrosive material compatible with the concrete, conduit and steel.

1078-8 TENSIONING PROCEDURE

A producer quality control representative shall be present during strand tensioning. Tension each strand to the load shown in the plans before placing the concrete.

Measure the load induced in the prestressing strand both by jacking gauges and strand elongations on at least the first five strands and every third strand thereafter on each pour. Measure loads on all other strands by either jacking gauges or strand elongations. When both methods of measurement are used, if a discrepancy between gauge and elongation of more than 5% is apparent, carefully check the entire operation and determine the source of error before proceeding. Make appropriate allowances in the computed elongation and jacking loads for load losses due to friction and all possible slippage or relaxation of the anchorage. Establish references periodically at each strand anchorage to indicate any yielding or slippage that may occur between the time of initial tensioning and final release of the strands.

In determining the applied load by measuring the elongation of the strand, use a modulus of elasticity taken from the typical stress-strain curve for the brand, size and type of strand tensioned. Submit stress-strain curve data for the actual heats of material used in the strands to the plant inspector before using the strands. Identify each reel or strand by tagging in accordance with AASHTO M 203. Mark the outer layer of each reel pack of strand with a wide color band. In addition, attach a metal tag to each reel pack labeled in accordance with AASHTO M 203.

Tension strands in a group or individually. Before full tensioning, bring each strand to an initial tension of 2,000 lbs. for all beds under 150 feet in length, 3,000 lbs. for all beds 150 feet to 300 feet in length and 4,000 lbs. for all beds longer than 300 feet in length. Measure this initial tension by a calibrated gauge or other approved means, and then compute the elongation due to initial tensioning. Use the difference between the required final tension and the initial tension to compute the expected additional elongation.

For precast prestressed deck panels, use a final prestressing force of 14,000 lbs. per strand for Grade 250 strand and 16,100 lbs. per strand for Grade 270 strand.

After initial tensioning, tension the strands until the required elongation and jacking load are attained and reconciled within the limits specified above. Keep a permanent record of the initial jacking load, the final jacking load, and the elongation produced thereby.

In single strand tensioning, rotation of the jacking ram is not allowed.

When draped strands are used, submit the bed layout showing the method of draping and tensioning the draped strands and also calculations determining the loads required for tensioning the draped strands. Drape the strands for all members to be cast in any one tensioning operation before casting any beam. Have end templates or bulkheads at ends of beams remain vertical or as otherwise shown in the plans. Perform draping for all members either simultaneously or in single or incremental lifts beginning at the center of the bed and working outward toward each end of the bed. Complete tensioning in the fully draped position is not allowed unless approved in writing. Requests to tension in the draped position will only be considered if the producer has the ability to tension from both the live and dead end of the casting bed. When the tensioning of draped strands is approved in writing verification of the proper stresses in the draped strands will be required. The verification of the stresses in the draped strands shall be completed according to the Materials and Tests Standard Operating Procedures for Tensioning Draped Strands in the Final Position.

Use round steel rollers of a type and dimensions approved by the Engineer for deflecting the draped strands. Round the part in contact with the strand to a diameter of not less than 3/4 inch. Use support and hold-down devices of sufficient rigidity with adequate support so the final position of the strands is as shown in the plans. Ensure that all parts are in good working order and roll freely to ensure equal distribution of stress in the draped strands.

With strands tensioned in accordance with the above requirements and with other reinforcement in place, cast the concrete members so as to achieve the required lengths. Maintain strand load between anchorages until the concrete reaches the required compressive strength for transfer of load from the anchorages to the members.

For personnel engaged in the tensioning operation, provide protection by effective shields adequate to stop a flying strand. Provide shields produced from steel, reinforced concrete, heavy timbers and other approved material at both ends of the bed.

1078-9 PLACING CONCRETE

Place concrete in accordance with Article 1077-8 and the additional requirements of this article.

Upon completion of stressing strand, place concrete within a reasonable time to prevent contamination of the strands and reinforcing steel.

Place concrete for girders 54 inches or less in height, and concrete for all cored slabs and box beams, in two or more equal horizontal layers. Place concrete for girders over 54 inches in height in three horizontal layers. When placing concrete in three layers locate the top of the first layer approximately at the top of the bottom flange and locate the top of the second layer approximately at the top of the web. To prevent separation of surfaces between layers, do not allow the time between successive placements onto previously placed concrete to exceed 20 minutes, unless the previously placed concrete has not yet stiffened, as evidenced by the continuous effective use of vibration. Should shrinkage or settlement cracks occur, the Engineer reserves the right to require additional layers and/or vibration.

The requirement of the above paragraph may be waived with the permission of the Engineer if SCC or intermediate flow concrete is used.

Vibration may be required to produce uniformly dense concrete without honeycomb while maintaining the integrity of the concrete mix without causing segregation. Segregation of the concrete within a member may be cause for rejection by the Engineer.

Place concrete in cold weather in accordance with Article 1078-10.

Place concrete in daylight unless an adequate lighting system meeting the approval of the Engineer is provided.

Do not exceed a temperature of 95°F in the freshly mixed concrete when placed in the forms.

Place the concrete in the bed in one continuous operation, finishing each member before proceeding to the next one. If the pour stops before the concrete in all the members in the bed is placed, start curing immediately. Do not place concrete in any remaining members in that bed setup once curing at elevated temperatures has begun.

When cored slabs and box beams are cast, employ an approved internal hold-down system to prevent the voids from moving. At least 6 weeks before casting cored slabs or box beams, submit to the Engineer for review and comment, detailed drawings of the proposed void material and hold-down system. In addition to structural details, indicate the location and spacing of the holds-downs. Submit the proposed method of concrete placement and of consolidating the concrete under the void.

The use of an approved external hold-down system may be used in conjunction with an approved internal hold-down system with the understanding that the external hold-down system shall be removed while the concrete remains plastic. The areas where an external hold-down

system exits the surface of the member shall be consolidated and finished with the surrounding area as specified in Article 1078-16.

1078-10 PLACING PRESTRESSED CONCRETE IN COLD WEATHER

(A) General

Place concrete when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is 35°F and rising. When the temperature allows, uniformly heat the aggregates and or water to a temperature not higher than 150°F. Place the concrete when the temperature of the heated concrete is at least 55°F and not more than 95°F.

Use aggregates that are free of ice, frost and frozen particles. Do not place concrete on frozen foundation material and ensure that the forms are free of ice.

Follow the guidelines set forth in Article 1078-11 for proper curing methods when placing concrete in cold weather.

Protect all concrete with heated enclosures or by insulation when the concrete is placed when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat is between 35°F and 50°F.

Provide and place, at directed locations, a sufficient number of maximum-minimum recording thermometers to provide an accurate record of the temperature surrounding the concrete during the entire protection /curing period. Place maximum-minimum recording thermometers within 50 feet of each end of the bed and at points not to exceed 100 feet between the end thermometers. Provide at least two thermometers for bed lengths of 100 feet or less.

Assume all risks connected with the placing of concrete under the cold weather conditions referred to herein.

(B) Heated Enclosures

Immediately enclose concrete that is placed when the air temperature is below 50°F. Enclose the concrete with a housing consisting of canvas or other approved material supported by an open framework which allows for the heat to be evenly circulated within the enclosure. Maintain the air surrounding the concrete at a temperature of at least 50°F and no more than 90°F when using dry heat. When using dry heat, provide means of preventing loss of moisture from the concrete.

1078-11 CURING CONCRETE

(A) General

Cure concrete by steam curing, radiant heat curing, portable heaters or water curing, as set forth below. As an option, cure concrete for prestressed piles with membrane curing compound as set forth below. Use a method or methods that prevent the concrete from losing moisture at any time before curing is complete. Use methods that do not deface or injure the concrete. Use curing procedures that prevent cracks from occurring in the members. Cure all members in any one bed by the same method.

Continue the curing period until the concrete reaches sufficient strength to permit transfer of load from the anchorage to the members. As soon as the concrete attains release strength, immediately release all forms in a continuous operation, without delay for other activities such as the cleaning of forms. As soon as the forms are removed, and after the Department's Inspector has had a reasonable opportunity to inspect the member, transfer the load from the anchorages to the members as quickly as possible in one continuous operation using the approved detensioning sequence.

(B) Curing at Elevated Temperatures

Perform radiant heat curing under a suitable enclosure that contains the heat and prevent moisture loss. Apply moisture by a cover of moist burlap, cotton matting, or similar approved material. Retain moisture by covering the member with an approved waterproof sheeting in combination with an insulating cover. Support the cover at a sufficient distance above the member being cured to allow circulation of the heat.

Provide steam curing enclosures essentially free of steam leakage to minimize moisture and heat losses. Do not allow the enclosure to come in contact with the members or forms for the members. Do not direct steam jets on the forms so as to cause localized high temperatures.

After placing and vibrating, allow the concrete to attain its initial set before the application of heat or steam. The concrete is considered to obtain its initial set when it has a penetration resistance of at least 500 psi when tested in accordance with AASHTO T 197. Take the sample of concrete tested for penetration resistance from the last load cast in the bed. Store the sample of concrete with the precast member and maintain in the same condition and environment as the member except for the periods of time necessary to prepare the test specimen and to perform the penetration resistance test. Conduct the penetration resistance test.

As an option, submit data indicating that an approved concrete mix attains its initial set after some particular time period. Different periods may be required for different weather conditions. If such data is submitted, consideration is given to permitting heat or steam introduced after the time indicated by such data instead of having to perform the penetration resistance test. Consideration is given to determining the time of initial set by methods other than AASHTO T 197 provided data supporting such other methods is submitted.

When the ambient air temperature is below 50°F, cover the forms after the placement of concrete and apply sufficient heat to maintain the temperature of the air surrounding the unit between 50° and 70°F.

When the ambient air temperature is above 70°F, start a water cure as set forth below or other approved method as soon as the concrete is able to receive the water without physical damage to its surface. Discontinuation of the cure is allowed upon introduction of steam, provided that a relative humidity of 100% is maintained.

The temperature within the curing enclosure shall not exceed 160°F.

Maintain a relatively uniform rate of increase of the temperature within the curing enclosure of approximately 40°F per hour, not to exceed 15°F per 15 minutes. Ensure that the temperature increase is relatively uniform throughout the length and on both sides and top of the concrete unit. Place recording thermometers within 50 feet of each end of the bed and at points not to exceed 100 feet between the end thermometers. Provide at least two thermometers for bed lengths of 100 feet or less. Calibrate recording thermometers at intervals not to exceed 6 months. Ensure that the temperature differential within the curing enclosure does not exceed 15°F. Submit complete temperature records for all cures before final approval of the members.

Continue steam curing until the concrete reaches the required transfer strength.

(C) Water Curing

Keep the concrete members damp by the application of water as soon as possible without damage to the concrete surface, and before the concrete obtains an initial set of 500 psi. Apply the water using soaker hoses and wet burlap or other approved means for the full length of each member. Apply water evenly along the entire length of the bed and as needed to maintain damp conditions.

When the ambient air temperature is below 50°F cover the forms after the placement of the concrete and apply sufficient heat in an approved manner to maintain the temperature of the air surrounding the member between 50°F and 70°F. After the concrete obtains an initial set of 500 psi, the air temperature surrounding the member is allowed to increase to 100°F while continually maintaining moisture on the surface of the concrete. Whenever heat is applied to the member, place temperature recording clocks on the bed as required when curing at elevated temperatures. The requirements for rate of temperature increase apply.

Maintain the application of heat (if used) and water until the concrete obtains release strength.

(D) Curing with Membrane Curing Compound

As an option, cure prestressed concrete piles with a membrane curing compound. Spray the entire surface of the concrete uniformly with a wax-free, resin-base curing compound conforming to Article 1026-2. Use clear curing compound to which a fugitive dye is added for color contrast.

Apply the membrane curing compound after the surface finishing is complete, and immediately after the free surface moisture disappears. In the event the application of curing compound is delayed, start another curing method immediately and continue until the application of the curing compound is started or resumed or until the concrete reaches the required detensioning strength.

Seal the surface with a single uniform coating of the specified type of curing compound applied at the rate of coverage recommended by the manufacturer or as directed by the Engineer, but not less than one gallon per 150 sf of area.

At the time of use, thoroughly mix the compound in a condition with the pigment uniformly dispersed throughout the vehicle. If the application of the compound does not result in satisfactory coverage, stop the method and apply water curing, as set out above, until the cause of the defective work is corrected.

At locations where the coating shows discontinuities, pinholes, or other defects, or if rain falls on the newly coated surface before the film dries sufficiently to resist damage, apply an additional coat of the compound immediately after the rain stops at the same rate specified herein.

When the ambient air temperature is below 50°F, cover the forms after the application of the curing compound and apply sufficient heat in an approved manner to maintain the temperature of the air surrounding the member between 50°F and 70°F. Whenever heat is applied to the members, place recording thermometers on the bed as required when curing at elevated temperatures. The requirements for rate of temperature increase also apply.

Completely remove any curing compound adhering to a surface to which new concrete is bonded by sandblasting, steel wire brushes, bush hammers or other approved means.

Protect the concrete surfaces to which the compound is applied from abrasion or other damage that results in perforation of the membrane film until the concrete achieves design strength and the members are de-tensioned.

1078-12 TRANSFER OF LOAD

A producer quality control representative or equivalent qualified personnel shall be present during removal of forms and during transfer of load.

Transfer load from the anchorages to the members when the concrete reaches the required compressive strength shown in the plans. Loosen and remove all formwork in one continuous operation as quickly as possible as soon as release strength is obtained. As soon as the forms are removed, and after the Department's Inspector has had a reasonable opportunity to inspect

the member, transfer the load from the anchorages to the members as quickly as possible in one continuous operation using the approved detensioning sequence.

For any particular group of members cast in the same bed, do not transfer the load to any concrete until the test cylinder breaks indicate that the concrete in all these members has reached the required strength as outlined in Subarticle 1078-4(C)(3). If these conditions are not met, delay the transfer of the prestressing load to the concrete until tests of additional cylinders show that the required strength is reached.

When curing at elevated temperatures, begin the procedures for transferring prestressing load immediately after curing is discontinued and the forms are released, and while the concrete is still hot to prevent cooling shrinkage and cracking. If so directed by the Engineer, cover members or otherwise protect so as to cool the concrete slowly after release to prevent thermal shock and the evaporation of moisture in the members.

Transfer load to not cause cracks in members. Transfer load by gradual release of the strands as a group, by gradual release of part of the group, or by burning the fully tensioned strands at the ends of the members. If intending to release the strands by a method other than gradual release of the entire group, submit the proposed method and pattern of release, if not so shown in the plans, for approval by the Engineer. Rigidly follow the approved method and pattern of release. When the fully tensioned strands are burned, burn each strand or group of strands simultaneously at each end of the bed in its indicated order in the pattern and at each end of each member before proceeding to the strands in the next group in the pattern at any point. Because of the critical nature of the bond development length in prestressed concrete panel construction, if transferring of stress by burning the fully tensioned strands at the ends of the member, burn each strand first at the ends of the bed and then at each end of each member before proceeding to the next strand in the burning pattern.

When detensioning all girders, box beams, cored slabs, piles, and panels do not burn strands quickly but heat with a low oxygen flame played along the strand for at least 5 inches until the metal gradually loses its strength. Apply heat at such a rate that failure of the first wire in each strand does not occur until at least 5 seconds after heat is first applied. When detensioning other members, follow the above procedure unless an alternate procedure is approved by the Engineer. Detensioning by arc welder is not allowed.

Incorporate the following in the method for single strand detensioning of members having draped strands:

(A) Release the pair of straight strands located in the uppermost position in the lower flange first.

(B) Then release the tension in the draped strands at the ends and uplift points in accordance with an approved pattern.

(C) Disengage all hold-down devices for draped strands and release the hold-downs.

(D) Then release the pair of straight strands located in the upper flange.

(E) Release the remaining straight strands of the pattern in accordance with an approved sequence.

(F) Release all strands in a manner meeting the Engineer's approval that will cause a minimum shock and lateral eccentricity of loading.

Failure to follow the above procedures for transfer of load is ground for rejection of the members involved.

1078-13 VERTICAL CRACKS IN PRESTRESSED CONCRETE GIRDERS BEFORE DETENSIONING

This section addresses prestressed concrete members that have vertical casting cracks before strand detensioning. Certain types of these cracks have been determined by the Department to render the girders unacceptable.

Unacceptable cracked members are those with two or more vertical cracks spaced at a distance less than the member depth which extend into the bottom flange. Such members are not serviceable and will be rejected by the Engineer. Members with two or more vertical cracks spaced at a distance less than the member depth but do not extend into the bottom flange are subject to an engineering assessment. Such members may not be serviceable and may be rejected by the Engineer.

Members with one or more vertical cracks that extend into the bottom flange and are spaced at a distance greater than the member depth are subject to an engineering assessment to determine their acceptability. If this engineering assessment is required, submit, at no additional cost to the Department, a proposal for repairing the member and a structural evaluation of the member prepared by an engineer licensed by the State of North Carolina. In the structural evaluation, consider the stresses under full service loads had the member not cracked and the effects of localized loss of prestress at the crack as determined by methods acceptable to the Department.

All members, except those defined as unacceptable, which exhibit vertical cracks before detensioning, shall receive a 7 day water cure as directed by the Engineer. The water cure shall begin within 4 hours after detensioning the prestressing strands and shall be at least 3 feet beyond the region exhibiting vertical cracks.

The Department has the final determination regarding acceptability of any members in question.

1078-14 PRESTRESSED CONCRETE GIRDER WEB SPLITTING

After detensioning of certain girders with draped strands, cracks occasionally occur in the webs at the ends of the girders.

Repair all cracks located in the web of girders appearing after detensioning that are 0.010 inches (0.25 mm) or greater in width by means of epoxy injection in accordance with the Standard Specifications and as approved by the Engineer.

Repair any web cracks that are less than 0.010 inches (0.25 mm) and greater than 0.005 inches (0.15 mm) in width by coating them with an approved clear, water based alkylalkoxysilane (silane) penetrating sealant having 100% solids. Use a sealant that meets the requirement of NCHRP 244 and Federal AIM VOC emissions standards and has been approved by the Engineer. Coat web cracks between 0.005 inches (0.15 mm) and 0.010 inches (0.25 mm) in width with silane within 2 weeks after they appear or before shipment to the site whichever occurs soonest.

Cracks located in the web less than or equal to 0.005 (0.15 mm) in width need not be coated.

Do not repair or coat any cracks without prior approval of the Engineer. No separate payment will be made for the treatment of cracks, as payment is included in the contract unit price bid for prestressed concrete girders..

1078-15 HANDLING, TRANSPORTING AND STORING

Members damaged while being handled or transported are rejected or require repair in a manner approved by the Engineer. All members are allowed to be handled immediately after transfer of load from the anchorages to the members is complete.

Store all prestressed members on solid, unyielding, storage blocks in a manner to prevent torsion or objectionable bending. In handling prestressed concrete girders 54 inches or less in height, including cored slabs and box beams, maintain them in an upright position at all times and pick them up within 5 feet of the points of bearing and transport and store supported only

within 3 feet of points of bearing. In handling prestressed concrete girders greater than 54 inches in height, maintain them in an upright position at all times and submit for approval the proposed method of lifting, transporting, and storing the girders. When requested, provide calculations to confirm girders are not overstressed by such operations.

Prestressed concrete panels are weak in the direction perpendicular to the prestressing strands; therefore, they are subject to breakage during handling, storing or transporting. Provide adequate blocking during all of these construction phases.

In handling, transporting, and storing prestressed members, use the number and location of supports in accordance with the plan requirements for the sizes, lengths and types of members involved, or as approved by the Engineer.

When handling the prestressed concrete members, a temporary stress of $5\sqrt{f_{ci}}$ is permitted, where f_{ci} is the strength of concrete at release, in pounds per square inch.

Do not transport members away from the casting yard until the concrete reaches the minimum required 28 day compressive strength and a period of at least 5 days elapses since casting, unless otherwise permitted.

Do not transport any member from the plant to the job site before approval of that member by the plant inspector. Such approval will be indicated by the compliance with the Department's RFID tag/label tagging policy in accordance with Section 1030 and verified product approval as noted by an authorized Field Inspection Report (FIR) or NCDOT alternate ID.

1078-16 FINAL FINISH

Finish prestressed concrete members that are intended for composite action with subsequently placed concrete or asphalt with a roughened surface for bonding. Make sure that no laitance remains on the surfaces to be bonded.

Rough float the tops of girders with the exception of the centerline and outside 4 inches of each girder which shall receive a smooth finish. Broom finish the top surface of the cored slab and box beam sections receiving an asphalt overlay. Rake the top surface of cored slab and box beam sections receiving a concrete overlay to a depth of 1/4 inch. No surface finish is required for sides and bottom of the slab and beam sections except the exposed side of the exterior unit as noted below. Provide a resulting surface finish essentially the same color and surface finish as the surrounding concrete.

Provide a 3/4 inch chamfer along the bottom edges on ends and sides of all box beam and cored slab sections, top outside edges of exterior sections and acute corners of sections. Round the top edges on ends of all sections with a 1/4 inch finishing tool. Provide square corners along top edges on all sections along shear keys. Do not chamfer vertical edges at ends of sections.

Fill all voids in the diagonal/curved face of the bottom flange of prestressed concrete girders and the outside face of exterior cored slabs and box beams with a sand-cement or other approved grout. Fill all voids in piles greater than 1/2 inch in diameter or depth as above. Provide a resulting surface finish essentially the same color and surface finish as the surrounding concrete. Repair voids greater than 1/4 inch in diameter or depth in other faces of these and other members except piles in a like manner. Where an excessive number of smaller voids exist in any member, the Engineer requires a similar repair.

Repair honeycomb, excessively large fins, and other projections as directed by the Engineer. Submit, at no additional cost to the Department, a proposal for repairing members with honeycomb, cracks or spalls. Do not repair members containing honeycomb, cracks, or spalls until a repair procedure is approved and the member is inspected by the Engineer. Any appreciable impairment of structural adequacy that cannot be repaired to the satisfaction of the Engineer is cause for rejection.

Clean and fill holes caused by strand hold downs upon removal from the casting bed. Use an approved material for patching that is listed on the NCDOT APL. Ensure that members are clean and surfaces have a uniform appearance.

Give the top surface of prestressed concrete panels a raked finish or other approved finish to provide an adequate bond with the cast-in-place concrete. As soon as the condition of the concrete permits, rake the top surface of the concrete making depressions of approximately 1/4 inch. Take care when raking not to catch and pull the coarse aggregate.

Clean reinforcing bars exposed on the tops of girders and exterior cored slabs or box beams of mortar build up and excessive rust.

Apply epoxy protective coating to the ends of prestressed members as noted in the plans.

1078-17 ALIGNMENT AND DIMENSIONAL TOLERANCES

(A) Piles

Manufacture piles within the tolerances indicated in Table 1078-2 and Figure 1078-1.

(B) Cored Slabs

To ensure a good, neat field fit, assemble cored slab spans in the yard and have pieces matchmarked. Ensure that pieces fit together neatly and in a workmanlike manner.

Manufacture cored slabs within the tolerances indicated in Table 1078-3 and Figure 1078-2.

(C) Girders

Manufacture girders within the tolerances indicated in Table 1078-4 and Figure 1078-3.

(D) Prestressed Concrete Panels

Manufacture prestressed concrete panels within the tolerances indicated in Table 1078-5.

(E) Box Beams

To ensure a good, neat field fit, assemble box beam spans in the yard and have pieces match-marked. Ensure that pieces fit together neatly and in a competent manner.

Manufacture box beams within the tolerances indicated in Table 1078-6 and Figure 1078-4.

1078-18 IDENTIFICATION OF MEMBERS

Permanently identify each prestressed member by number and date of manufacture, and paint this information, or otherwise mark as approved by the Engineer, on at least one end of the member as soon as practical after manufacture. In the case of girders or cored slabs, paint other identification as to station, span and position within the span on at least one end of the member. All members shall additionally be identified by the use of an RFID tag/label embedded into the member in accordance with Section 1030 applied in accordance with Subarticle 1030-2(F).

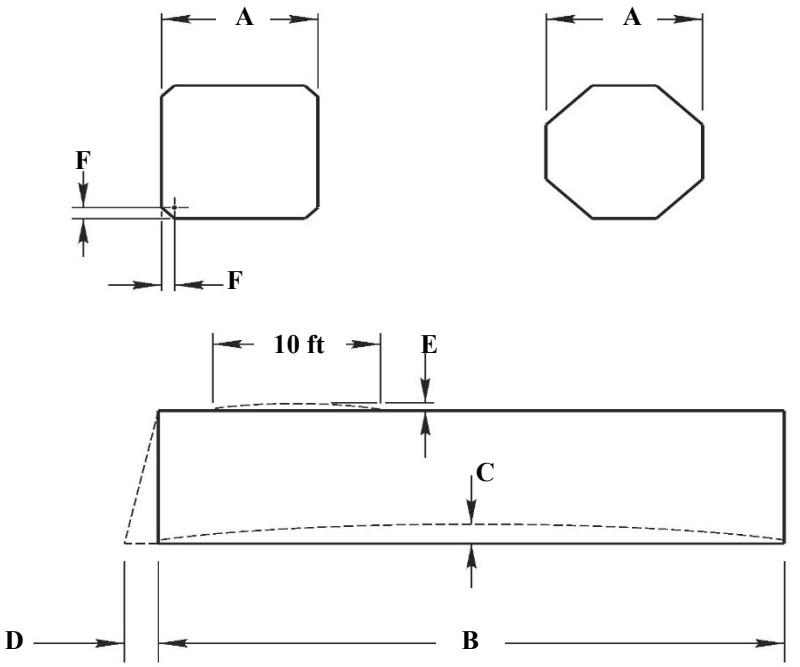
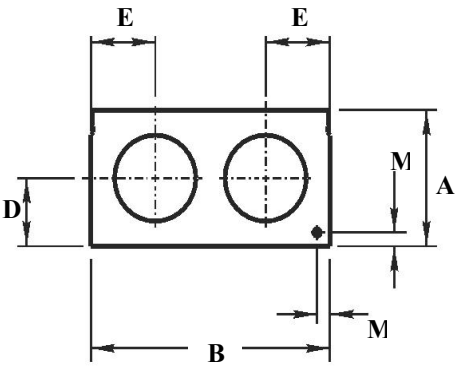


Figure 1078-1. Prestressed Piles. Dimensions shown are in Table 1078-2.

TABLE 1078-2 TOLERANCES FOR PRESTRESSED PILES (Refer to Figure 1078-1)	
Dimension	**Tolerance**
Width (A)	-1/4" to +3/8"
Length (B)	± 1 1/2"
Horizontal alignment Deviation from a straight line parallel to the centerline of pile (C)	1/8" per 10 ft
Squareness of ends (D)	1/8" per 12" of width, 3/16" max.
Local smoothness (E)	1/4" in 10 ft
Position of strands (F)	1/4"
Position of mild reinforcing steel, including spiral pitch	1/2"



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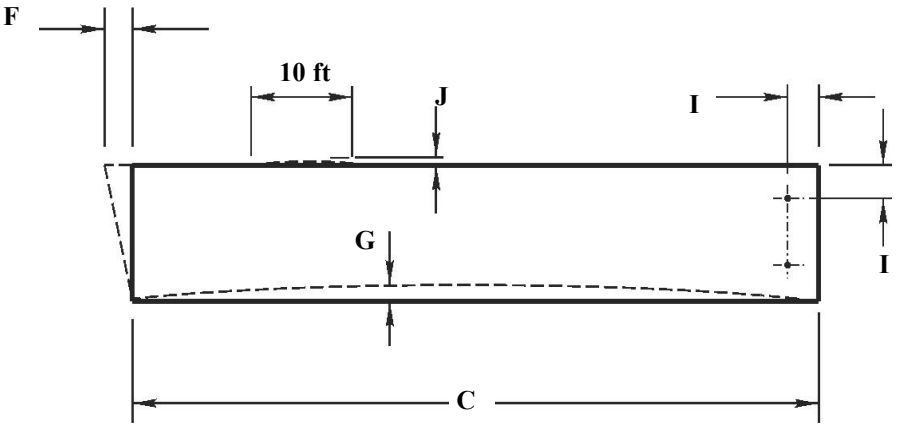

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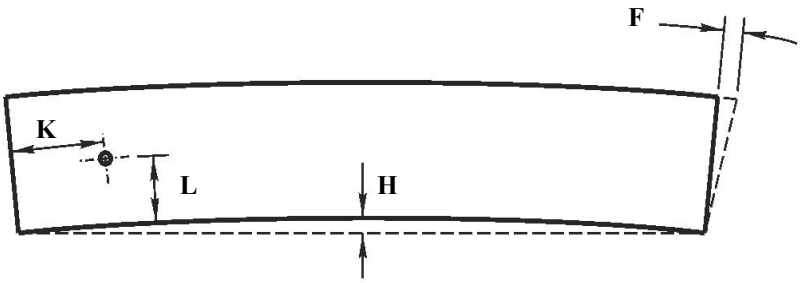


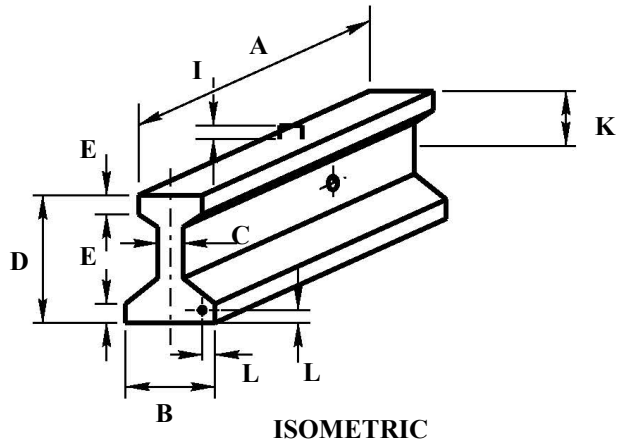
ELEVATION

1 **Figure 1078-2. Prestressed cored slabs.** Dimensions shown are in Table 1078-3.

TABLE 1078-3 TOLERANCES FOR PRESTRESSED CORED SLABS (Refer to Figure 1078-2)	
Dimension	**Tolerance**
Depth (A)	+3/8" to -1/8"
Width (B)	± 1/4"
Length (C)	± 1/8" per 10 ft
Position of voids - Vertical (D)	± 3/8"
Position of voids - Horizontal (E)	± 3/8"
Position of void Ends – Longitudinal	+1", -3"
Square ends - Deviation from square (horizontal)or vertical) or designated skew (F)	±1/4"
Horizontal alignment - Deviation from a straight line parallel to the centerline of member (G)	0-30 ft long: 1/4" 30-50 ft long: 3/8" 50+ ft long: 1/2"
Camber - Differential between adjacent units (H)	1/4" per 10 ft, 3/4" max.
Camber - Differential between high and low members of same span (H)	3/4" max.
Position of dowel holes - Deviation from plan position (I)	1/4"
Width - Any one span	Plan width +1/8" per joint
Width - Differential of adjacent spans in the same structure	1/2"
Bearing area - Deviation from plane surface	1/16"
Local smoothness (J)	1/4" in 10 ft
Position of holes for transverse strands	Horizontal (K): ±1/2" Vertical (L): ±3/8"
Position of strands (M)	± 1/4"

1078-19 QUALITY CONTROL

Maintain a daily quality control record form approved by the Engineer including pertinent information concerning tensioning, concrete quality and placement, curing and detensioning. Have this form signed and dated by a certified concrete technician. Furnish a copy of the completed or up-to-date form to the Materials and Tests Unit upon request and before any members are approved. A sample form, indicating the minimum required information, is available from the Materials and Tests Unit.



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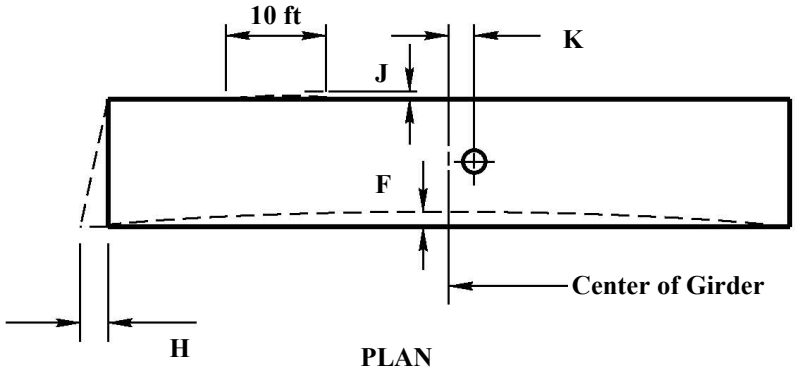

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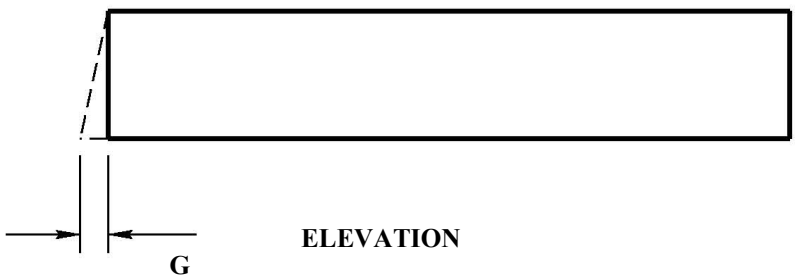


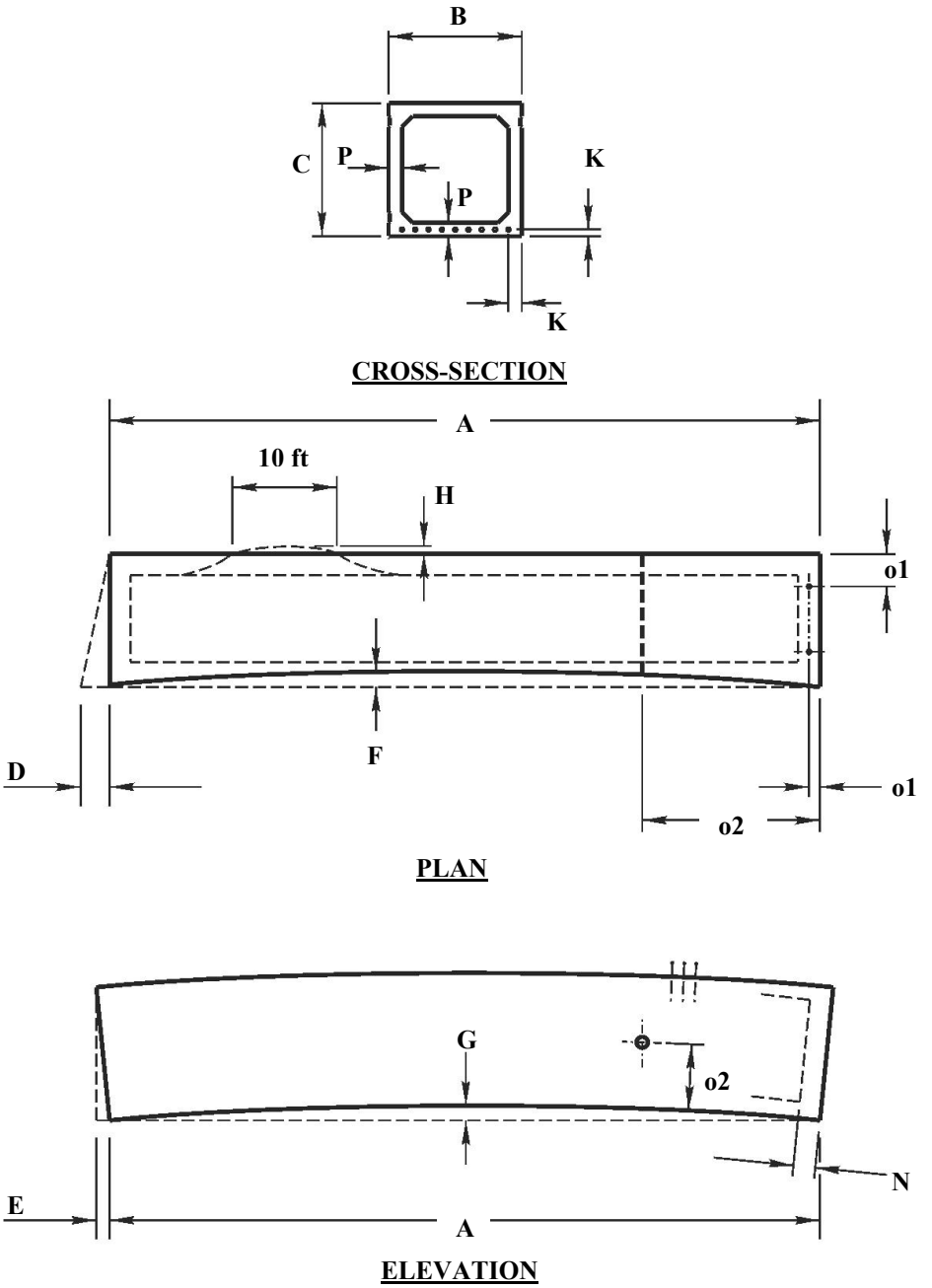
ELEVATION

1 **Figure 1078-3. Prestressed Girders.** Dimensions shown are in Table 1078-4.

TABLE 1078-4 TOLERANCES FOR PRESTRESSED GIRDERS (Refer to Figure 1078-3)	
Dimension	**Tolerance**
Length (A) Girders 80 ft. or shorter	± 1/8" per 10 ft
Length (A) Girders longer than 80 ft.	± 1/8" per 10 ft Not to exceed 1 1/2"
Width - Flanges(B)	+3/8" to -1/8"
Width - Web (C)	+3/8" to -1/8"
Depth - Overall (D)	+1/2" to -1/4"
Depth - Flanges (E)	± 1/4"
Horizontal alignment (top or bottom flange) Deviation from a straight line parallel to the centerline of beam (F)	± 1/8" per 10 ft Not to exceed 1.5"
Bearing plate Deviation from plane surface	1/16"
Girder ends Deviation from square or designated skew (G and H)	Vertical (G): ± 1/8" per 12" of girder height Horizontal (H): ± 1/2"
Position of stirrups - Projection above top of girder (I)	± 1/2"
Position of stirrups – Placement along girder length	± 1"
Local smoothness of any surface (J)	1/4" in 10 ft
Position of holes for diaphragm bolts (K)	± 1/4"
Position of strands (L)	± 1/4"

Dimensions followed by an alphabetical suffix are shown in Figure 1078-3. The length (A) is measured along the top of the top flange. The tolerances at girder ends (G and H) are increased to 1 inch if the girder end is to be encased in a full depth concrete diaphragm.

TABLE 1078-5 TOLERANCES FOR PRESTRESSED CONCRETE PANELS	
Dimension	**Tolerance**
Length (Transverse direction to girders)	-1/4" to +1/2"
Width (Longitudinal direction to girders)	-1/8" to +1/4"
Depth	0 to +3/8"
Position of Strand Horizontal Dimension Vertical Dimension	 ± 1/4" ± 1/4"



1 **Figure 1078-4. Prestressed Box Beams.** Dimensions shown are in Table 1078-6.

TABLE 1078-6 TOLERANCES FOR BOX BEAMS (Refer to Figure 1078-4)	
Dimension	**Tolerance**
Length (A)	± 1"
Width (overall) (B)	± 1/4"
Depth (overall) (C)	+ 1/4"
Variation from specified plan end squareness or skew (D)	± 1/8" per 12" width, ± 1/2" max
Variation from specified elevation end squareness or skew (E)	± 1/8" per 12", ± 1/2" max
Sweep, for member length (F) up to 40 ft	± 1/4"
Sweep, for member length (F) 40 to 60 ft	± 3/8"
Sweep, for member length (F) greater than 60 ft	± 1/2"
Differential camber between adjacent members (G):	1/4" per 10 ft., 3/4" max
Local smoothness of any surface (H)	1/4" in 10 ft
Position of strands (K)	± 1/4"
Longitudinal Position of blockout (N)	± 1"
Position of dowel holes (o1)	± 1/4"
Position of sleeves cast in beams, in both horizontal and vertical plane (o2)	± 1/2"
Position of void (P)	± 3/8"
Bearing area – deviation from plane surface	± 1/16"
Width - Any one span	Plan width + 1/8" per joint
Width – Differential of adjacent spans in the same structure	1/2"

SECTION 1079
BEARINGS AND BEARING MATERIALS

1079-1 PREFORMED BEARING PADS

Provide preformed bearing pads composed of multiple layers of 8 oz/sy cotton duck impregnated and bound with high quality natural rubber, or equally suitable materials approved by the Engineer, that are compressed into pads of uniform thickness. Ensure that the thickness of the preformed bearing pads is 3/16 inch with a tolerance of ± 1/16 inch. Use cotton duck that meets Military Specification MIL-C-882-E for 8 oz/sy cotton army duck or equivalent. Provide enough pads as to produce the required thickness after compressing and vulcanizing. Ensure that the finished pads withstand compressive loads perpendicular to the plane of the laminations of not less than 10,000 psi without detrimental extrusion or reduction in thickness.

Furnish a Type 3 certification in accordance with Article 106-3 certifying that the preformed bearing pads meet this specification.

1079-2 ELASTOMERIC BEARINGS

(A) General

Provide elastomeric bearings that meet the requirements of AASHTO M251, except as specified herein.

Use elastomeric bearings provided by a NCDOT approved as found on the Department's producer/supplier list. All producer/suppliers must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT producer/supplier list. Submit working drawings and manufacturing procedures for approval by the Engineer. Refer to Subarticles 1079-2(D). Furnish a Type 3 certification in accordance with Article 106-3 certifying that elastomeric bearings satisfy this *Standard*

Specification and all design criteria. Include the lot number, description and test results in the certification.

Internal holding pins are required for all shim plates when the contract plans indicate the structure contains the necessary corrosion protection for a corrosive site.

Repair laminated (reinforced) bearing pads utilizing external holding pins via vulcanization. Submit product data for repair material and a detailed application procedure to the Materials and Tests Unit for approval before use and annually thereafter.

(B) Elastomer Properties

The elastomer for all bearings shall be classified as Grade 3.

The shear modulus of the elastomer for laminated (reinforced) bearings shall be 160 psi, unless otherwise noted in the plans.

Provide Grade 50 or Grade 60 durometer hardness elastomer in all (unreinforced) bearings, unless otherwise noted in the plans.

(C) Testing

The optional test procedures of AASHTO M 251 are not required, except as specified herein.

Determine the shear modulus of the elastomer for laminated (reinforced) bearings in accordance with ASTM D4014.

At the Manufacturer's option, plain (unreinforced) bearings may be tested using the methods of Appendices X1 and X2 of AASHTO M 251.

Test at least two bearings per lot or as directed by the Engineer. Define a “lot” as a group of 100 or less bearings with or without holes or slots, which are:

(1) Manufactured in a reasonably continuous manner from the same batch of elastomer and cured under the same conditions, and

(2) Of the same type (plain or laminated) and of similar size (no dimensions shall vary by more than 40%).

A lot may include bearings from multiple projects and purchasers.

(D) Working Drawings

Submit a set of detailed fabrication drawings and procedures of laminated (reinforced) bearings to the Engineer for review, comments and acceptance. Show complete details and all material specifications. Clearly identify any proposed deviations from details shown in the plans or requirements of the *Standard Specifications*. Obtain drawing approval before manufacturing of the bearings.

SECTION 1080
PAINT AND PAINT MATERIALS

1080-1 GENERAL

All batches or lots of paint products shall be Department approved prior to use by the Materials and Tests Unit. Self-curing inorganic zinc paint shall also be pre-qualified as required in Article 1080-5. Deliver all Department approved paints to the point of application in sealed and original containers clearly marked with the type of paint and batch or lot numbers clearly labeled on the container. At the point of application all paints shall arrive ready to be mixed for use without additional oil or thinner. Mix all paints in accordance with the manufacturer’s printed instructions. All paints or paint components that harden or curdle in the container and will not break up with a paddle to form a smooth, uniform consistency will be rejected by the Engineer. Any thinning necessitated by weather conditions shall be approved in writing and

use only those thinners approved by the manufacturer. Thinning of any waterborne paints shall be prohibited. Upon receipt at the point of application, store all paint materials in a moisture free environment between 40°F and 110°F or at such temperatures within this range recommended by the manufacturer of which the more stringent shall apply. The storage areas shall be equipped with a device capable of recording daily high and low temperatures.

1080-2 PAINT VEHICLES, THINNERS AND DRYERS

Paint vehicles, thinners and dryers shall meet the requirements for these ingredients that are included in the *Standard Specifications* for the paint being used. Only ingredients recommended by the manufacturer which have a history of compatibility with each other and so recorded on the manufacturer product data sheet may be used.

1080-3 PACKING AND MARKING

Ship paint and paint materials in strong, substantial containers that are properly labeled and plainly marked with the weight, color and volume in gallons of the paint content; a true statement of the percentage composition of the pigment; the proportions of pigment to vehicle; and the name and address of the manufacturer. Any package or container not so marked as described above or exceeding 5 gallons total volume shall require prior approval by the Department.

1080-4 INSPECTION AND SAMPLING

All paint components shall be sampled and approved by the Department's Material and Tests Unit, either at the point of manufacture or at the point of application. Inspection and sampling will be performed at the point of manufacture wherever possible. The Contractor shall not begin painting until the analysis of the paint has been performed, and the paint has been accepted by the Department. When sampling paint products, use the Department sampling procedure. In order for materials to be evaluated and accepted by the Department, coating manufacturers shall submit completed performance test data from the AASHTO Product Evaluation & Audit Solutions or test results from ISO certified laboratories reporting requirements as required for each paint listed in Articles 1080-5 through 1080-10.

1080-5 SELF-CURING INORGANIC ZINC PAINT

Use only Department approved and qualified inorganic zinc paint. These products shall be requalified every five years unless the formulation of the product or manufacturing process is changed, in which case, the product shall be requalified before use. Samples for qualification shall be submitted to the State Materials Engineer six months in advance along with the following:

(A) A minimum one quart sample of each component of paint including the manufacturer's name, location, product name, mixing instructions, batch number and SDS.

(B) At least three panels prepared as specified in AASHTO M 300, Bullet Hole Immersion Test.

(C) At least six panels of 4 inch x 6 inch x 1/4 inch for the MEK Rub test, ASTM D4752 and the Adhesion Pull Test, ASTM D4541.

For new qualifications or where product formulation has changed provide the Department the following.

(A) A certified test report from an approved independent testing laboratory that the product has been tested for slip coefficient and meets AASHTO M 300, Class B.

(B) A certified test report from an approved independent test laboratory for the Salt Fog Resistance Test, Cyclic Weathering Resistance Test, and Bullet Hole Immersion Test as specified in AASHTO M 300.

Use the same batch of paint for all samples and panels. The independent test laboratory report may be for a typical batch of the same product. Submit samples and reports for qualification at least six months in advance of anticipated need. The Materials and Tests Unit will conduct all tests of paints in accordance with ASTM, Federal Test Method Standard No. 141 and various other methods in use.

Use a self-curing inorganic zinc paint meeting the Type I Inorganic Zinc Primer paint specified in AASHTO M 300 and the following:

(A) Use mixed paint with zinc content of not less than 72% by mass of the total solids.

(B) The slip coefficient meets AASHTO M 300, Class B.

(C) The adhesion shall be no less than 400 psi in accordance with ASTM D4541.

(D) Cure the paint to meet the solvent rub requirements in ASTM D4752.

(E) Formulate the paint to produce a distinct contrast in color with the blast cleaned metal surfaces and with the finish paint.

1080-6 COAL TAR EPOXY PAINT

Use coal tar epoxy paint meeting SSPC-Paint 16.

1080-7 ORGANIC-ZINC REPAIR PAINT

Use organic-zinc repair paint meeting SSPC-Paint 20 Type II or Federal Specification TT-P-641. Organic-zinc repair paint is not tinted and is applied 3 to 4 wet mils of paint per coat. Do not use zinc paint in aerosol spray cans. Use organic-zinc repair paint that is listed on the NCDOT APL.

1080-8 METALLIZATION SEALERS

Use low-viscosity, clear or colored and pigmented as approved by the Engineer. Sealer products are formulated to flow over and be absorbed into the natural pores of the thermal sprayed coating (TSC). The pigment particle size for colored sealer must be small enough to flow easily into the pore of the TSC, nominally a 5-fineness of grind per ASTM D1210.

1080-9 WATERBORNE PAINTS

Paint manufacturers must have a Department approved and qualified self-curing inorganic zinc product to submit a waterborne paint product for approval.

(A) Composition

Use ingredients and proportions as specified in Tables 1080-1 through 1080-3. Do not use Chrome Green.

Provide raw materials based on the specified ingredients that are uniform, stable in storage, and free from grit and coarse particles. Do not use rosin or rosin derivatives. Beneficial additives such as anti-skinning agents, suspending agents or wetting aids are allowed.

(B) Properties

(1) General

Use both Type I and II paints that meet Tables 1080-1 through 1080-3.

(2) Odor

Normal for the materials permitted in accordance with ASTM D1296.

(3) Color

The colors before and after weathering when compared with AMS-STD-595 are Brown #30045, Green #24108 and Gray #26622. There are no color requirements for white waterborne paint. The Engineer may approve the use of semi-gloss or gloss products for the above Department colors.

(4) Working Properties

Use a paint that is easily applied by brush, roller or spray when tested in accordance with Federal Test Method Standard No. 141, Methods 4321, 4331 and 4541. Ensure that the paint shows no streaking, running or sagging during application or while drying.

(5) Storage Conditions

Prior to application, ensure that the paint shows no thickening, curdling, gelling or hard caking when tested as specified in Federal Test Method Standard No. 141, Method 3011, after storage for 6 months from the date of delivery, in a full, tightly covered container, at a temperature of 50°F to 110°F.

(6) Skinning

No skinning is allowed in a 3-quarters filled closed container after 48 hours when tested in the standard manner specified in Federal Test Method Standard No. 141, Method 3021.

(7) Salt Contamination

Minimize the content of salt contamination by the incorporation of only high purity materials. Ensure that the specific resistance of the aqueous leachate of the composite of the pigments in required proportions is at least 5,000 ohm-cm when tested in accordance with ASTM D2448.

(8) Early Rust Resistance

Provide each type of paint that meets the early rust requirements specified in *Structural Steel Shop Coatings Program* Section 7.

(C) Inspection

All materials supplied under this Specification are subject to random inspection by the Department.

Supply samples of any or all ingredients used in the manufacture of this paint, along with the supplier's name and identification for the material when requested.

(D) Volatile Organic Compound (VOC) Content

Ensure that the VOC content after formulation, but before thinning, complies with the VOC limit for the applicable coatings category per Federal regulations. Notify the coating specifier if State or local regulations reduce the maximum VOC content permitted for coatings applied in a specific locality.

(E) Color Variation

A color variation of 5 Δe units from the specified color will be acceptable. After 3 months weathering, the color shall not vary more than 5 Δe units from the original color value.

Table 1080-1
Composition of Pigments for Waterborne Paints, % By Weight

Property	Brown		White		Gray		Test Method
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	
Pigment Content	20%	25%	35%	40%	13%	17%	ASTM D3723
Major Pigments							
Calcium Carbonate	-	-	30%	-	-	-	ASTM D1199
Magnesium Silicate	-	-	-	12%	-	-	ASTM D605
Titanium Dioxide	-	-	45%	-	70%	-	ASTM D476, Type II
Zinc Phosphate	10%	-	10%	-	10%	-	ASTM D6280
Iron Oxide	45%	-	-	-	-	-	ASTM D3721
Tinting Pigments							
Lamp Black	-	-	2%	-	-	-	ASTM D209
Phthalocyanine Pigments	-	-	-	2%	-	-	ASTM D1135 & D3256
Acid Soluble Pigments [A]	-	-	-	0	-	0	-
Lead	-	0.005%	-	0.005%	-	0.005%	-
Volatiles	-	2.0 lb/gal	-	2.0 lb/gal	-	2.0 lb/gal	ASTM D2369
Coarse Particles and Skins, as Retained on Std. 325 Mesh Screen	-	0.5%	-	0.5%	-	0.5%	ASTM D185
Rosin or Rosin Derivatives	-	0	-	0	-	0	-

A. Use a 5% acetic acid solution with a pH 4 + 2 to determine solubility.

Table 1080-2
Composition of Vehicle for Waterborne Paints, % By Weight

Property	Brown		White		Gray		Test Method
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	
HG-56 [A] Solids	30%	-	30%	-	30%	-	
Water	-	55%	-	55%	-	58%	
Methyl Carbitol	5%	-	5%	-	5%	-	
Texanol	2%	-	2%	-	4%	-	

A. Or approved equivalent

Table 1080-3
Properties of Waterborne Paints, % By Weight

Property	Brown		White		Gray		Test Method
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	
Consistency [A] Sheer Rate 200 rpm, Ounces	255	350	255	350	255	350	ASTM D562
Consistency [A] Sheer Rate 200 rpm,	3.2	3.5	3.2	3.5	90	100	ASTM D562
Density, lb./US gallon	9.7	-	11.0	-	9.35	-	ASTM D1475
Fineness of Grind, Hegman Units	5.0	-	5.0	-	5.0	-	ASTM D1210
Drying Time, Hours, Tack Free	-	3	-	3	-	3	ASTM D1640
Drying Time, Hours, Dry Hard	-	24	-	24	-	24	ASTM D1640
Flash Point, F (degrees)	Report Value	Report Value	Report Value	Report Value	Report Value	Report Value	ASTM D3278
Early Rust	9	-	9	-	9	-	*Structural Steel Shop Coatings Program*
Leneta Sag Test	10+	-	10+	-	10+	-	ASTM D4400
Gloss, Specular @ 60 degrees	Report Value	Report Value	Report Value	Report Value	40	-	ASTM D523
pH	8.0	9.0	8.0	9.0	8.0	9.0	ASTM E70
Adhesion [B]	4B	-	4B	-	4B	-	ASTM D3359
Color, AMS-STD-595	30045	-	-	-	26622	-	ASTM D2244

A. Consistency 48 hours or more after manufacture.
B. Prepare the specimen for adhesion by applying 2 dry mils of coating to a 3 inch X 5 inch X 0.25 steel panel cleaned to a minimum SSPC-SP 6 finish with a 1.7 +0.5 mil profile.

1080-10 WATERPROOFING EPOXY

Waterproofing epoxy coating systems are intended for protecting concrete exposed to splash zones and tidal water. Use 100% solids epoxy coatings that adhere to concrete, wood, steel, and other structural materials. Multi-coat systems shall utilize a red primer coat with a gray topcoat to provide visual aid in ensuring adequate coverage during application. Use waterproofing epoxy systems found on the NCDOT APL. Waterproofing epoxy coating materials, which includes primer and topcoat, shall meet the following criteria in Table 1080-4.

TABLE 1080-4
WATERPROOFING EPOXY PROPERTIES

Property	Values	Test Method
Absorption, 24 hr, max. (%)	0.5%	ASTM D570
Bond Strength, 14 days, min.	1500 psi	ASTM C882
Tensile Strength, 7 days, min.	2000 psi	ASTM D638

1080-11 PAINT FOR VERTICAL MARKERS

For vertical markers, use a waterborne acrylic or alkyd type material meeting Table 1080-5. Apply sufficient paint to completely cover the color of the underlying substrate along with any surface imperfections.

TABLE 1080-5
PROPERTIES OF PAINT FOR VERTICAL MARKERS

Property	Requirement	Test Method
Color	# 27040 Black or # 13538	AMS-STD-595
Adhesion to Substrate	3A Min.	ASTM D3359

1080-12 EPOXY RESIN FOR REINFORCING STEEL

Submit epoxy resin powder products to the State Materials Engineer for approval. Epoxy resins shall meet ASTM A775 or ASTM A934 to qualify for use. A list of prequalified epoxy resin powder sources is available from the State Materials Engineer. Manufacturers of approved epoxy resin powder products shall submit a request for requalification every 5 years and any time a change is made in the manufacturing process, change is made to the chemical composition of the epoxy resin or a requalification is requested by the Engineer.

Use powdered resin of any color that provides contrast to the corroded or uncorroded surface of the steel. Provide material of the same quality as that used for prequalification tests and as represented by test reports forwarded to the State Materials Engineer.

Ensure the manufacturer of the epoxy resin supplies to the coating applier information on the resin that is essential to the proper use and performance of the resin as a coating. Ensure the manufacturer of the resin furnish the coating applier a written certification signed by a responsible officer of the company that the material furnished for coating the reinforced steel is the same formulation as that for which test reports were previously submitted to the State Materials Engineer.

With each batch of coating material, furnish a written certification by the coating applier to the Engineer which properly identifies the batch number, material, quantity represented, date of manufacture, name and address of manufacturer and includes a statement that the supplied coating material is the same composition as that prequalified.

1080-13 ABRASIVE MATERIALS FOR BLAST CLEANING STEEL

Select the gradation of the abrasive to impart the anchor profile specified.

(A) Mineral and Slag Abrasives

Use blasting abrasives with suitable steel or mineral abrasives containing no more than 100 ppm of any corrosive compound such as sulfate or chloride or 100 ppm of any EPA characteristic waste compound such as lead, chromium or arsenic. Mineral and slag abrasives as defined by SSPC AB-1 are not to be recycled without written permission from the Department. The end user of the abrasive (e.g. shop or contractor), shall provide the Department with the abrasive conformance testing certificate as required in SSPC AB-1 and perform field quality control testing immediately prior to use at the minimum frequency specified in SSPC AB-1.

(B) Ferrous Metallic Abrasives

Ferrous metallic abrasives are new and previously unused material. The end user (e.g. shop or contractor) of the abrasive shall provide the Department with the abrasive conformance testing certificate as required by SSPC AB-3 and perform the abrasive cleanliness testing and conductivity testing immediately prior to use when not recorded on the manufacturer's certification. The frequency for this testing is once per 55 gallon barrel of abrasive.

(C) Cleanliness of Recyclable Ferrous Metallic Abrasives

Shop facilities shall annually acquire a composite sample of their recycled abrasive (work mix) in the Department's Materials and Tests Unit presence. A composite sample is a mixture of individual samples taken from a minimum of three separate areas of the work mix. The composite sample is to be tested at an accredited laboratory and provide the Department with a TCLP analysis and sulfate and chloride testing. The shop shall provide annually, the Department with a notarized Type 3 certification certifying the plant location has not used their facilities or equipment for the removal of lead based coatings. Prior to starting work, field contractors recycled work mix used shall meet the requirements of SSPC AB-2 prior to first use for each Department project.

Shop and Field Contractors cleaned work mix shall meet the requirements of SSPC AB-2 and maintain the size and shape of the abrasive to impart the specified profile. The quality control inspector shall document and test the cleaned work mix prior to starting work once every 12 hours or once every work shift whichever period is shorter. Abrasive testing shall meet and be performed in accordance with SSPC AB-2, ASTM D4940, ASTM D7393, SSPC PA-17 and the contract.

Nonconforming work mix shall not be used, shall be removed from equipment and shall be disposed of in accordance with federal, state, and local regulations and project specification requirements. If non-compliant work mix is detected during continuous recycling following three failing testing attempts blasting and handling equipment shall be checked for residual contamination after removal of the contaminated media. Following cleaning, new compliant media should be fed through the equipment and shall be tested for compliance with requirements of SSPC-AB 2 before production work resumes.

1080-14 FIELD PERFORMANCE AND SERVICE

Do not use paint products inspected by the Engineer and found to exhibit poor performance in similar North Carolina environments. Poor performance is defined as any coating failing to meet ASTM D610, Grade 5, or having greater than 3% rusting or disbonding before attaining 5 years of service.

SECTION 1081
EPOXY AND ADHESIVES

1081-1 EPOXY RESIN ADHESIVE SYSTEMS

(A) General

This section addresses epoxy resin adhesive systems to be used for bonding hardened concrete, fresh concrete, or other materials to hardened concrete. The classification of these epoxy systems is consistent with ASTM C881, but is limited to epoxy Types I – V and Grades 1 – 3. Use epoxy resin adhesive systems found on the NCDOT APL.

(B) Classification

Epoxies are classified using a Type/Grade nomenclature (e.g. Type I, Gr. 1), where Type is defined by the application and determines performance requirements and Grade correlates to viscosity. Any combination of Type and Grade of epoxy listed below are permitted for evaluation and acceptance on the APL.

Types are defined as:

(1) Type I: Designed for non-load bearing applications as a neat epoxy or as a binder for epoxy mortar where hardened concrete or other materials are bonded to hardened concrete. This epoxy type is suitable for non-structural crack repairs where the epoxy is poured on the surface to penetrate cracks by gravity.

(2) Type II: Designed for non-load bearing applications as a neat epoxy to bond fresh concrete to hardened concrete.

(3) Type III: Designed for bonding aggregates to hardened concrete (e.g. for High Friction Surface Treatments (HFST)) or as a binder for mortar repairs of contact surfaces in traffic areas.

(4) Type IV: Designed for load bearing applications as a neat epoxy or as a binder for epoxy mortar where hardened concrete or other materials are bonded to hardened concrete. This application includes the installation of anchors, such as anchor bolts, dowel bars, threaded rods, rebar, and other fixtures in hardened concrete. This epoxy type also provides a high modulus that when combined with the desired viscosity, makes it suitable for pressure injection into concrete cracks.

(5) Type V: Designed for load bearing applications as a neat epoxy where fresh concrete is bonded to hardened concrete.

Grades are defined as:

(1) Grade 1: Low viscosity.

(2) Grade 2: Medium viscosity.

(3) Grade 3: Non-sagging gel.

Many epoxies meet the requirements of more than one Type classification due to the material satisfying the physical property and performance requirements of multiple type classes. When epoxies meet the requirements of more than one Type classification, the epoxy will be listed with each of the Types it qualifies for, such as Type I/II, Gr. 2.

(C) Requirements

Epoxies shall conform to the requirements shown in Table 1081-1 using the test methods described in Article 1081-3. Epoxy systems that appear on the NCDOT APL have been verified to meet the performance requirements shown in Table 1081-1. Further consideration of the installation requirements and environment is required when selecting an epoxy system for a particular application.

Type IV epoxy resin systems used for embedding anchors or other post-installed fixtures in hardened concrete shall be evaluated by the Contractor and verified by the manufacturer to ensure the pull-out strength of the anchor system in the proposed installed configuration provides a maximum of 125% of the yield load listed in the plans. "Anchor system" refers to the combined mechanical properties provided by the total assembly, which consists of the substrate material, the epoxy bonding material, and the anchor fixture, as a finished installation. Evaluation of the anchor system shall utilize a concrete compressive strength between 2,500 psi (minimum) and the design compressive strength of the concrete that the anchor will be installed in (maximum). The manufacturer of the selected Type IV epoxy system shall provide the Manufacturer's Printed Installation Instructions (MPII), as described in ASTM E488, including directions on hole preparation, sizing, spacing, minimum installation depth for the type of anchor to be installed and the pull-out strength obtained. The Manufacturer's MPII is accepted as certification that for the particular anchor grade, diameter and embedment depth specified, the anchor system will not fail by adhesive failure.

Field testing may be required for adhesively anchored fixtures.

List the properties of the adhesive on the container and include density, minimum and maximum temperature application, setting time, shelf life, pot life, shear strength and compressive strength.

(D) Properties of Epoxy Resin Systems

(1) All integral fillers, pigments and thixotropic agents shall be fine enough to not separate, settle or cause skinning during storage of the epoxy components. Do not use abrasive fillers such as alumina and silica flour. Do not use solvents. When mineral fillers are to be added during mixing, they shall be inert, readily dispersible and except for sand, have fineness such that 99% of the material will pass a No. 325 sieve.

(2) The coefficient of expansion of cured epoxy is 6 times greater than that of concrete. Therefore, to reduce spalling and peeling during temperature changes, avoid thick layers of pure epoxy. A 4:1 by weight sand-epoxy mortar has approximately the same coefficient of expansion as concrete.

(3) The shelf life of parts A and B shall be at least one year from the date of manufacture.

(4) Types I through V epoxy resin systems are moisture insensitive and can be applied on clean, dry or damp surfaces free of standing water.

TABLE 1081-1
PROPERTIES OF MIXED EPOXY RESIN SYSTEMS

Property	Epoxy Type				
	I	II	III	IV	IV
Viscosity (P)					
Grade 1, max	20	20	20	20	20
Grade 2, min	20	20	20	20	20
Grade 2, max	100	100	100	100	100
Consistency (in)					
Grade 3, max	1/4	1/4	1/4	1/4	1/4
Gel Time (min)	30[A]	30	15	30[A]	30
Bond Strength (psi)					
Hardened to Hardened Concrete:				1000	-
2 days (moist cure)	1000	-	-	1500	-
14 days (moist cure)	1500	-	1500[B]	-	1500
Fresh Concrete to Hardened Concrete:					
14 days	-	1500	-		
Absorption, 24 h, max, (%)	1	1	1	1	1
Thermal Compatibility	-	-	pass		
Compressive Yield Strength, min, 7 days (psi)	8000	5000	-	10000	8000
Tensile Strength, min, 7 days (psi)[C]	5000	2000	2500	7000	6000
Elongation, min, 7 days (%)[C]	1	1	30	1	1

A. Minimum gel time of 5 minutes is required when used with automated proportioning, mixing and dispensing equipment is used.

B. A bond strength minimum value of 250 psi, as determined by ASTM C1583, is acceptable in lieu of bond strength value obtained by ASTM C882.

C. Not required for Viscosity Grade 3 Systems.

(E) Test Methods for Epoxies

(1) Viscosity

Determine the viscosity of the mixture in accordance with ASTM D2556 and ASTM C881.

(2) Consistency

Determine the consistency of a Grade 3 epoxy in accordance with ASTM C881.

(3) Gel Time

Determine the gel time of the mixture in accordance with ASTM C881.

(4) Bond Strength

Determine the bond strength in accordance with ASTM C882.

(5) Absorption

Determine the absorption in accordance with ASTM D570.

(6) Thermal Compatibility

Determine the thermal compatibility in accordance with ASTM C884.

(7) Compressive Yield Strength and Compressive Modulus

Determine the compressive yield strength in accordance with ASTM D695.

(8) Tensile Strength and Tensile Elongation

Determine the tensile strength and tensile elongation of the mixture in accordance with ASTM D638. Tensile strength and tensile elongation are also required for Grade 3 consistency epoxies though not required by ASTM C881.

(F) Prequalification

All epoxy resin systems shall be on the NCDOT Approved Products List before use. Manufacturers choosing to supply material for Department jobs must submit an application through the Product Evaluation Program with the following information for each type and brand name:

(1) Contact information, including name, address and telephone number of the manufacturer,

(2) Brand/Trade name of the material,

(3) Type of the material in accordance with Article 1081-1 and 1081-4,

(4) Technical data sheet stating at a minimum product description, yield, technical information, mixing directions, finishing directions, curing, clean-up and precautions/limitations,

(5) Safety Data Sheets,

(6) Certified test data published through participation in the AASHTO Product Evaluation & Audit Solutions program showing the product meets the specifications of Table 1081-1.

Products will remain on the NCDOT APL as long as the formulation and manufacturing process remain unchanged, and the product performs as intended in the field.

(G) Acceptance

When materials on the NCDOT APL are furnished to a project, submit to the Engineer a Type 3 material certification in accordance with Article 106-3 for each lot or batch delivered.

When materials are furnished to the Bridge Maintenance Unit, the terms of acceptance will be listed in the bid solicitation. The Engineer reserves the right to reject any epoxy that does not perform adequately in the field.

(H) Supply

Supply epoxy resin in two components, labeled as “Component A - Contains Epoxy Resin” and “Component B - Contains Curing Agent”, for combining immediately before use in accordance with the manufacturer’s instructions. Mark each container with the manufacturer’s name, NCDOT type, lot or batch number, quantity, date of manufacture, shelf life or expiration date, color, mixing instructions, usable temperature range and hazards or safety precautions.

Furnish the two components in separate non-reactive containers. Provide containers of such size that the proportions of the final mix can be obtained by combining a single container of one component with one or more whole containers of the other component.

(I) Notes on Use of Epoxies

(1) Safety

Epoxies can irritate the eyes, skin and respiratory tract. Therefore, wear chemical splash goggles, chemically-resistant gloves and protective clothing and boots when

handling epoxies. Respiratory protection is usually not needed if epoxies are mixed and applied in well-ventilated areas, but avoid prolonged breathing of vapors. Follow all SDS instructions for proper use of these materials.

(2) Mixing

Stir parts A and B individually until each component is homogeneous. Use a separate stirrer for each component.

Combine parts A and B, either by weight or volume, as specified in the manufacturer's instructions. Stir the mixture vigorously, periodically scraping the sides and bottom of the container. Small quantities of epoxy usually require 2 to 3 minutes to mix homogeneously; 5-gallon quantities can take up to 10 minutes of mixing.

Temperature affects the viscosity and pot life of epoxies. Most laboratory tests are conducted at 77°F. Higher temperatures render epoxies thinner and faster setting; lower temperatures induce higher viscosities and longer pot lives.

Add sand or other fillers to liquid epoxies only after parts A and B have been thoroughly mixed. Stir in the sand or filler until all particles are completely coated.

(3) Storage and Substrate Temperature

Store epoxies at temperatures between 50°F and 90°F. Epoxy components exposed to the extremes of this range or outside this range should be conditioned to 77°F before mixing and blending. If heat is necessary, always use indirect methods such as hot water or a heated room to condition components.

The Epoxy Class, either A, B, or C as defined by ASTM C881, shall be used as a design basis when procuring epoxy for installation. Epoxy Classes define the epoxy performance across a range of substrate temperatures when the epoxy system is applied. For example, Class A epoxies, which are designed for applications below 40°F, will have viscosity and gel time values consistent with those shown in Table 1081-1 when applied to materials at temperatures below 40°F. Using the same material at 70°F could result in much shorter gel times and altered viscosity.

Seal previously opened containers to be airtight. Unsealed containers can absorb moisture from the atmosphere, which can alter the chemical reaction of the mixture.

1081-2 POLYESTER RESIN ADHESIVE

(A) General

Polyester resin is used specifically for embedding dowel bars, threaded rods, rebars and other fixtures in hardened concrete.

Polyester resin adhesive systems shall be evaluated by the Contractor and verified by the manufacturer to ensure the pull-out strength of the anchor system in the proposed installation configuration provides a minimum of 125% of the yield load listed in the Plan. "Anchor system" refers to the combined mechanical properties provided by the total assembly, which consists of the substrate material, the epoxy bonding material, and the anchor fixture, as a finished installation. Evaluation of the anchor system shall utilize a concrete compressive strength between 2,500 psi (minimum) and the design compressive strength of the concrete that the anchor will be installed in (maximum). The manufacturer of the selected Type IV epoxy system shall provide the Manufacturer's Printed Installation Instructions (MPII), as described in ASTM E488, including directions on hole preparation, sizing, spacing, minimum installation depth for the type of anchor to be installed and the pull-out strength obtained. The Manufacturer's MPII is accepted as certification that for the particular anchor grade, diameter and embedment depth specified, the anchor system will not fail by adhesive failure.

Field testing may be required for adhesively anchored fixtures.

(B) Materials

Package components of the adhesive in containers of such size that one whole container of each component is used in mixing one batch of adhesive. Use containers of such design that all of the contents may be readily removed, and are well sealed to prevent leakage. Furnish adhesive material that requires hand mixing in two separate containers designated as Component A and Component B. A self-contained cartridge or capsule will consist of two components which will be automatically mixed as they are dispensed, as in the case of a cartridge, or drilled into, as in the case of a capsule.

Clearly label each container with the manufacturer's name; date of manufacture; batch number; batch expiration date; all directions for use and such warning of precautions concerning the contents as may be required by Federal or State laws and regulations.

(C) Mixing of Adhesive

Mix adhesive in conformance with the manufacturer's instructions.

1081-3 HOT BITUMEN

Mix the adhesive asphaltic material with the filler homogeneously.

(A) Physical Requirements

Supply materials meeting Tables 1081-2 or 1081-3 and 1081-4.

TABLE 1081-2
ADHESIVE PROPERTIES OF ASPHALTIC MATERIAL WITH FILLER

Property	Min.	Max.	Test Method
Softening point,°F.	200	-	ASTM D36
Penetration, 100 g, 5 sec., 77°F	10	18	ASTM D5
Flow, inch, as modified in Subarticle 1081-3(B)	-	0.2	ASTM D5329
Viscosity, 400°F, poises or ASTM D4402 as modified in Subarticle 1081-3(B)	30	75	ASTM D2669
Flash Point, C.O.C.,°F.	550	-	ASTM D92

TABLE 1081-3
ASPHALT PROPERTIES OF ASPHALTIC MATERIAL WITHOUT FILLER

Property	Min.	Max.	Test Method
Penetration, 100 g, 5 sec., 77°F	25	-	ASTM D5
Viscosity, 275°F poises	12	100	ASTM D2171
Viscosity Ratio, 275°F	-	2.2	See Subarticle 1081-3(B)

TABLE 1081-4
FILLER PROPERTIES

Property	Min.	Max.	Test Method
Filler Content, % by Weight	65%	75%	See Subarticle 1081-3(B)
Filler Fineness, % Passing No. 325	75%	-	ASTM C430 as modified in Subarticle 1081-3(B)
Filler Fineness, % Passing No. 200	95%	-	
Filler Fineness, % Passing No. 100	100%	-	

(B) Test Methods

(1) Flow

Determine flow according to Section 6 of ASTM D5329 with the exception that the oven temperature shall be 158°F ± 2°F and sample preparation done according to Section 7.1 of ASTM D5.

(2) Viscosity

Viscosity is to be determined according to ASTM D2669 or ASTM D4402 using a spindle speed of 10 rpm. Heat the adhesive to approximately 410°F and allowed to cool. Determine viscosity at 400°F ± 1°F.

(3) Asphalt Properties

Properties of the base asphalt are to be determined on the material obtained from the following extraction and Abson recovery methods. Extract the asphalt by heating the adhesive just to the point where it will easily flow and then transfer 125 to 150 g into 400 ml of trichloroethylene with a temperature of 125°F to 150°F. Thoroughly stir this mixture to dissolve the asphalt. Decant the trichloroethylene-asphalt mixture decanted and the asphalt recovered using the Abson recovery method, ASTM D1856 as modified by the following. The extraction methods of ASTM D2172 do not apply and there will be no filtration of the solvent asphalt mixture. The extraction solution of trichloroethylene and asphalt shall be centrifuged for at least 30 minutes at 770 times gravity in a batch centrifuge. Decant this solution in the distillation flask, taking care not to include any filler sediment. Apply heat and bubble carbon dioxide solution slowly to bring the solution temperature to 300°F. At this point the carbon dioxide flow is increased to 800 ml to 900 ml per minute. The solution temperature is maintained at 320°F to 335°F with this carbon dioxide flow for at least 20 minutes and until the trichloroethylene vapors have been completely removed from the distillation flask. Repeat the above extraction-recovery method as necessary to obtain the desired quantity of asphalt. Use the asphalt recovered to determine penetration, 275°F viscosity, and 275°F viscosity ratio.

(4) Viscosity Ratio

Determine the 275°F viscosity ratio by comparing the 275°F viscosity on the base asphalt before and after the thin-film oven test. Perform the thin-film oven test in accordance with ASTM D1754. Determine the specific gravity by pycnometer as in ASTM D70 for use in the thin-film oven test. Calculate the 275°F viscosity ratio by dividing the viscosity after the thin-film oven test by the original 275°F viscosity.

(5) Filler Material

Separate the filler material from the asphalt to determine Filler Content and Filler Fineness. Determine the portion by weight of the adhesive insoluble in 1,1,1 trichloroethane by weighing 10.00 ± 0.01 grams of solid adhesive into a centrifuge flask with approximately 100 ml volume such as that specified in ASTM D1796. Add 50 ml of 1,1,1-trichloroethane to the adhesive, which should be broken up in small pieces to speed up the dissolution solids. Place the sample flask in a balanced centrifuge and spin using a minimum relative centrifugal force of 150 in accordance with ASTM D1796 for 10 minutes. Remove the sample flask and decant the solid, taking care not to lose any solids. Repeat the application of solvent and centrifuging until the solvent becomes clear and the filler is visually free of asphalt. Dry the filler at 160°F ± 5°F to remove solvent and weigh the resulting filler. Filtration of the decanted solvent may be performed to verify there is no loss of filler. Percent filler content is calculated as follows:

$$\text{Filter Content, \% by Weight} = \frac{\text{Filler Weight, grams} \times 100}{\text{Original Adhesive Weight, grams}}$$

Determine Filler Fineness according to ASTM C430 using number 325, 200 and 100 sieves. This method is to be modified by using a water soluble non-ionic wetting agent, such as Triton X-100, to aid the wetting action. Concentration of the surfactant solution shall be approximately 1% by weight. Thoroughly wet the one-gram dry sample in the surfactant solution and allowed to soak for 30 minutes. Transfer the filler completely into the sieve cup and apply water spray for 2 minutes. Surfactant solution may be added as needed and physical means used to disperse any clumped particles. Dry the sample and handle as described in ASTM C430.

(C) Prequalification

Interested parties shall submit a sample to a qualified independent testing laboratory for testing in accordance with Subarticle 1081-3(A) at no cost to the Department. Submit a Type 2 materials certification in accordance with Article 106-3 with the results and the name of the testing laboratory along with a qualification sample(s) of the same lot to the Department for evaluation.

(D) Packaging and Labeling

Pack the adhesive in self-releasing cardboard containers which will stack properly. Containers shall have a net weight of 50 lbs. to 60 lbs. and contain two to four subcompartments. Ensure the label shows the manufacturer, quantity and batch number. Print “Bituminous Adhesive for Pavement Markers” or similar wording on the label.

(E) Certification

A certification from the manufacturer showing the physical properties of the bituminous adhesive and conformance with the specifications shall be required before use.

(F) Application

Apply the adhesive according to the manufacturer’s requirements and the following requirements.

Apply the adhesive when the road surface, ambient air and pavement marker temperatures are in the range of 50°F to 160°F on dry pavement.

The composition of the adhesive shall be such that its properties will not deteriorate when heated to and applied at temperatures up to 425°F using either air or oil-jacketed melters.

Melt and heat the bituminous adhesive in either thermostatically controlled double boiler type units using heat transfer oil or thermostatically controlled electric heating pots. Do not use direct flame units.

Heat the adhesive to between 375°F and 425°F and applied directly to the pavement surface from the melter/applicator by either pumping or pouring. Maintain the application temperature between 375°F and 425°F as lower temperatures may result in decreased adhesion while higher temperatures may damage the adhesive.

Use sufficient adhesive to ensure total contact with the entire bottom of the pavement marker. Apply pavement markers to the adhesive immediately (within 5 seconds) to assure bonding. Place the pavement marker in position by applying downward pressure until the marker is firmly seated with the required adhesive thickness and squeeze-out. Remove excessive adhesive squeeze-out from the pavement and immediately remove adhesive on the exposed surfaces of pavement markers. Soft rags with mineral spirits or kerosene may be used if necessary, to remove adhesive from exposed faces of pavement markers. No other solvent may be used.

Do not waste or spill any excess adhesive on Department right of way. Remove and properly dispose of any adhesive spilled or dumped at such location. The Contractor, at no cost to the Department, shall correct any damage incurred to the Department, highway or appurtenances as a result of misplaced adhesive.

The adhesive may be reheated and reused. However, the pot life at application temperatures shall not exceed the manufacturer's recommendations.

Clean out of equipment and tanks may be performed using petroleum solvents such as diesel fuel or similar materials. All solvents shall be removed from the equipment tanks and lines before the next use of the melter.

1081-4 EPOXY RESIN ADHESIVE FOR BONDING TRAFFIC MARKERS

(A) General

This section covers epoxy resin adhesive for bonding traffic markers to pavement surfaces.

(B) Classification

The types of epoxies and their uses are as shown below:

Type I

Rapid Setting, High Viscosity, Epoxy Adhesive. This type of adhesive provides rapid adherence to traffic markers to the surface of pavement.

Type II

Standard Setting, High Viscosity, Epoxy Adhesive. This type of adhesive is recommended for adherence of traffic markers to pavement surfaces when rapid set is not required.

Type III

Rapid Setting, Low Viscosity, Water Resistant, Epoxy Adhesive. This type of rapid setting adhesive, due to tis low viscosity, is appropriate only for use with embedded traffic markers.

Type IV

Standard Set Epoxy for Blade Deflecting-Type Plowable Markers.

(C) Requirements

Epoxies shall conform to the requirements set for in AASHTO M237.

(D) Prequalification

Refer to Subarticle 1081-1(E)

(E) Acceptance

Refer to Subarticle 1081-1(F)

SECTION 1082
STRUCTURAL TIMBER AND LUMBER

1082-1 GENERAL

Use Southern Pine timber and lumber graded in accordance with the current grading rules of the Southern Pine Inspection Bureau unless otherwise specified or approved by the Engineer. Use stress rated grades equal to or higher than the grades specified in this section or as otherwise specified in the contract. For temporary crossings, the use of stress rated lumber having stress ratings below those specified may be used if approved by the Engineer.

Have all wood products, including any preservative treatment, inspected and/or tested by an NCDOT approved commercial inspection company before it is delivered to the project. Provide industry standard commercial inspection reports and treatment test reports for each shipment of treated wood products before its use on the project. Perform inspections of preservative treated materials in accordance with American Wood Protection Association (AWPA) Standard M2. In addition, brand, hammer mark, ink stamp or tag each piece with the inspection company's

unique mark to indicate it has been inspected. All inspections shall be completed at no cost to the Department.

1082-2 UNTREATED TIMBER AND LUMBER

Lumber that is 2 inches to 4 inches thick and 2 inches to 4 inches wide shall conform to Structural Light Framing, Grade No. 1 Dense MC19. Lumber that is 2 inches to 4 inches thick and 6 inches wide or wider shall conform to Structural Joists and Planks, Grade No. 1 Dense MC19. Lumber that is 5 inches and thicker along the least dimension shall conform to Dense or Select Structural (Sel Str). Rough lumber will be acceptable except where surfacing is called for by the contract. Rough lumber may vary ± 1/4 inch from the dimensions shown on the contract or bill of material.

1082-3 TREATED TIMBER AND LUMBER

(A) General

Grade marked lumber will not be required. Brand or ink stamp each piece of treated lumber in accordance with the AWPA Standard M6. After treatment, handle the timber and lumber carefully to avoid breaking through the treated layer. This includes using rope slings, without sudden dropping, breaking of the fibers, bruising or penetrating the surface with tools or hooks. All drilled holes or cuts should be at least 1 foot above the earth to limit the potential for decay, with the exception of sign and guardrail end unit posts which are allowed.

(B) Bridges, Fender Systems and Piles

Lumber for bridges or fender systems that is 2 inches to 4 inches thick and 2 inches to 4 inches wide shall conform to Structural Light Framing, Grade No. 1 Dense. Lumber for bridges or fender systems that is 2 inches to 4 inches thick and 6 inches wide and wider shall conform to Structural Joists and Planks, Grade No. 1 Dense. Timbers for bridges or fender systems that are 5 inches and thicker along the least dimension shall conform to Structural Lumber, Dense or Select Structural (Sel Str). Lumber for fender systems shall conform to Dense or Select Structural (Sel Str).

Timber for piles shall meet ASTM D25 except that the timber shall be Southern Pine.

Rough lumber will be acceptable except where surfacing is called for by the contract or bills of material. Rough lumber may vary ± 1/4 inch from the dimensions shown in the plans or bill of material.

(C) Guardrail Posts, Blockouts and related components

Sawn timbers for guardrail posts, blockouts and related components shall be Southern Pine, conforming to Grade No. 1. Rough lumber will be acceptable. An allowable tolerance of 3/8 inch scant will be permitted from nominal dimensions.

(D) Fence Posts and Braces

Sawn fence posts and braces shall be Southern Pine, S4S, and conform to Grade No. 2 for posts up to 4 inches x 4 inches in cross section, and Grade No. 1 for posts larger than 4 inch x 4 inch in cross section.

Round posts and braces shall meet Subarticle 1050-2(A).

(E) Sign Posts and Battens

Lumber for sign posts no larger than 4 inches x 4 inches shall conform to Structural Light Framing, Grade No. 1. Lumber for sign posts larger than 4 inches x 4 inches and lumber for sign battens shall conform to Timbers, Grade No. 1. Use fully dressed S4S lumber for sign posts and battens.

A tolerance of 1/2 inch scant will be permitted from nominal dimensions of sign posts. A tolerance of 1 inch under and 3 inches over will be permitted in the length of the post.

(F) Poles

Timber for poles shall meet ANSI O5.1 except the timber shall be either treated Southern Pine or treated Coastal Douglas Fir. Use 40 feet Class 3 poles unless otherwise specified in the contract.

1082-4 PRESERVATIVE TREATMENT

(A) General

All timber and lumber is required to be treated with a preservative treatment in accordance with AASHTO M 133 or AWPA Standards, using a wood preservative registered by the US Environmental Protection Agency under the Federal Insecticide, Fungicide and Rodenticide Act.

Preservative treated wood products will not be accepted for use unless they have been inspected and found satisfactory, both before and after treatment as provided in Article 1082-1, and shall be delivered to the project site in a condition acceptable to the Engineer.

Use treating plants that have laboratory facilities at the plant site for use of the inspector in accordance with AWPA Standard T1.

In areas of frequent human contact, the use of chromated copper arsenate (CCA) treated wood is not permitted. Instead use material treated to the applicable AWPA Use Category with an appropriate preservative system permitted by EPA. "Frequent human contact" is defined as areas include decking, handrail and canopy posts, and rails of pedestrian bridges; other instances of human contact areas may include fencing, decorative borders, and other uses of treated wood at recreational facilities such as welcome centers, rest areas and weigh stations.

(B) Timber Preservatives

Use timber preservatives conforming to AASHTO M-133 or AWPA Standard U1, Section 4, Table 1.

(C) Bridges, Fender Systems and Piles

Treat timber and lumber for bridges and fender systems in accordance with AASHTO M-133 or AWPA Standard U1, Commodity Specification A: Sawn Products.

Treat piles in accordance to AWPA Standard U1, Commodity Specification E: Round Timber Piling.

(D) Guardrail Posts, Blockouts and Related Components

Treat guardrail posts, blockouts and related items in accordance to AASHTO M-133 or AWPA Standard U1, Commodity Specification A: Sawn Products, UC4B. The same type of preservative is to be used throughout the entire length of the project.

(E) Fence Posts and Braces

Treat sawn posts and braces in accordance with AASHTO M-133 or AWPA Standard U1, Commodity Specification A. Sawn Products, UC4B.

Treat round posts and braces in accordance with AASHTO M-133 or AWPA Standard U1, except require retention of preservative as below.

Before treatment, peel round posts and braces cleanly for their full length, remove all bark and cambium, and trim all knots and projections flush with the surface of the surrounding wood. Machine peeling will be permitted. Cut the ends to the proper length before treatment.

The same type of preservative shall be used throughout the entire length of the project.

(F) Sign Posts and Battens

Treat sign posts and battens in accordance with AASHTO M-133 or AWPA Standard U1, Commodity Specification A: Sawn Products UC4B.

The same type of preservative shall be used throughout the entire length of the project.

All timber shall have moisture content of not greater than 19% before treatment. Redry timber treated with chromated copper arsenate after treatment until it has moisture content of not greater than 25%.

(G) Poles

Treat poles in accordance with AASHTO M-133 or AWPA Standard U1, Commodity Specification D: Poles, UC4C.

The same type of preservative shall be used throughout the entire length of the project.

SECTION 1084
PILES

1084-1 PILES

(A) Treated Timber Piles

Timber for treated timber piles shall meet Article 1082-3. Give treated timber piles a preservative treatment in accordance with Article 1082-4.

(B) Steel Piles

Coat steel piles as required by the plans. Galvanize steel piles in accordance with Section 1076 or metallize steel piles in accordance with the *Thermal Sprayed Coatings (Metallization) Program*. Use Department approved supplier/producer as found on the NCDOT APL. Apply a barrier coat to any portion of the aluminum metallized steel piling encased in concrete. Use an approved waterborne barrier coating with a low-viscosity as found on the NCDOT APL which readily absorbs into the pores of the aluminum thermal sprayed coating. Apply waterborne coating at the spreading rate that results in a theoretical 1.5 mil dry film thickness. Provide a manufacturer certification in accordance with Article 106-3 Type 2 Certification that the resin chemistry of the waterborne coating is compatible with the 99.9% aluminum thermal sprayed alloy and suitable for tidal water applications. Before incorporating steel piles into the work, obtain all applicable certified Mill Test Reports clearly identifiable to the lot of material by heat numbers, submit these reports to the Engineer for review and analysis and receive approval of such test reports from the Engineer. Transfer the heat number of each painted pile to the newly painted surface with a permanent marker of a color contrasting to the paint once the paint has fully cured.

(1) Steel H-Piles

Steel H-piles shall meet ASTM A572 Grade 50 or ASTM A588.

(2) Steel Pipe Piles

Use uniform diameter steel pipe piles conforming to ASTM A252 Grade 3 modified (50,000 psi). Make all joints and seams in the pipe pile watertight. Unless otherwise indicated by the contract, the ends of pipe pile may be flame cut. Square flame cut ends with axis of the pile to provide a full uniform bearing over the entire end area when the pile is being driven. Welding procedure qualification for AWS D1.1 is required for pipe piles requiring splicing. The welding shall be performed by a Department certified welder.

(3) Steel Sheet Piles

For permanent applications, use hot rolled steel sheet piles and meet ASTM A572 or ASTM A690 unless otherwise required by the plans.

For temporary applications, use hot rolled steel sheet piles and meet ASTM A328.

(C) Prestressed Concrete Piles

Prestressed concrete piles shall meet Section 1078.

SECTION 1086
PAVEMENT MARKERS

1086-1 TEMPORARY RAISED PAVEMENT MARKERS

(A) General

Use raised pavement markers found on the NCDOT APL. Products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT APL. .

Use raised pavement markers of the prismatic reflector type, or better as approved by the Engineer. The markers shall be constructed either of an injection molded plastic body and base or consist of a plastic shell filled with a mixture of inert thermosetting compound and filler material. Either construction type shall contain one or more integrated prismatic reflective lenses to provide the required color designation.

The minimum reflective area of the lens face is 2.0 sq.in.

The color of the reflective pavement marker housing shall match the pavement marking color, which it supplements.

All raised pavement marker reflective lenses shall be in close conformance with the AMS-STD-595 colors as listed below when viewed at night.

Crystal:	Color No. 17886 (White)
Yellow:	Color No. 13538
Red:	Color No. 11302

(B) Adhesives

(1) Epoxy

The epoxy shall meet Section 1081-4.

Review Subarticle 1081-4(B) for description of epoxy types suitable for markers to be installed. Use an epoxy adhesive type that is appropriate for the pavement and ambient temperature per the manufacture's recommendations. It is recommended that the ambient temperature during application of Types II and IV epoxy shall be at least 50°F and preferably higher than 60°F. These adhesives harden relatively slowly at 50°F, but the hardening rate rapidly accelerates as temperature increases.

(2) Hot Bitumen

The hot bitumen shall meet Article 1081-3.

(3) Pressure Sensitive

As supplied by the manufacturer.

(C) Material Certification

Furnish a Type 2 material certification in accordance with Article 106-3 for all raised pavement markers before use.

1086-2 PERMANENT RAISED PAVEMENT MARKERS

(A) General

Use raised pavement markers found on the NCDOT APL. Products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT APL. The markers shall be constructed either of an injection molded plastic body and base or consist of a plastic shell filled with a mixture of inert thermosetting compound and filler material. Either construction type shall contain one or more integrated prismatic reflective lenses to provide the required color designation. Raised pavement markers (permanent) shall be of the glass or plastic face lens type and meet Subarticle 1086-1(A). Plastic lenses shall have an abrasion resistant coating.

(1) Potted Markers

Potted marker shells shall be made of molded methyl methacrylate conforming to Federal Specification L P 380C, Type I, Class 3. Filling material shall be an inert thermosetting compound selected for strength, resilience, and adhesion adequate to meet physical requirements of the specifications. Sand or other inert granulars shall be embedded in the surface of the inert thermosetting compound and filler material before its curing to provide a surface, which will readily bond to the adhesive.

(2) Injection-molded Markers

Injection-molded markers shall consist of polymer materials selected for strength and resilience adequate to meet the physical requirements of the specifications. The bottom surface of the marker shall contain grooves or nonsmooth structure designed to increase bonding with the adhesive.

(B) Optical Requirements

All optical performance for permanent raised pavement markers shall conform to ASTM D4280.

(C) Physical Properties

All physical properties for permanent raised pavement markers shall conform to ASTM D4280.

(D) Hot Bitumen Adhesives

Use hot bitumen adhesive for mounting the pavement markers to asphalt concrete roadways. The hot bitumen adhesive shall meet the requirements of Article 1081-3. Other adhesives such as epoxy or cold bituminous adhesive pads are not acceptable on asphalt concrete roadways for permanent applications.

(E) Epoxy Adhesives

Use epoxy adhesive for mounting the pavement markers to concrete roadways. The epoxy adhesive shall comply with Section 1081-4. Other adhesives such as hot and cold bituminous or adhesive pads are not acceptable on concrete roadways for permanent applications.

(F) Material Certification

Furnish a Type 2 material certification in accordance with Article 106-3 for all raised pavement markers before use.

1086-3 NON-CAST IRON SNOWPLOWABLE PAVEMENT MARKERS

(A) General

Use non-cast iron snowplowable pavement markers found on the NCDOT APL. Products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT APL. The non-cast iron snowplowable pavement

marker shall consist of a housing with one or more glass or plastic face lens type reflective lenses to provide the required color designation. The marker shall be designed or installed in a manner that minimizes damage from snowplow blades. Plastic lens faces shall use an abrasion resistant coating.

(B) Housings

(1) Dimensions

The dimension, slope and minimum area of reflecting surface shall conform to dimensions as shown in the plans. The minimum area of each reflecting surface shall be 1.44 sq.in.

(2) Materials

Use non-cast iron snowplowable pavement markers that are on the NCDOT Approved Products List.

(3) Surface

The surface of the housing shall be free of scale, dirt, rust, oil, grease or any other contaminant which might reduce its bond to the epoxy adhesive.

(4) Identification

Mark the housing with the manufacturer's name and model number of marker.

(C) Reflectors

(1) General

Laminate the reflector to an elastomeric pad and attach with adhesive to the housing. The thickness of the elastomeric pad shall be 0.04 inch.

(2) Reflector Type

(a) One-direction, one color (crystal)

(b) Bidirectional, one color (yellow and yellow)

(c) Bidirectional, two colors (red and crystal)

(d) Bidirectional, two colors (red and yellow)

All pavement marker reflective lenses shall be in close conformance with the AMS-STD-595 colors as listed below when viewed during night situations.

Crystal:	Color No. 17886 (White)
Yellow:	Color No. 13538
Red:	Color No. 11302

(3) Reflector Optical Requirements

(a) Definitions

Define “horizontal entrance angle” as the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the marker.

Define “observation angle” as the angle, at the reflector, between observer's line of sight and the direction of the light incident on the reflector.

Define “specific intensity (S.I.)” as candlepower of the returned light at the chosen observation and entrance angles for each footcandle of illumination at the reflector.

$$\textbf{S.I.} = RL \times (D \times D) \times IL$$

Where:

S.I. = Specific Intensity
RL = Reflected Light
IL = Incident Light
D = Test Distance

(b) Optical Performance

Test the reflector for specific intensity as described below:

Form a 1 inch diameter flat pad using #3 coarse steel wool per Federal Specification FF-W-1825. Place the steel wool pad on the reflector lens. Apply a load of 50 lbs. and rub the entire lens surface 100 times. Do not abrade the red lens of the Type 3 and Type 4 bi-directional units.

Locate the reflector to be tested with the center of the reflecting face at a distance of 5 feet from a uniformly bright light source having an effective diameter of 0.2 inch.

The photocell must be an angular ring 0.37 inch I.D. x 0.47 inch O.D. Shield it to eliminate stray light. The distance from light source center to the center of the photoactive area shall be 0.2 inch. If a test distance of other than 5 feet is used, modify the source and receiver in the same proportion as the test distance.

After abrading the lens surface using the above steel wool abrasion procedure, the specific intensity of each crystal reflecting surface at 0.2 degrees observation angle must not be less than the following when the incident light is parallel to the base of the reflector.

TABLE 1086-1
MINIMUM SPECIFIC INTENSITY
(candle/footcandle/unit marker)

Color	Horizontal Entrance Angle	
	0 Degrees	20 Degrees
Crystal	3.00	1.20
Yellow	1.80	0.72
Red	0.75	0.30

(D) Properties

All optical and physical properties for snowplowable pavement markers shall conform to ASTM D4383.

(E) Epoxy Adhesive

The epoxy adhesive shall meet the requirements of Section 1081-4. Mix the epoxy adhesive rapidly by a two component type automatic metering, mixing and extrusion apparatus.

(F) Material Certification

Furnish a Type 2 material certification in accordance with Article 106-3 for all raised snowplowable markers before use.

SECTION 1087
PAVEMENT MARKINGS

1087-1 GENERAL

Yellow and white pavement markings shall be retroreflective. Black pavement markings shall be matte, non-retroreflective.

The material manufacturer has the option of formulating the pavement marking material according to his own specifications; however, the manufacturer shall meet all the minimum requirements specified herein.

All pavement marking materials, pigments, beads, highly reflective media and resins shall be free from all skins, dirt and foreign objects.

Use pavement marking materials capable of being fabricated into pavement markings of specified dimensions and adhering to asphalt and Portland cement concrete pavements when applied in accordance with their manufacturer's recommendation.

Pavement marking materials upon heating shall not exude fumes, which are toxic, or injurious to persons or property.

Homogeneously mix all pavement marking materials.

1087-2 COMPOSITION

(A) Paint Composition

Pavement marking paint shall be a ready mixed type paint product conforming to Federal Specification TT--P-1952 with spraying consistency suitable for use as a retroreflective pavement marking. Glass beads are dropped by suitable pressurized means into the wet paint as it is applied to the pavement.

(B) Removable Tape Composition

Removable tape pavement marking shall be composed of materials as specified by their manufacturer.

Use removable tape markings capable of conforming to pavement contours, breaks, faults, etc. through the action of traffic at normal pavement temperatures. The tape shall have resealing characteristics such that it is capable of fusing with itself and previously applied marking tape of the same composition under normal conditions of use. The removable tape markings shall be patchable.

Use removable tape markings capable of adhering to the pavement by a pressure-sensitive pre-coated adhesive or as directed by the manufacturer.

(C) Thermoplastic Composition

Use thermoplastic alkyd/maleic pavement markings composed of the materials in Table 1087-1.

TABLE 1087-1
PHYSICAL PROPERTIES
OF THERMOPLASTIC ALKYD/MALEIC PAVEMENT MARKINGS

Component	By Weight
Alkyd/Maleic Binder	18.0% Min
Glass Beads (Premixed)	30.0% Min
Titanium Dioxide Pigment (ASTM D476 Type 2)	10.0% Min.

Use white thermoplastic that does not contain anatase titanium dioxide pigment.

Calcium carbonate and inert fillers may be as opted by the manufacturer, providing all other qualifications are met.

The total silica content used in the formulation of the thermoplastic shall be the premixed reflective media. Uniformly disperse the pigment, beads, media and filler in the binder.

The alkyd/maleic binder shall consist of a mixture of synthetic resins (at least one synthetic resin shall be solid at room temperature) and a high boiling point plasticizers. At least 1/2 of the binder composition shall be 100% maleic-modified glycerol of resin and be no less

than 15% by weight of the entire material formulation. The binder shall contain no petroleum hydrocarbon resins. Use resins/rosins that are maleic-modified glycerol esters.

The thermoplastic material shall be free of contaminates and be homogeneously dry-blended or hot mixed from 100% virgin stock using no reprocessed materials, (excluding the requirement to use reprocessed glass).

The thermoplastic material shall not deteriorate or discolor when held at the application temperatures for at least 4 hours or upon repeated reheating (at least 4 times).

The color, viscosity and chemical properties versus temperature characteristics of the thermoplastic material shall remain constant for up to 4 hours at the application temperature and be the same from batch to batch.

The thermoplastic material shall be readily applicable at temperatures between 400°F and 440°F from the approved equipment to produce lines and symbols of the required above the pavement thickness.

(D) Cold Applied Plastic Composition

The cold applied plastic pavement marking shall consist of a mixture of high quality polymeric materials, pigments and reflective media distributed throughout its base cross-sectional area, with a reflective media bonded to the top surface.

The cold applied plastic markings shall adhere to the pavement by a pressure-sensitive pre-coated adhesive.

The cold applied plastic shall conform to pavement contours, breaks, faults, etc. through the action of traffic at normal pavement temperatures. The film shall have resealing characteristics such that it is capable of fusing with itself and previously applied marking tape of the same composition under normal conditions of use. The cold applied plastic pavement marking shall be patchable.

1087-3 COLOR

All pavement markings, without reflective media, shall visually match the color chips that correspond to the AMS-STD-595 for the following colors:

Crystal: Color No. 17886 (White)
Yellow: Color No. 13538
Black: Color No. 37038

1087-4 GLASS BEADS

(A) Composition

The silica content of the glass beads shall be at least 60%.

Manufacture the beads from 100% recycled non-pigmented glass from a composition designed to be highly resistant to traffic wear and to the effects of weathering. All standard intermix and drop-on glass beads shall be manufactured using 100% North American recycled glass cullet.

All intermixed and drop-on glass beads shall not contain more than 75 ppm arsenic or 200 ppm lead.

(B) Physical Characteristics

Use glass beads that are colorless, clean, transparent and free from milkiness, excessive air bubbles, skins and foreign objects. Use glass beads with a minimum refractive index of 1.50 when tested by the liquid immersion method at 77°F ± 9°F in accordance with ASTM D1214 using the Becke Line Method or an equivalent method. Use glass beads that are spherical in shape and essentially free of sharp angular particles or particles showing surface scarring or scratching.

All intermixed and drop-on glass beads shall comply with NCGS § 136-30.2 and 23 USC § 109(r).

(C) Gradation & Roundness

Use drop-on and intermixed glass beads in all pavement markings with at least 80% true spheres when tested in accordance with ASTM D1155. Drop-on and intermixed glass beads used on any pavement markings shall meet Table 1087-2.

TABLE 1087-2
GLASS BEAD GRADATION REQUIREMENTS

Sieve Size	Gradation Requirements	
	Minimum	Maximum
Passing #20	100%	--
Retained on #30	5%	10%
Retained on #50	40%	80%
Retained on #80	15%	40%
Passing #80	0%	5%
Retained on #200	0%	5%

(D) Chemical Resistance

Conduct the following chemical resistance test on all glass beads:

Place 3 to 5 g portions of the same glass bead batch to be tested in three separate glass beakers or three porcelain dishes. Cover one sample with distilled water, cover the second sample with 3N solution of sulfuric acid and cover the third sample with 50% solution of sodium sulfides. After one hour of immersion, examine the glass bead samples microscopically for evidence of darkening or frosting. All three samples shall show no evidence of darkening or frosting.

(E) Moisture Resistance

Conduct the following moisture resistance test on drop-on glass beads:

Place a 2 lb. minimum sample of glass beads in a clean, washed cotton bag with a thread count of 50 warp, 50 woof. Immerse the bag containing the sample in a container of water for 30 seconds or until the water covers the spheres, whichever is longer. Remove the bag from water and force excess water from the sample by squeezing the bag. Suspend the bag and allow to drain for 2 hours at room temperature 70°F to 72°F. Then mix the sample in the bag by shaking thoroughly. Transfer the sample slowly to a clean dry glass funnel having a stem of 4 inches in length with 1/4 inch inside diameter. The entire sample shall flow freely through the funnel without stoppage. When first introduced in the funnel, if the spheres clog, it is permissible to lightly tap the funnel to start the flow.

1087-5 PACKAGING FOR SHIPMENT

Deliver all pavement marking and reflective media materials to the project in suitable containers packaged by the manufacturer. Clearly and adequately mark each material container to indicate the material, color, date of manufacture, process, batch or lot number, manufacturer's name and location, temperature application range, shelf life and include the SDS.

Thermoplastic pavement marking materials shall be in block or granular form packaged in either suitable corrugated containers or thermal degradable plastic bags to which it will not adhere during shipment or storage.

Package reflective media in moisture resistant packaging.

1087-6 STORAGE LIFE

All pavement marking materials shall meet these specifications for one year from the date of shipment from the manufacturer to the Contractor, or the project when stored properly by the

manufacturer's recommendation. Replace any pavement marking materials not meeting these specifications.

1087-7 TESTS TO BE PERFORMED

When independent test laboratory tests are required, perform them on samples taken by an agency certified by the Department from the same process, batch or lot number as the material shipped to the project. The test reports shall contain the lot number. Use Department approved independent test laboratories.

Perform the following tests on thermoplastic pavement marking materials, intermixed glass beads and drop-on glass beads unless prescribed otherwise by the Engineer:

(A) Intermixed and Drop-on Glass Beads

Use X-ray Fluorescence for the normal sampling procedure for intermixed and drop-on beads, without crushing, to check for any levels of arsenic and lead. If any arsenic or lead is detected, the sample shall be crushed and repeat the testing using X-ray Fluorescence. If the X-ray Fluorescence test shows more than LOD of 5 ppm, test the beads using United States Environmental Protection Agency Method 6010B, 6010C or 3052 for no more than 75 ppm arsenic or 200 ppm lead.

(B) Thermoplastic Pavement Marking Material Composition

(1) % Binder tested in accordance with ASTM D4797.

(2) % Titanium Dioxide Pigment tested in accordance with ASTM D3720 or D4764.

(3) % Glass Beads tested in accordance with ASTM D4797.

(C) Flash Point

The thermoplastic shall have a flashpoint of no less than 500°F when tested in accordance with ASTM D92 Cleveland Open Cup (COC).

(D) Requirements

The thermoplastic material after heating for 240 ± 5 minutes at 425 ± 3°F and cooled to 77 ± 3°F shall meet the following:

(1) Color

(a) White

Daylight reflectance 2° Standard observer and CIE illuminant

Using XYZ scale D65/10° - 80% minimum

ASTM E1349

Yellowness Index - The white thermoplastic shall not exceed a yellowness index of 12.0 per ASTM E313

(b) Yellow

Obtain Color Values Y,x,y per ASTM E1349 using C/2° illuminant/observer

Results shall be $Y \geq 45\%$, and x,y shall fall within PR#1 chart chromaticity limits.

(2) Bond Strength

The bond strength shall be 200 psi or greater in accordance with ASTM D4796.

(3) Cracking Resistance at Low Temperatures

After applying a 4 inch, 125 mil draw-down to concrete blocks and cooling to 15 ± 3°F, the material shall show no cracks at an observation distance of 12 inches.

(4) Specific Gravity

The specific gravity shall be 1.95-2.20 in accordance with ASTM D792.

(5) Softening Point

The softening point shall be 215 ± 15°F in accordance with ASTM D36.

(6) Drying Time

When applied at a thickness of 125 mils, the material shall set to bear traffic in no more than 2 minutes when air and substrate temperature is 50°F ± 3°F (and no more than 10 minutes when the air and substrate temperature is 90°F ± 3°F when applied at temperature of 412.5 ± 12.5°F in accordance with AASHTO T 250.

(7) Alkyd/Maleic Binder Determination

The thermoplastic material shall immediately dissolve in diacetone alcohol. Slow dissolution is evidence of the presence of hydrocarbon binder components.

(8) Indentation Resistance

The Shore Type A2 Durometer with a 4.41 lb. load applied shall be between 40 and 75 units after 15 seconds at 115°F in accordance with ASTM D2240.

1087-8 MATERIAL CERTIFICATION

Furnish the following pavement marking material certifications in accordance with Article 106-3.

When tested, the material shall meet the physical and chemical characteristics provided by the manufacturer. NCDOT reserves the right to compare these test results to baseline test results gathered by the NCDOT Materials and Tests Unit.

If not NCDOT standard glass beads, then must meet AASHTO M 247 Type 3 or 4 and a NCDOT Type 2 Material Certification must be provided.

Drop-on Reflective Media	Type 3 Material Certification and Type 4 Material Certification
Intermix Reflective Media	Type 2 Material Certification and Type 3 Material Certification
Paint	Type 3 Material Certification
Removable Tape	Type 3 Material Certification
Extruded Thermoplastic	Type 3 Material Certification and Type 4 Material Certification
Heated-In-Place Thermoplastic	Type 3 Material Certification
Cold Applied Plastic	Type 2 Material Certification and Type 3 Material Certification
Polyurea	Type 2 Material Certification and Type 3 Material Certification

SECTION 1088
DELINEATORS

1088-1 REFLECTIVE UNIT REQUIREMENTS FOR DELINEATORS

(A) Definition

Refer to ASTM D4956.

Define “entrance angle” as the angle at the reflector between direction of light incident on it and direction of reflector axis.

Define “observation angle” and “specific intensity” in accordance with Subarticle 1086-3(C)(3)(a).

(B) Reflective Elements

(1) Prismatic Plastic Type

(a) General

Use an acrylic plastic prismatic reflector hermetically sealed to an acrylic plastic back. The reflector shall consist of a clear and transparent face, herein referred to as a lens, with an acrylic plastic back fused to the lens under heat pressure around the entire perimeter of the lens. Where a central mounting hole is required, permanently seal the unit against dust, water and water vapor.

The lens shall consist of a smooth front surface free from projections or indentations except a central mounting hole and identification markings. Mold the manufacturer's trademark legibly into the face of the lens.

(b) Specific Intensity

Refer to ASTM D4956.

The specific intensity of each prismatic plastic type reflector shall meet Table 1088-1 measurements made with reflectors spinning. Failure to meet the specific intensity minimum will constitute failure of the lot.

TABLE 1088-1
OPTICAL PROPERTIES OF PRISMATIC PLASTIC TYPE REFLECTORS

Observation Angle (Degrees)	Entrance Angle (Degrees)	Minimum Specific Intensity (Candlepower per Footcandle)		
		Crystal	*Yellow*	*Red*
0.1°	0°	119	71	29
0.1°	15°	119	28	--
0.1°	20°	47	28	11
0.1°	35°	50	30	--

Locate the prismatic plastic type reflector to be tested at a distance of 100 feet from a single light source having an effective diameter of 2 inches operate the light source at approximately normal efficiency. Measure the return light from the reflector by a photoelectric photometer having a minimum sensitivity of 1 x 10 footcandles per mm scale division. The photometer shall have a receiver aperture of 0.5 inch diameter, shielded to eliminate stray light. The distance from light source center to aperture center shall be 2.1 inches for 0.1 degree observation angle. During testing, spin the reflectors to average the orientation effect.

If a test distance other than 100 feet is used, modify the source and aperture dimensions, and the distance between source and aperture, in the same proportion as the test distance.

(c) Durability

(i) Seal Test

Use the following test to determine if a reflector is adequately sealed against dust and water:

Submerge 50 samples in water at room temperature. Subject the submerged samples to a vacuum of 5 inches gauge for 5 minutes. Restore atmospheric pressure and leave the samples submerged for 5 minutes, then examine the samples for water intake. Evidence of any water is a failure. Failure of more than 2% of the number tested will be cause for rejection.

(ii) Heat Resistance Test

Test three reflectors for 4 hours in a circulating air oven at 175°+5°F. Place the test specimens in a horizontal position on a grid or perforated shelf, permitting free air circulation. At the conclusion of the test, remove the samples from the oven and permit them to cool in air to room temperature. The samples, after exposure to heat, shall show no change in shape and general appearance when compared with unexposed control standards. Any failures will be cause for rejection.

(2) High Performance Sheeting Grade

The reflective sheeting shall be Grade C retroreflective sheeting that conforms to Article 1092-2.

1088-2 GUARDRAIL AND BARRIER DELINEATORS

(A) Brackets and Casings for Delineators

Make brackets for guardrail and barrier delineators out of 12 gauge galvanized steel, 0.063 inch thick aluminum alloy, or .080 inch thick polycarbonate. Use molded plastic type guardrail and barrier delineators that consist of a plastic casing and a reflective element.

(B) Reflective Element Requirements

The reflective element shall meet Article 1088-1. In addition, guardrail delineators and side mounted barrier delineators shall have a minimum reflective area of 7 sq.in. Top mounted barrier delineators shall have a minimum reflective area of 28 sq.in.

(C) Material Certification

Furnish a Type 2 material certification in accordance with Article 106-3 for all guardrail and barrier (permanent) delineators and a Type 7 material certification for all guardrail and barrier delineators (temporary) before use.

(D) Approval

All materials are subject to the approval of the Engineer.

1088-3 GUARDRAIL END DELINEATION

(A) General

Use guardrail end delineation that is adhesive coated yellow reflective sheeting applied with a pressure sensitive adhesive backing.

(B) Reflective Sheeting Requirements

Use Grade C yellow retroreflective sheeting which conforms to Article 1092-2 for all guardrail end delineation. In addition, guardrail end delineation shall have a minimum reflective area of 2 sf for curved end sections or cover the entire portion of square end sections. See *Roadway Standard Drawings*.

(C) Material Certification

Furnish a Type 2 material certification in accordance with Article 106-3 for all guardrail end delineation before use.

(D) Approval

All materials are subject to the approval of the Engineer.

1088-4 OBJECT MARKERS

(A) General

Use 7 feet galvanized steel U-shaped channel posts as supports for delineators that are fabricated from steel conforming to ASTM A36 or ASTM A409. Use 7 feet posts, which weigh at least 1.12 lbs/lf after fabrication and application of protective finish. Punch or drill all posts with 3/8 inch diameter holes on the centerline, spaced on 1 inch centers, starting 1 inch from the top and extending at least 24 inches down the posts. Make sure that the holes are clean and the posts are free of burrs. Hot dip galvanize the posts after fabrication for the full length and total area in accordance with ASTM A123.

(B) Reflectors

Use 3 inches diameter prismatic plastic reflectors on object markers that meet Subarticle 1088-1(B)(1).

(C) Reflective Sheeting Requirements

Use Grade C retroreflective sheeting on object markers that meet Article 1092-2.

(D) Panel Requirements

Use panels that meet Article 1092-1.

(E) Fasteners

Use fasteners that meet Article 1092-1.

(F) Material Certification

Furnish a Type 5 material certification in accordance with Article 106-3 for sheeting, a Type 2 material certification for delineators and a Type 1 material certification for U-channel posts before use.

(G) Approval

All materials are subject to the approval of the Engineer.

1088-5 TUBULAR MARKERS

(A) General

Provide tubular markers that are made of ultraviolet stabilized plastic impact resistant material found on the NCDOT APL. Products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT APL. Provide yellow, white or gray tubular markers as shown in the plans.

Provide tubular markers that are flexible or have a flexible joint at the base, such that it will return to its original shape and position if struck by a 5,000 lb vehicle at a velocity of 55 mph. When struck the tubular markers shall not permanently distort to a degree that would prevent reuse.

Use tubular markers that are circular in shape and have a minimum height of 36 inches with a broadened base. Use tubular markers that have a minimum height of 42 inches on roadways with posted speed limits greater than 50 mph.

Design tubular markers that have white retroreflective collars or as shown in the contract.

Where retroreflective collars are required, provide Grade C retroreflective sheeting or better that meets Article 1092-2. Use retroreflective sheeting bands with a minimum width of 4 inches with 6 inches between the bands. Apply a continuous strip of sheeting completely around the tubular marker to ensure 360° retroreflectivity.

(B) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new tubular markers and retroreflective collars and a Type 7 material certification for all used tubular markers and retroreflective collars before use.

(C) Approval

All materials are subject to the approval of the Engineer.

1088-6 FLEXIBLE DELINEATOR

(A) General

Provide flexible delineators found on the NCDOT APL. Products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT APL.

(B) Retroreflective Sheeting

Use retroreflective sheeting that is a minimum area of 16 sq.in., with a minimum width of 3 inches. The reflective sheeting shall be Grade C retroreflective sheeting or better and shall conform to Article 1092-2.

Use retroreflective sheeting which is yellow, red or white, as shown in the plans. Attach the retroreflective sheeting on the front and back of the delineator post as required by the contract.

(C) Post

Design a delineator post that is flexible and made of recycled material. Provide a delineator post that is resistant to impact, ultraviolet light, ozone, hydrocarbons and stiffening with age.

Provide a post that is not seriously affected by exhaust fumes, asphalt or road oils, dirt, vegetation, soil, deicing salts or any other types of air contamination or materials likely to be encountered. Upon weathering, the post shall not exhibit serious discoloration, checking or cracking, peeling or blistering, swelling, shrinking or distortion, or any other detrimental effects. Weathering shall not cause appreciable strength or flexibility loss.

Design a post with a smooth surface that is free from irregularities or defects. The surface of the post shall not soil excessively. If soiling does occur, it shall be easily cleaned using detergent and water, or solvent.

Use posts that have a convex shaped cross-section. The chord distance for the cross-section shall be from 3.5 inches to 4.5 inches in length.

Design a post such that it can maintain straightness throughout its entire life. Straight is defined as no point along its length any more than 1 inch away from a perfectly straight edge placed longitudinally along any side of the post.

Provide a post in which both sides of the top of the post accepts, and holds securely, retroreflectorized sheeting.

Design posts that are gray in color.

(D) Base Support

Provide a base support that is hot rolled rail steel or new billet steel meeting Article 1088-5, the physical requirements of ASTM A499 and the chemical requirements of ASTM A1.

Use a base support that is a uniform flanged U-channel post with a nominal weight of 3 lb./ft. before holes are punched. Use base support posts that are 18 inches in length and

have sufficient number of 3/8 inch diameter holes on 1 inch centers to facilitate attachment of the flexible post.

(E) Anchoring

Design a delineator post for a permanent installation to resist overturning, twisting and displacement from wind and impact forces.

(F) Temperature

Design flexible delineators that do not bend, warp or distort and remain straight, when stored or installed at temperatures up to + 120°F. Design all components of the flexible delineator, post and reflective sheeting to remain stable and remain fully functional within a temperature range of - 20°F to + 120°F.

(G) Impact Resistance, Wind Resistance

Design flexible delineators that meet the impact and wind resistance of the current evaluation criteria of the AASHTO Product Evaluation & Audit Solutions.

(H) Product Identification

Provide flexible delineator post that are permanently identified, on the rear side, with the manufacturer's name and the month and year of fabrication in order to provide a tracking method for ongoing outdoor evaluation, and specification quality control. The letters shall be at least 1/4 inch in height and permanently affixed to the rear of the marker.

(I) Material Certification

Furnish a Type 2 and Type 3 material certification in accordance with Article 106-3 for all flexible delineators before use.

(J) Approval

All materials are subject to the approval of the Engineer.

SECTION 1089
TRAFFIC CONTROL

1089-1 WORK ZONE SIGNS

(A) General

Use Grade B fluorescent orange retroreflective sheeting on rigid work zone sign substrates. All sheeting shall conform to Article 1092-2. Cover the entire sign face of the sign substrate with Department approved sheeting as found on the NCDOT APL. No bubbles or wrinkles will be permitted in the material. Products manufactured prior to December 31, 2019 shall meet NCHRP 350 or MASH crash requirements for Category II work zone devices.

(1) Work Zones Signs (Stationary)

Use approved composite or aluminum substrate for sign backing. For aluminum substrate sign thickness, refer to Table 901-2.

Use work zone signs (stationary) and sign supports as found on the NCDOT APL.

(2) Work Zones Signs (Barricade Mounted)

Use approved composite or roll-up signs for barricade mounted sign substrates. No other type of sign substrate is allowed on barricades. Approved composite barricade mounted warning signs (black on orange) shall be Grade B retroreflective sheeting that meets the requirements of Article 1092-2.

(3) Use work zone signs (barricade mounted) and barricade assemblies as found on the NCDOT APL. Work Zones Signs (Portable)

Use approved composite or roll-up sign substrates on portable sign stands. No other type of sign substrate is allowed on portable sign stands.

Use work zone signs (portable) and sign supports as found on the NCDOT.

(a) Composite

Use Grade B fluorescent orange retroreflective sheeting that meets the requirements of Article 1092-2.

(b) Roll-up Signs

Use Grade B fluorescent orange retroreflective sheeting for roll-up signs that meet the requirements of Article 1092-2.

Use roll up signs that have a minimum 3/16 inch x 1 1/4 inches horizontal rib and 3/8 inch x 1 1/4 inches vertical rib.

(B) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new reflective sheeting used on work zone signs meeting the retroreflective requirements of Article 1092-2. Furnish a Type 7 material certification for all used signs meeting the minimum retroreflective requirements of Article 1092-2.

(C) Approval

All materials are subject to the approval of the Engineer.

(D) Warranty

Refer to Subarticle 1092-2(B) for warranty requirements of rigid sign retroreflective sheeting.

Roll-up fluorescent orange retroreflective signs will maintain 80% of its retroreflectivity as described in Article 1092-2 for years 1 and 2 and 50% for year 3.

Rigid and rollup fluorescent orange signs shall maintain a fluorescence luminance factor of 13% for 3 years and conform to Article 1092-2.

Rigid and roll up fluorescent orange signs shall maintain a total luminance factor of 25 for 3 years and conform to Article 1092-2.

1089-2 WORK ZONE SIGNS SUPPORTS

(A) General

Products manufactured prior to December 31, 2019 shall meet NCHRP 350 or MASH crash requirements for Category II work zone devices.

(1) Work Zone Signs (Stationary)

Provide work zone sign supports for work zone signs (stationary) that are sturdy, durable and crashworthy. Use work zone signs (stationary) and sign supports as found on the NCDOT APL.

Use 3 lb U-channel steel posts, 4 inches x 4 inches wood posts or perforated square steel tubing posts for all work zone signs. Dual mount signs with surface areas greater than 10 sf on either 3 lb U-channel steel posts, 4 inches x 4 inches wood posts or perforated square steel tubing posts having the equivalent or greater strength of 3 lb U-Channel Steel posts. Perforated square steel tubing breakaway posts certified by the manufacturer for single mounting purposes may be used for the single mounting of stationary work zone signs for signs greater than 10 sf.

3 lb. steel U-channel posts shall comply with Subarticle 1094-1(B) and may be galvanized steel or painted green by the post manufacturer.

(2) Work Zone Signs (Portable)

Use work zone signs and portable work zone sign stands that are sturdy, durable and crashworthy. Use work zone signs (portable) and sign supports as found on the NCDOT APL.

(B) Material Certification

Provide portable work zone signs and stands that are listed on the NCDOT Approved Product List. Furnish a Type 3 material certification in accordance with Article 106-3 for all new work zone sign (stationary) posts and a Type 7 material certification for all used work zone sign (stationary) posts before use.

Furnish a Type 3 material certification in accordance with Article 106-3 for all new portable work zone sign stand assemblies and a Type 7 material certification for all used portable work zone sign stand assemblies before use.

(C) Approval

All materials are subject to the approval of the Engineer.

1089-3 BARRICADES

(A) General

Construct barricades out of perforated square steel tubing, angle iron or other Department approved materials.

Use barricade rails constructed of approved composite, hollow/corrugated extruded rigid polyolefin, HDPE or other Department approved material that have a smooth face and alternating orange and white retroreflective stripes that slope at an angle of 45°.

Use barricades as found on the NCDOT APL. Products manufactured prior to December 31, 2019 shall meet NCHRP 350 or MASH crash requirements for Category II work zone devices.

(B) Supports

Support barricade rails in a manner that shall be visible to the motorist and provide a stable support not easily blown over by wind or traffic.

(C) Retroreflective Sheeting

Use Grade B retroreflective sheeting that meets Article 1092-2. Flame treat rails before applying the sheeting if required by the sign sheeting manufacturer. Apply the reflective sheeting with a pressure sensitive adhesive to both sides of the rails.

Use the same color sheeting on each rail of any individual barricade.

(D) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new barricades and a Type 7 material certification for all used barricades before use.

(E) Approval

All materials are subject to the approval of the Engineer.

1089-4 SEQUENTIAL FLASHING WARNING LIGHTS

(A) General

Provide sequential flashing warning lights that meet all of the requirements for Type A warning lights in accordance with the MUTCD.

(B) Power System

Each light unit shall be capable of operating fully and continuously for a minimum of 200 hours when equipped with a standard battery set.

(C) Light Display

Each light in the sequence shall be yellow and flashed at a rate of not less than 55 times per minute and not more than 75 times per minute. The flash rate and flash duration shall be consistent throughout the sequence.

(D) Reliability

The lights shall be weather independent and visual obstructions shall not interfere with the operation of the lights.

(E) Material Certification

Furnish a Type 3 material certification in accordance with article 106-3 for all new Sequential Flashing Warning Lights and a Type 7 material certification for all used Sequential Flashing Warning Lights.

(F) Approval

Use sequential flashing warning lights listed on the NCDOT APL.

1089-5 CHANNELIZING DEVICES

(A) Drums

(1) General

Provide drums composed of a body, alternating orange and white 4-band pattern of Type III-High Intensity or higher prismatic retroreflective sheeting and ballasts.

(2) Body

Provide a drum made of orange, impact resistant, ultraviolet plastic material capable of maintaining its integrity upon impact throughout a temperature range of -20°F to 125°F. When struck, the drum shall not permanently distort to a degree that would prevent reuse, nor roll excessively after impact. Design the drum to prevent water from accumulating and freezing in the top or bottom.

Provide a drum that is cylindrical in shape with the following dimensions; a minimum height of 36 inches, a minimum top outer diameter of 18 inches, a bottom outer diameter of 21 inches to 24 inches, and a minimum weight of 7 lbs. The top outer diameter shall not exceed the bottom outside diameter. Provide closed tops on drums to prevent accumulation of debris.

(3) Retroreflective Stripes

Provide at least four retroreflective bands with two orange and two white alternating horizontal circumferential bands. The top band shall always be orange. Use a 6 inch to 8 inch wide band Type III–High Intensity or higher prismatic retroreflective sheeting meeting the requirements of Article 1092-2 for each band. Do not exceed 2 inches for any non-retroreflective spaces between orange and white stripes. Do not splice the retroreflective sheeting to create the 6 inch band. Apply the retroreflective sheeting directly to the drum surface. Do not apply the retroreflective sheeting over a pre-existing layer of retroreflective sheeting. Do not place bands over any protruding corrugations areas. No damage to the retroreflective sheeting should result from stacking and unstacking the drums, or vehicle impact.

(4) Ballast

Ballast drums using the sandbag ballast method, the tire sidewall ballast method or the preformed weighted base ballast method. When properly ballasted, the drums shall be wind resistant to the extent of withstanding wind created by traffic under normal roadway conditions, including high speed truck traffic in close proximity to the drums. Do not place ballast on top of the drum.

(a) Sandbag Ballast Method

Supply a sandbag with 50 lb. of sand with each drum. Place the sandbag inside the body on top of the detachable base. Upon impact the main body of the drum shall deform and become detached from the base, allowing vehicles to easily pass over the remaining base.

(b) Tire Sidewall Ballast Method

Design the base of the drums to accommodate no more than two tire sidewalls that when combined will have a weight of at least 30 lb and no more than 50 lb. Use the manufacturer's required tire sidewall ballast. Upon impact the main body of the drum shall deform and become detached from the tire sidewalls, allowing vehicles to easily pass over the tire sidewall ballasts.

(c) Preformed Weighted Base Ballast Method

Supply a preformed base specifically designed for the model drum. The weight of each drum's preformed base will be self-certified by the manufacturers. Each drum with preformed bases shall be approved by the Work Zone Traffic Control Unit. Upon impact, the main body of the drum shall deform and become detached from the base allowing vehicles to easily pass over the remaining base.

(5) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new drums and a Type 7 material certification for all used drums before use.

(6) Approval

All materials are subject to the approval of the Engineer.

(B) Skinny Drums

(1) General

Provide skinny drums composed of a body, alternating orange and white stripes of Type III-High Intensity or higher prismatic retroreflective sheeting and ballasts

(2) Body

Provide a skinny drum made of orange, impact resistant, ultraviolet plastic material capable of maintaining its integrity upon impact throughout a temperature range of - 20°F to 125°F. When struck, the skinny drum shall not permanently distort to a degree that would prevent reuse, nor roll excessively after impact. Design the skinny drum to prevent water from accumulating and freezing in the top or bottom.

Provide a skinny drum that is cylindrical in shape with the following dimensions; a minimum height of 42 inches, a minimum top outer diameter of 4 inches and a bottom outer diameter of 7.5 inches. The top outer diameter shall not exceed the bottom outside diameter. Provide closed tops on drums to prevent accumulation of debris.

(3) Retroreflective Stripes

Provide at least four retroreflective bands with two orange and two white alternating horizontal circumferential bands for each skinny drum. The top band shall always be

orange. Use a 6 inch to 8 inch wide band Type III–High Intensity or higher prismatic retroreflective sheeting that meets Article 1092-2 for each band. Do not exceed 2 inches for any non-retroreflective spaces between orange and white stripes. Do not splice the retroreflective sheeting to create the 6 inch band. Apply the retroreflective sheeting directly to the skinny drum surface. Do not apply the retroreflective sheeting over a pre-existing layer of retroreflective sheeting. Do not place bands over any protruding corrugation areas. No damage to the reflective sheeting should result from stacking and unstacking the skinny drums, or vehicle impact.

(4) Ballast

Ballast skinny drums using a preformed base specifically designed for the model skinny drum. Each base shall be at least 15 lb and circular or polygonal with equal sides. When properly ballasted, the skinny drums shall be wind resistant to the extent of withstanding wind created by traffic under normal roadway conditions, including high speed truck traffic in close proximity to the skinny drums. Do not place ballast on top of the drum. Upon impact, the main body of the drum shall deform and become detached from the base allowing vehicles to easily pass over the remaining base.

(5) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new skinny drums and a Type 7 material certification for all used skinny drums before use.

(6) Approval

All materials are subject to the approval of the Engineer.

(C) Cones

(1) General

Use cones made of ultraviolet stabilized plastic impact resistant material meeting MUTCD and this article. Orange will be the predominant color on cones.

Use cones conical in shape with a minimum height of 28 inches or 36 inches. The 28 inch cones shall have a minimum base dimension of 13.75 inches, and the 36 inch cones shall have a minimum base dimension of 14.5 inches as shown in the *Roadway Standard Drawings*. The 28 inch and 36 inch cones (excluding ballast) shall have a minimum weight of 7 lbs. and 10 lbs. respectively. When in an upright position, have the cones display the same dimensions regardless of their orientation to oncoming traffic.

(2) Ballasts

Provide wind resistant cones that do not blow over under normal roadway conditions, including high speed truck traffic in close proximity to the cones when properly ballasted. Provide cones that do not permanently distort to a degree that would prevent reuse when struck.

Achieve ballasting of the cones by using any of the following methods:

(a) Cones with bases that may be filled with ballast,

(b) Doubling the cones or using heavier weighted cones, or

(c) Cones with special weighted bases or weights such as rubber rings that can be dropped over the cones and onto the base to provide increased stability.

(3) Retroreflective Sheeting

Where retroreflective cones are required, provide a cone with flexible, prismatic cone sheeting having impact resistance and attached with precoated pressure sensitive adhesive. The retroreflective sheeting shall meet or exceed the retroreflectivity

requirements of Grade B sheeting in Article 1092-2. Use two retroreflective bands, the top one is 6 inches wide and the bottom one is 4 inches wide; see *Roadway Standard Drawings*.

(4) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new cones with or without retroreflective sheeting and a Type 7 material certification for all used cones with or without retroreflective sheeting before use.

(5) Approval

All materials are subject to the approval of the Engineer.

1089-6 FLASHING ARROW BOARDS

(A) General

Provide a trailer mounted arrow board that meets or exceeds the physical and operational requirements of the MUTCD and found on the NCDOT APL. Products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT APL.

The following specifications supplement those basic requirements. Provide a totally mobile complete unit capable of being located as traffic conditions demand.

The display housing shall meet the minimum size requirements of a Type C panel with a 15 or 25 lamp configuration.

The display housing shall have a hand-crank mechanism to allow raising and lowering the display with a locking device to ensure the display housing will remain secured in either position

The display housing will have a minimum height of 7 feet from the bottom of the sign to the ground when raised in the upright position.

The display housing assembly shall be of weather resistant construction.

The lamps shall be controlled to provide the following modes as a minimum: Flashing Right or Left Arrow, Flashing Double Arrow and Caution Mode (four outermost corner lamps).

(B) Power System

Provide a unit that is solar powered and supplemented with a battery backup system that includes a 110/120 VAC powered on-board charging system.

The unit shall also be capable of being powered by standard 110/120 VAC power source.

The batteries, when fully charged, shall be capable of powering the display for 20 continuous days with no solar power.

Store the battery bank and charging system in a lockable, weather and vandal resistant box.

(C) Controller

Provide automatic brightness/dimming of the display and a manual override dimming switch.

The controller shall provide a battery-charge status indicator.

Mobile radio or any other radio transmissions shall not affect the controller.

Store the controller in a lockable, weather and vandal resistant box.

(D) Trailer

Finish all exterior metal surfaces with Federal orange enamel per AMS-STD-595, color chip ID# 13538 or 12473 respectively. The trailer shall be able to support a 100 mph wind load with the display fully extended.

The trailer shall be equipped with leveling jacks capable of stabilizing the unit in a horizontal position when located on slopes 6:1 or flatter.

The trailer shall be properly equipped in compliance with North Carolina Law governing motor vehicles.

Provide a minimum 4 inch wide strip of fluorescent orange retroreflective sheeting to the frame of the trailer. Apply the sheeting to all sides of the trailer. The retroreflective sheeting shall be Grade C that conforms to Article 1092-2. Drums may be supplemented around the unit in place of the sheeting.

(E) Reliability

Provide a sign unit that all components are rated to operate at temperatures ranging from -30°F to 165°F.

The sign manufacturer shall notify the Work Zone Traffic Control Unit whenever modifications are made to a prequalified sign on the NCDOT APL.

The Work Zone Traffic Control Unit will review changes and per its discretion either make no change to the sign's status or remove it from the list until the sign can be reevaluated.

(F) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new flashing arrow boards, a Type 7 material certification for all used flashing arrow boards, and wind load certifications required in Subarticle 1089-6(D) for all new and used flashing arrow boards before use.

(G) Approval

The sign shall be on the NCDOT APL before use on construction projects in North Carolina. A sign may be removed from the NCDOT APL due to unsatisfactory field performance and shall not return to the list until the manufacturer identifies the reason for the failure and the problem has been corrected to the satisfaction of the Department.

The sign manufacturer shall notify the Department whenever modifications are made to their sign that was prequalified on the NCDOT APL. The Department will review changes and per its discretion, either make no change to the sign's status on the NCDOT APL or remove the sign from the list until the sign can be reevaluated.

1089-7 PORTABLE CHANGEABLE MESSAGE SIGNS

(A) General

Provide trailer or truck mounted portable changeable message signs that meet MUTCD and found on the NCDOT APL. Products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT APL.

A trailer mounted portable changeable message sign shall be a totally mobile complete sign unit capable of being located as traffic conditions demand.

(B) Display Panel

Provide sign capable of sequentially displaying at least 2 phases of 3 lines of a programmable message with at least 8 characters per line and a character height of at least 18 inches.

The display characters will be composed of LED elements. The display panel may be of the following types- Full Matrix, Continuous Line Matrix, and Character Matrix.

Messages are to be automatically centered and proportionally spaced on each line of a Full Matrix and Continuous Line Matrix displays. Character Matrix displays shall display odd number character messages one character left of the centerline.

The display characters shall be protected with a polycarbonate lens that shall not decrease the daytime visibility of the sign.

The display panel shall have an electro-hydraulic system to allow raising and lowering the display with 360° rotation capability. The distance from the bottom of the sign to the ground shall be at least 7 feet. A locking device(s) shall be provided to ensure the display will remain secure in the raised, lowered and rotated positions. The sign shall have the capability to be raised and rotated to its operating position by one person.

A manual backup mechanism for the raising and lowering the display panel shall be provided in the event the electro-hydraulic system fails.

The display panel assembly shall be of weather resistant construction

(C) Power System

The unit shall be Solar powered and supplemented with a battery backup system which includes a 110/120 VAC powered on-board charging system.

The batteries, when fully charged, shall be capable of powering the display for 20 continuous days with no solar power. The unit shall be capable of being powered by standard 110/120 VAC power source.

Store the battery bank and charging system in a lockable, weather and vandal resistant box.

(D) Controller

The controller shall be capable of being equipped with the necessary hardware and software to allow wireless communication with other portable changeable message signs or other components of an intelligent transportation system. The controller shall also provide at a minimum; a keyboard, a display for message review and editing, a light source for nighttime operations, an event time clock and all other required controls for the operation of the display. Program each controller with password protection that will deter unauthorized programming of the controller. Change the controller password from the factory default and periodically change the controller password to deter unauthorized programming of the controller. The password system is recommended to include at least two levels of security such that operators at one level may only change message sequences displayed using preprogrammed sequences and operators at a higher level may create and store messages or message sequences.

The controller shall include the following capabilities; manually dimming the display, storing at least 99 user generated messages, adjusting the flash rate of display and display phasing and monitoring battery-charge status.

Mobile radio or any other radio transmissions shall not affect the controller.

The controller shall be stored in a locked, weather and vandal resistant box when not in use and after changes to the messages are made.

The controller shall be pre-programmed with messages shown below and stored in memory:

MAX SAFE SPEED 25 MPH	MAX SAFE SPEED 30 MPH
STOP AHEAD	YIELD AHEAD
MAX SAFE SPEED 35 MPH	MAX SAFE SPEED 40 MPH
MAX SAFE SPEED 45 MPH	MAX SAFE SPEED 50 MPH
ONE LANE BRIDGE	SURVEY CREW
MAX SAFE SPEED 55 MPH	DETOUR AHEAD
CAUTION DETOUR AHEAD	LANE CLOSED AHEAD
RIGHT LANE CLOSED	LEFT LANE CLOSED
CENTER LANE CLOSED	SINGLE LANE AHEAD
MERGE LEFT	MERGE RIGHT
KEEP LEFT	KEEP RIGHT
PASS LEFT	PASS RIGHT
USE LEFT LANE	USE RIGHT LANE
MERGE AHEAD	ROAD MACHINES AHEAD
ROAD WORK AHEAD	FLAGGER AHEAD
BUMP	DIP
STOP AHEAD	YIELD AHEAD
BE PREPARED TO STOP	SIGNAL AHEAD
SIGNAL NOT WORKING	DO NOT PASS
ONE LANE BRIDGE	SURVEY CREW
SHOULDER WORK	SOFT SHOULDER
PAVEMENT ENDS	LANE ENDS
ROAD CLOSED 1/4 MILE	ROAD CLOSED 1/2 MILE
ALL TRAFFIC EXIT LEFT	ALL TRAFFIC EXIT RIGHT
ROAD NARROWS	ROAD CLOSED AHEAD
RAMP CLOSED	REDUCE SPEED
ROAD PAVING AHEAD	ALL TRAFFIC MUST STOP
SLOW MOVING TRAFFIC	NIGHT WORK AHEAD
CAUTION FLAGGER AHEAD	RUNAWAY TRUCK RAMP
MEDIAN WORK AHEAD	
LEFT LANE NARROWS	RIGHT LANE NARROWS
TEST PATTERN A[A]	TEST PATTERN B[B]

A. Test Pattern A is 1/2 of the LEDs on at a time.

B. Test Pattern B is for the remaining 1/2 of the LEDs on at a time.

(E) Trailer

Finish all exterior metal surfaces with Federal orange enamel per AMS-STD-595; color chip ID# 13538 or 12473 respectively except for the sign face assembly that shall be flat black.

Provide a minimum 4 inches wide strip of fluorescent orange retroreflective sheeting to the frame of the trailer. Apply the sheeting to all sides of the trailer. The retroreflective sheeting shall be Grade C that conforms to Article 1092-2. Drums may be supplemented around the unit in place of the sheeting.

The trailer shall be able to support a 100 mph wind load with the display fully extended.

The trailer shall be equipped with leveling jacks capable of stabilizing the unit in a horizontal position when located on slopes 6:1 or flatter.

The trailer shall be properly equipped in compliance with North Carolina Law governing motor vehicles.

(F) Reliability

Provide a sign unit that all components are rated to operate at temperatures ranging from -30°F to 165°F.

(G) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new changeable message signs, a Type 7 material certification for all used changeable message signs and wind load certifications required in Subarticle 1089-7(E) for all new and used changeable message signs before use.

(H) Approval

The sign shall be listed on the NCDOT APL before use on construction projects in North Carolina. A sign may be removed from the NCDOT APL due to unsatisfactory field performance and shall not return to the list until the manufacturer identifies the reason for the failure and the problem has been corrected to the satisfaction of the NCDOT.

The sign manufacturer shall notify NCDOT whenever modifications are made to their sign that was prequalified on the NCDOT APL. The Department will review changes and per its discretion will either make no change to the sign's status on the NCDOT APL or remove the sign from the list until the sign can be reevaluated.

1089-8 TEMPORARY CRASH CUSHIONS

(A) General

Provide temporary crash cushions that meet Test Level II for work zones that have a posted speed limit of 45 mph or less. Provide temporary crash cushions that meet Test Level III devices for work zones that have a posted speed limit of 50 mph or greater.

Use temporary crash cushions as found on the NCDOT APL. Products manufactured prior to December 31, 2018 shall meet NCHRP 350 or MASH crash requirements for Category III work zone devices.

Provide redirective temporary crash cushions or non-directive temporary crash cushions that capture errant vehicles without complete penetration through the device.

The temporary crash cushion shall contain the debris resulting from impact within the structure of the temporary crash cushion.

Include in the temporary crash cushion package any required rear transition panels to connect the back of the temporary crash cushion to rigid or flexible barrier systems. Include any required portable base, as recommended by the manufacturer of the temporary crash cushion, to connect the bottom of the temporary crash cushion to a paved surface. Temporary crash cushion shall not be placed on an unpaved surface.

(B) Retroreflective End Treatments

Provide a yellow nose wrap that visually matches the color chip that corresponds to the AMS-STD-595 for Yellow (Color No. 13538) for all temporary crash cushions.

The retroreflective end treatment shall meet the requirement for retroreflectivity in Article 1088-1 and *Roadway Standard Drawings*.

(C) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new temporary crash cushions and a Type 7 material certification for all used temporary crash cushions before use.

(D) Approval

Use temporary crash cushions listed on the NCDOT APL.

1089-9 ATTENUATORS

(A) General

Provide truck mounted attenuators that meet Test Level II for work zones that have a posted speed limit of 45 mph or less. Provide truck mounted attenuators that meet Test Level III for work zones that have a posted speed limit of 50 mph or greater.

Use attenuators as found on the NCDOT APL. Products manufactured prior to December 31, 2018 shall meet NCHRP 350 or MASH crash requirements for Category III work zone devices.

Use trucks with gross vehicle tare weight as described in the NCHRP 350 crash test for the impact attenuator provided. Provide truck in accordance with the manufacturer's specifications. Ballasting methods are not permitted.

Use the attenuator in accordance with the manufacturer's specifications. Provide truck mounted attenuators with standard trailer lighting systems, including brake lights, tail lights and turn signals.

(B) Retroreflective End Treatment

The retroreflective end treatment shall meet Article 1088-1 and *Roadway Standard Drawings*.

(C) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new truck mounted attenuators and a Type 7 material certification for all used truck mounted attenuators before use.

(D) Approval

Use truck mounted attenuators listed on the NCDOT APL.

1089-10 FLAGGER

(A) 24 Inch Stop and Slow Paddle

(1) Retroreflective Sheeting

Use retroreflective sheeting with a smooth, sealed outer surface that will display the same color both day and night. Cover the entire sign face with Grade B retroreflective sheeting. Retroreflective sheeting shall meet Article 1092-2. The distance from the bottom of the sign to the ground shall be at least 6 feet.

(2) Material Certification

Furnish a Type 3 material certification in accordance with Article 106-3 for all new reflective sheeting used on flagger paddles and a Type 7 material certification for all used sheeting before use.

(3) Approval

All materials are subject to the approval of the Engineer.

(B) Vest

(1) Apparel Materials

Use highly-visibility safety apparel that meets the Performance Class 2 or higher requirements of the ANSI/ISEA 107-2010 or the equivalent revision. For nighttime flagging operations, Performance Class 3 safety apparel is required.

(2) Apparel Verification

All safety apparel shall have the original tag or label indicating that it meets the requirements of the ANSI/ISEA 107-2010 or the equivalent revision. Approval

All safety apparel is subject to the approval of the Engineer.

SECTION 1090
PORTABLE CONCRETE BARRIER

1090-1 PORTABLE CONCRETE BARRIER

(A) General

Use portable concrete barrier that meets Section 854, Section 1077 and the plans. The requirement for approved galvanized connectors will be waived if the barrier remains the property of the Contractor.

Use portable concrete barrier as found on the NCDOT APL. Products manufactured prior to December 31, 2019 shall meet NCHRP 350 or MASH crash requirements for Category III work zone devices.

(B) Material Certifications

All portable concrete barriers will have either a RFID tag/label tagged in accordance with Section 1030 applied in accordance with Subarticle 1030-2(F) or a certification. If the portable concrete barrier does not have an RFID tag/label, furnish a Type 3 material certification in accordance with Article 106-3 for all new portable concrete barrier and a Type 7 material certification for all used portable concrete barrier before use.

(C) Anchor Bolts

Use anchor bolts that meet ASTM F3125.

(D) Approval

All materials are subject to the approval of the Engineer.

SECTION 1091
ELECTRICAL MATERIALS

1091-1 GENERAL REQUIREMENTS

(A) New Materials

Furnish new equipment, materials and hardware unless otherwise specified.

(B) Electrical Industry Standards

Provide electrical materials in accordance with the appropriate UL standard when such standard is identified in the plans. All electrical materials shall be listed with a qualified testing laboratory that is approved by the North Carolina Department of Insurance, Office of State Fire Marshal such as UL, Intertek, ETL or CSA.

(C) Certification

Furnish a Type 3 material certification in accordance with Article 106-3.

1091-2 Wire and Cable

Use only stranded copper conductors, unless otherwise shown in the contract Provide wire and cable with identification labels or tags on either the wire or cable itself or on the coil, reel or smallest container in which the product is packaged when delivered to the project. Show the manufacturer's name, gauge, UL symbol and type of wire or cable on the identification label or tag. When requested by the Department, furnish samples of wire and cable to the Department at no additional cost.

Use wire and cable of the type and size shown in the contract meeting the following applicable UL standards at minimum: 44, 83, 493, 719, 854, 1063 and 1581.

Where required by the plans, use soft or annealed solid bare copper wire conforming to ASTM B3.

1091-3 CONDUIT

(A) Conduit Bodies, Boxes and Fittings

Use conduit bodies, boxes, and fittings that meet UL Standard 514A or 514B for electrical and communications installations.

(B) Rigid Metallic Conduit

Provide rigid hot dipped galvanized steel conduit that meets UL Standard 6 with rigid full weight sherardized or galvanized threaded fittings.

(C) PVC Conduit

Provide non-metallic conduit and duct including associated couplings, approved for above and below ground use with or without concrete encasement in accordance with UL Standard 651. Provide Schedule 40 conduit unless otherwise specified.

(D) Liquid-Tight Flexible Metal Conduit (LFMC)

Provide conduit that meets UL Standard 360. If used as an equipment grounding conductor, LFMC must meet the equipment grounding requirements of the NEC. Ensure conduit has insulated throat and malleable iron watertight fittings.

(E) Liquid-Tight Flexible Nonmetallic Conduit

Provide conduit that meets UL Standard 1660.

(F) Solid Wall HDPE Conduit

Use HDPE conduit that conforms to UL Standard 651A. Provide conduit meeting Table 1091-1 with minimum wall thickness ratios corresponding to EPEC-40 (Schedule 40), EPEC-80 (Schedule 80) or EPEC-B (SDR 13.5) as listed in UL Standard 651A and Table 1091-1.

TABLE 1091-1
HDPE CONDUIT SIZE

Conduit Trade Size	Furnish
1"	EPEC-40
1 1/4"	EPEC-40
1 1/2"	EPEC-B (SDR 13.5)
2"	EPEC-B (SDR 13.5)
2 1/2"	EPEC-B (SDR 13.5)
3"	EPEC-B (SDR 13.5)
4"	EPEC-B (SDR 13.5)
5"	EPEC-80
6"	EPEC-80

Ensure the polyethylene (PE) resin compounds used in manufacturing the conduit meet or exceed the cell classification PE 334480C (black with 2% minimum carbon black) or PE 334480E (colored conduit with UV inhibitors) in ASTM D3350 and Table 1091-2.

TABLE 1091-2 RESIN PROPERTIES		
Property	**Requirement**	**Test Method**
Density	0.940 - 0.947g/cm^3	ASTM D1505 ASTM D792 ASTM D4883
Melt Index (condition 190/2.16 is acceptable)	< 0.4 grams/10 minutes	ASTM D1238
Flexural Modulus	80,000 psi, min.	ASTM D790
Tensile Strength	Tensile Strength 3,000 psi, min.	ASTM D638
Elongation	Elongation 400%, min.	ASTM D638
Slow Crack Growth Resistance	An ESCR as per condition B, 10% IGEPAL requirement of F_{10}>96 hrs is allowable	ASTM D1693
Hydrostatic Design Basis	"0" for Non-Pressure Rated Pipe	ASTM D2837
UV Resistance (Outdoor Conduit Only)	Stabilize with at least 2% by weight carbon black or colored with UV Inhibitor	ASTM D4218

Furnish conduits in the colors for the applications shown in Table 1091-3. For conduits manufactured with stripes, ensure that a minimum of three stripes are uniformly spaced around the conduit with 120 degrees of separation. Do not use "Solid Yellow" or "Black with Yellow Stripes" conduit.

TABLE 1091-3 CONDUIT COLORS		
Conduit Contents	**Preferred Solid Color**	**Alternate**
Signal Cable	Black	None
Loop Lead-in Cable	White	Black with White Stripes
Communication Cable (Copper, Fiber-Optic, Coaxial)	Orange	Black with Orange Stripes
Electrical Power Cable	Red	Black with Red Stripes

Ensure the HDPE conduit is resistant to benzene, calcium chloride, ethyl alcohol, fuel oil, gasoline, lubricating oil, potassium chloride, sodium chloride, sodium nitrate and transformer oil and is protected against degradation due to oxidation and general corrosion.

Furnish conduit with a coefficient of friction of 0.10 or less in accordance with Telcordia GR-356.

Ensure the supplied conduit is identified and certified as meeting, UL Standard 651A. Ensure the conduit is marked at least with the following information on 5 feet or less intervals:

(1) Material: HDPE

(2) Trade Size: i.e., 2 inches

(3) Conduit Type: SDR 13.5 or EPEC-B

(4) Manufacturer's name or trademark

(5) Manufacturer's production code to identify manufacturing date, facility, etc.

(6) NRTL symbol or listing number

Furnish coilable conduit that is supplied on reels in continuous lengths for transportation and storage outside. Ensure that the process of installing the coilable conduit on the reel does not alter the properties or performance of the conduit for its intended purpose.

(G) Conduit Plugs, Pull Line and Tracer Wire

Furnish conduit plugs that provide a watertight barrier when installed in conduit. Furnish conduit plugs sized in accordance with conduit. Ensure conduit plug provides a means to secure a pull line to the end of the plug. Provide removable and re-usable conduit plugs. Conduit plugs are not required to be listed electrical devices.

For all spare conduits, furnish woven polyester pull tape with a minimum rated tensile strength of 2,500 lbs. Pull lines are not required to be listed electrical devices.

Provide green insulated number 14 AWG, THWN, stranded copper wire to serve as tracer wire.

1091-4 DUCT AND CONDUIT SEALER

Use duct and conduit sealer or mastic which is a putty-like compound and:

(A) Is permanently non-hardening, non-oxidizing, and non-corrosive to metals, rubber, plastic, lacquer and paints;

(B) Is readily workable for thumbing into openings and forming into seals around wires inside conduits and openings around conduits;

(C) Has a service temperature range of minus 30°F to 200°F;

(D) Is clean, non-poisonous and non-injurious to human skin;

(E) Seals against water, dust and air and shall adhere to wood, glass, plastics, metal, rubber and painted surfaces; and

(F) Is non-conductive.

1091-5 ELECTRICAL JUNCTION BOXES

(A) General

Provide electrical junction boxes with covers of the type and size indicated by the contract or plans for the termination of conduits.

(B) Polymer Concrete (PC) Junction Boxes

Provide polymer concrete (PC) boxes which have bolted covers and open bottoms. Provide vertical extensions of 6 inches to 12 inches as required by project provisions.

Use polymer concrete material made of an aggregate consisting of sand and gravel bound together with a polymer and reinforced with glass strands to fabricate box and cover components which are exposed to sunlight. Other thermoplastic materials may be used for components which are not normally exposed to sunlight.

Provide certification that the polymer concrete boxes and covers meet Tier 15 requirements of ANSI/SCTE 77. Provide certification that testing methods are compliant with ANSI/SCTE 77.

Provide the required logo on the cover. Provide at least two size 3/8 inch diameter hex head stainless steel cover bolts to match inserts in the box. Provide pull slot(s) with stainless steel pin(s). Polymer concrete junction boxes are not required to be listed electrical devices.

(C) Cast Metal (BR/SW) Junction Boxes

Provide three-piece cast-metal barrier rail (BR) box with replaceable flange, or two-piece cast metal side walk (SW) box with non-replaceable flange, as shown in the plans. The

box shall be hot dipped galvanized with factory or field drilled conduit entrances. Provide a hot dipped galvanized cover with checkered imprint, pry bar slots, and reinforcing ribs for heavy loading, neoprene gasket, and brass or stainless steel bolts. Provide a blind tapped (1/4 inch NC thread minimum) boss on interior of box for grounding.

1091-6 GROUNDING ELECTRODES

Provide grounding electrodes of the following types as indicated in the specifications and plans.

(A) Ground Rods

Provide 5/8 inch diameter, 10 feet long, copper-clad steel ground rods with 10 mil thick copper cladding.

(B) Sectional Ground Rods

Provide sectional ground rods comprised of 5/8 inch diameter, 10 feet long, steel ground rods with 10 mil thick copper cladding, welded together in a butt configuration with an exothermic weld. As an alternative, provide UL listed bronze couplers designed to connect 5/8 inch diameter copper-clad steel rods. Do not use threaded ground rods or threaded couplers. Provide minimum lengths required by plans.

SECTION 1092
SIGNING MATERIALS

1092-1 SIGNS AND HARDWARE

Fabricate signs from aluminum alloy sheets. Use supporting frames and accessories made of aluminum. Use galvanized steel backing plates and mounting bolts. Use materials that conform to Tables 1092-1 and 1092-2.

Filler metal shall conform to AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, and the Interim Specifications as shown on the plans.

Aluminum sign studs, welded to the sign panels in accordance with Article 901-3, shall be capable of withstanding a direct pull-out load of 400 lb. Furnish a Type 3 material certification in accordance with Article 106-3 demonstrating conformance to this requirement. The Materials and Tests Unit will take samples of the studs and make random field tests of the welded studs to verify the statement of certification. Failure of more than 5% of the studs tested on any one sign or failure of 3 or more studs in a row will be sufficient evidence for rejection of stud welding on the entire sign. When tested in tension, the studs shall not fail in the weld area, but fail in the threaded portion of the stud. Corrective actions will be determined by the Engineer.

Drill bolt holes and slots to finished size or they may be punched to finished size, provided the diameter of the punched holes is at least twice the thickness of the metal being punched. Flame cutting of bolt holes and slots will not be permitted. No galvanizing of any steel part will be allowed until all welding, cutting, milling, punching, and drilling of the part has been completed.

TABLE 1092-1 ALUMINUM SIGN MATERIALS		
Aluminum Materials	**Alloy Specification**	**Test Method**
Extruded Bars	6061-T6	ASTM B221
Sheets and Plates	6061-T6,5052-H38 or 3004-H38	ASTM B209
Structural Shapes	6061-T6	ASTM B308
Standard Weight Pipe	6061-T6	ASTM B241
Castings	356-T7	ASTM B26
Bolts	6061-T6, 2024-T4[A]	ASTM B211
Nuts (1/4" Tap and under)	2024-T4[A], 6061-T6 or 6262-T9	ASTM B211
Nuts (5/16" Tap and over)	2024-T4[A], 6061-T6 or 6262-T9	ASTM B211
Nuts (3/8" Self-locking)	2017-T4, 6061-T6	ASTM B211
Washers (std. flat) Alclad	2024-T4[A] or 6061-T6	ASTM B209
Washers (std. lock)	7075-T6	ASTM B211
Welded Studs (1/4")	5356-H12 or 5356-H32	ASTM B211

A. The alloy shall have anodic coating of 0.0002 inch minimum thickness with dichromate or boiling water seal

TABLE 1092-2 STEEL SIGN MATERIALS		
Galvanized Steel Materials	**Test Method for Base Metal**	**Test Method for Galvanizing**
Structural Shapes and Plates	ASTM A36	ASTM A123
Standard Weight Black Pipe	ASTM A53	ASTM A123
Bolts and Nuts	ASTM A307	ASTM F2329
Washers (std. flat and lock)	ASTM A307	ASTM F2329
High Strength Bolts, Nuts and Washers	ASTM A325	ASTM B695 Class 55

1092-2 RETROREFLECTIVE SHEETING

Reflectorize all signs. Use colors and sheeting grades of the sign backgrounds and messages as shown in the contract. After preparation of the sign panels, in accordance with Subarticle 901-3(D), apply retroreflective sheeting as required herein. The retroreflective sheeting shall consist of white or colored sheeting having a smooth outer surface and the property of a retroreflector over its entire surface.

Retroreflective sheeting shall meet ASTM D4956 and be listed on the NCDOT APL. Products must be current with the applicable AASHTO Product Evaluation & Audit Solutions workplan to remain on the NCDOT APL.

The reflective material specified herein is intended for use on surfaces of various traffic control devices, including drums, barricades, traffic cones and highway signs, to assure their adequate visibility at all times upon exposure to a light source when totally dry or wet. Provide reflectorization that produces a wide-angle retroreflectivity, enhancing nighttime visibility. This retroreflective sheeting shall consist of encapsulated, enclosed lens or prismatic with a transparent plastic having a smooth, flat outer surface. Provide material that is flexible, of good appearance, free from ragged edges, cracks and extraneous materials, and exhibits good quality workmanship.

(A) Performance and Test Requirements

TABLE 1092-3 MINIMUM COEFFICIENT OF RETROREFLECTION FOR NC GRADE A (Candelas Per Lux Per Square Meter)								
Observation Angle, degrees	**Entrance Angle, degrees**	**White**	**Yellow**	**Green**	**Red**	**Blue**	**Fluorescent Yellow Green**	**Fluorescent Yellow**
0.2	-4.0	525	395	52	95	30	420	315
0.2	30.0	215	162	22	43	10	170	130
0.5	-4.0	310	230	31	56	18	245	185
0.5	30.0	135	100	14	27	6	110	81
1.0	-4.0	80	60	8	16	3.6	64	48
1.0	30.0	45	34	4.5	9	2	36	27

TABLE 1092-4 MINIMUM COEFFICIENT OF RETROREFLECTION FOR NC GRADE B (Candelas Per Lux Per Square Meter)									
Observation Angle, degrees	**Entrance Angle, degrees**	**White**	**Yellow**	**Green**	**Red**	**Blue**	**Fluorescent Yellow Green**	**Fluorescent Yellow**	**Fluorescent Orange**
0.2	-4.0	380	285	38	76	17	300	230	115
0.2	30.0	215	162	22	43	10	170	130	65
0.5	-4.0	240	180	24	48	11	190	145	60
0.5	30.0	135	100	14	27	6	110	81	30
1.0	-4.0	80	60	8	16	3.6	64	48	7.5
1.0	30.0	45	34	4.5	9	2	36	27	5.6

TABLE 1092-5 MINIMUM COEFFICIENT OF RETROREFLECTION FOR NC GRADE C (Candelas Per Lux Per Square Meter)							
Observation Angle, degrees	**Entrance Angle, degrees**	**White**	**Yellow**	**Green**	**Red**	**Blue**	**Brown**
0.2	-4.0	250	170	45	45	20	12
0.2	30.0	150	100	25	25	11	8.5
0.5	-4.0	95	62	15	15	7.5	5
0.5	30.0	65	45	10	10	5	3.5

For areas printed with transparent colors, the coefficient of retroreflection shall not be less than 70% of the values for the corresponding color.

(1) Adhesive

Meet ASTM D4956.

(2) Field Performance

The fabricator shall date all signs (month, year) at the completion of fabrication. That date constitutes the start of the field performance obligation period.

The installer shall date all signs (month, year) at the completion of installation.

(B) Manufacturer's Warranty and Obligations

(1) Warranty

The sheeting manufacturer warrants to the Department that all materials furnished under this Specification will be new, of good components and workmanship and agrees to the following conditions.

Retroreflective sheeting processed and applied to sign blank materials in accordance with the manufacturer's manuals shall be warranted by the manufacturer to perform effectively as stated in this section. The manufacturer's manuals shall contain a complete descriptive explanation of all the requirements necessary of the sign fabricator.

(2) Obligation Grades A, B and C

(a) Years 1 through 7 (Years 1 Through 2 for Fluorescent Orange)

Cover the cost of restoring the sign face in its field location to its original effectiveness at no cost to the Department for materials, labor and equipment. In addition to the reflective requirements for Grade B fluorescent orange, the sheeting shall at least maintain a total Luminance Factor (Y) of 25 in accordance with ASTM D4956 and a Fluorescence Luminance Factor (YF) of 13% in accordance with ASTM E2301 for 3 years. Maintain at least 80% of fluorescent orange sheeting reflectivity for years 1 and 2.

(b) Years 8 through 10 (Year 3 for Fluorescent Orange)

Replace the sheeting required to restore the sign face to its original effectiveness. Maintain 50% of fluorescent orange sheeting reflectivity for year 3.

(c) Years 11 through 12

Replace 50% of the sheeting required to restore the sign face to its original effectiveness.

1092-3 CERTIFICATION

Provide a Type 6 material certification in accordance with Article 106-3 for all retroreflective sheeting used in the manufacture of signs certifying that the sheeting meets Section 1092.

SECTION 1094
GROUND MOUNTED SIGNS

1094-1 GROUND-MOUNTED SIGN SUPPORTS

(A) Breakaway or Simple Steel Beam Sign Supports

Fabricators of breakaway or simple steel beam sign supports shall be AISC Category I certified.

Steel supports for Type A and B ground mounted signs shall be galvanized rolled steel sections, either breakaway or simple design, as required by the contract. Fabricate supports from plates, W shapes, and S shapes, as required by the contract, and they shall conform to ASTM A36. Splices in the supports will not be permitted. Perform galvanizing before assembly that conforms to ASTM A123. Cutting steel supports to length after they have been galvanized will not be permitted in new construction. The support(s) shall be

uniformly straight to within 1/8 inch tolerance for pieces less than 20 feet in length, and 1/4 inch tolerance for pieces over 20 feet in length.

Fabricate high strength bolts, nuts and washers required for breakaway supports from steel in accordance with ASTM F3125 and galvanize in accordance with ASTM B695, Class 55.

(B) 3 lb Steel U-Channel Supports

Make 3 lb steel U-channel supports out of rerolled rail steel or new billet steel, conforming to the mechanical requirements of ASTM A499, Grade 60, and the chemical requirements of ASTM A1, for rails having nominal weights of 91 lbs. per yard or greater. Proportion the cross section so a moment of 1,450 ft-lb, applied to the cross section normal to the flanges, will produce an extreme fiber stress no greater than 39,500 psi. Use posts that weight 3 lbs/lf. Punch or drill all posts with 3/8 inch diameter holes on the centerline, spaced 1 inch on centers, starting 1 inch from the top and extending to the bottom of the supports. Galvanize these posts after fabrication for the full length and total area in accordance with ASTM A123. The zinc coating inside of the 3/8 inch diameter holes shall not exceed specification requirements enough to prevent a 5/16 inch diameter bolt from freely passing through.

Use U-channel support sections of the same general configuration as that shown in the contract, however minor variations may be considered acceptable by the Engineer provided all other requirements are met.

(C) 2 lb Steel U-Channel Supports

Use 2 lb steel U-channel supports that are variable length galvanized steel, U-shaped channel supports.

Fabricate the U-channel supports from steel meeting ASTM A1008 or ASTM A499, or alternate approved by the Engineer. The posts shall weigh 2 lbs/lf, and be of the length necessary to meet the erection requirements of the contract. Before galvanizing, punch or drill 3/8 inch diameter holes on 1 inch centers, beginning 1 inch from the top of the post, for a minimum distance equal to the vertical dimension of the respective sign or mile marker. Galvanize these posts after fabrication in accordance with ASTM A123. The zinc coating inside of the 3/8 inch diameter holes shall not exceed Specification requirements enough to prevent a 5/16 inch diameter bolt from freely passing through.

U-channel support sections shall be of the same general configuration as that shown in the contract, however, minor variations may be considered acceptable by the Engineer, provided all other requirements are met.

(D) Steel Square Tube Supports

Use steel square tube supports of variable length galvanized steel. The support shall be a minimum 14 gauge steel square tube. Before galvanizing perforated square tubes punch or drill all posts with 7/16 inch diameter holes on the centerline, spaced 1 inch on centers on all four sides, starting 1 inch from the top and extending to the bottom of the posts.

Galvanize perforated supports after fabrication for the full length and total area in accordance with ASTM A653, Grade 50, meeting G90 galvanizing requirements. The zinc coating inside of the 7/16 inch diameter holes shall not exceed specification requirements enough to prevent a 3/8 inch diameter bolt from freely passing through.

Steel square tube support sections shall be of the same general configuration as that shown in the contract, however, minor variations may be considered acceptable by the Engineer, provided all other requirements are met.

(E) Wood Supports

Wood supports shall conform to Section 1082.

1094-2 RIVETS FOR SIGN OVERLAYS

Rivets for sign overlays shall be 1/8 inch diameter aluminum rivets of the pull through type, and be approved by the Engineer. Submit for approval several samples of rivets, along with adequate descriptive catalog literature.

SECTION 1096
OVERHEAD SIGN STRUCTURES

1096-1 ALUMINUM OVERHEAD SIGN STRUCTURES

Materials for aluminum overhead sign structures shall conform to Article 1092-1 and *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, and the Interim Specifications as shown on the plans. Where the Contractor proposes to use materials that are not covered by these references, such use will be contingent on the Engineer's approval of these materials.

1096-2 STEEL OVERHEAD SIGN STRUCTURES

Use Category I certified by the American Institute of Steel Construction Fabricators for steel overhead sign structures as required by Subarticle 1072-1(A). Use either structural carbon steel or structural low-alloy steel for steel overhead sign structures meeting *AASHTO LRFD Bridge Design Specifications*. Other steel may be used, subject to the approval of the Engineer. Structural steel that has been cold-rolled to increase the yield strength will be permitted. Mechanically galvanize all fasteners. Hot-dip galvanize all other components of the structural assembly after fabrication has been completed. The galvanizing shall meet ASTM B695, Class 55, for fasteners and ASTM A123 for other structural steel.

1096-3 WELDING

Perform all welding in the fabrication of the supports by AWS certified welders. Furnish a copy of the AWS certification for each welder used for fabrication. All welds shall be free of cracks, blow holes, slag, and other irregularities, and be wire brushed, sandblasted or otherwise cleaned. Refer to Article 1076-3 for additional requirements for galvanizing.

Aluminum welding processes and procedures, shielding gases, preparation, weld quality, inspection and correction of welds, and the qualification of welding procedures, welders and welding operators will be governed by the AWS Structural Welding Code, D1.2.

The welding of steel components, including structural details, filler metal, workmanship and technique, qualification and inspection will be based on the applicable requirements of the AWS Structural Welding Code, D1.1.

SECTION 1098
SIGNALS AND INTELLIGENT TRANSPORTATION SYSTEM MATERIALS

1098-1 GENERAL REQUIREMENTS

(A) Qualified Products

Furnish new equipment, materials, and hardware unless otherwise required by the Engineer. Inscribe manufacturer's name, model number, serial number and any additional information needed for proper identification on each piece of equipment housed in a case or housing.

ITS and Signals Qualified Products List (QPL) is available on the Department's website.

Certain signal and communications equipment, material and hardware shall be pre-approved on the QPL by the date of installation. Equipment, material and hardware not pre-approved when required will not be allowed for use on the project. Consult the QPL website to obtain pre-approval procedures.

(B) Submittal Requirements

Furnish a Type 3 material certification in accordance with Article 106-3. When requested by the Department, provide additional certifications from independent testing laboratories and sufficient data to verify item meets applicable specifications. Ensure additional certification states the testing laboratory is independent of the material manufacturer and neither the laboratory nor the manufacturer has a vested interest in the other.

Identify all proprietary parts in Contractor-furnished material. The Department reserves the right to reject material that uses proprietary components not commercially available through electronic supply houses.

For Contractor-furnished material listed on the QPL, furnish submittals in the format defined by the QPL.

For Contractor-furnished material not on the QPL, furnish one electronic copy of the equipment list including three copies of catalog cuts. Identify proposed material on catalog cuts by a reproducible means (highlighter pen does not transfer to copies). Ensure material lists contain material description, brand name, manufacturer's address and telephone number, stock number, size, identifying trademark or symbol and other appropriate ratings.

Submit for approval catalog cuts and/or shop drawings for materials proposed for use on the project. Allow 30 days for review of each submittal. Do not fabricate or order material until receipt of Engineer's approval.

Submit one electronic copy of each catalog cut and/or drawing and show for each component the material description, brand name, stock-number, size, rating, manufacturing specification and the intended use (identified by labeling all components with the corresponding contract line item number). Present the submittals neatly arranged in the same order as the contract bid items.

An electronic (PDF) copy of reviewed submittals will be returned to the Engineer from the ITS and Signals Unit.

(C) Observation Period

Warrant workmanship and Contractor-furnished equipment for a 30 day observation period under the payment and performance bond from date of acceptance.

If workmanship or equipment fails during the 30 day observation period, repair or replace with new equipment and begin a new 30 day observation period.

The observation period for this work is not part of the work to be completed by the project completion date.

(D) Warranties

Unless otherwise required herein, provide manufacturer's warranties on Contractor-furnished equipment for material and workmanship that are customarily issued by the equipment manufacturer and that are at least 2 years in length from successful completion of the 30 day observation period. Include unconditional coverage for all parts and labor necessary or incidental to repair of defective equipment or workmanship and malfunctions that arise during warranty period.

Ensure all contractor-furnished equipment, including pieces and components of equipment, hardware, firmware, software, middleware, internal components and subroutines, which perform any date or time data recognition function, calculation or sequencing will support a four digit year format for at least 50 years.

Upon successful completion of the 30 day observation period, transfer manufacturer's warranties with proper validation by the manufacturer to the Department or its designated maintaining agency.

(E) Firmware Licensing and Upgrades

Provide the Department with a license to duplicate all programmable devices in equipment for maintenance and software upgrades. Provide binary or hexadecimal format files for each device that may be programmed by the Department. Ensure files are provided on PC compatible approved media.

Ensure firmware performance upgrades that occur during the contract period are available to the Department at no additional cost.

Make firmware upgrades that are developed to correct operating characteristics available to the Department at no additional cost until the warranty period expires.

(F) Plan of Record Documentation

Before final acceptance, furnish plan of record documentation of all fieldwork. Plan of record documentation will be subject to approval before final acceptance. Store documentation in a manila envelope placed in a weatherproof holder mounted within each cabinet or housing for easy access.

Except for standard bound manuals, bind all 8 1/2 inches x 11 inches documentation, including 11 inches x 17 inches plans folded to 8 1/2 inches x 11 inches, in logical groupings in either 3-ring or plastic slide-ring loose-leaf binders. Permanently label each grouping of documentation.

Provide manual, electrical schematic diagram, and cabinet wiring diagram for each control equipment cabinet and piece of equipment in cabinet. Place manuals and prints in weatherproof holder. For wiring diagrams and electrical schematic diagrams not bound into printed manuals, provide copies at least 22 inches x 34 inches.

Provide Operator's Manuals containing detailed operating instructions for each different type or model of equipment. Ensure manuals contain instructions for possible modification to equipment.

Provide maintenance procedures manuals containing detailed preventive and corrective maintenance procedures for each different type or model of equipment.

Provide detailed wiring diagrams that include interconnection of equipment with pin-out configurations, pin functions, and cable part numbers. For communications systems, camera systems, video imaging loop emulator detection systems, intelligent transportation systems, closed loop signal systems and other computerized systems, provide one electronic copy of system connection diagrams showing system interconnection cables and associated terminations and place a hard copy in the cabinet.

(G) Wire and Cable

Furnish wire and cable on reels. When requested by the Department, furnish samples of wire and cable to the Department at no additional cost.

(H) Electrical Service for Traffic Signals

Furnish external electrical service disconnects with a single pole 50 A inverse time circuit breaker with at least 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure. For electrical service to an Advanced Transportation Controller (ATC) cabinet, provide a single pole 30 A inverse time circuit breaker with at least 10,000 RMS symmetrical amperes short circuit current rating. Ensure service disconnects are listed as meeting UL Standard UL-489 and marked as being suitable for use as service equipment. Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint finish, light gray in color, to yield a minimum thickness of 2.4 mils. Provide ground bus and neutral bus with at least 5 terminals with minimum wire capacity range of number 14 through number 4. Ensure each service has only one disconnecting

means in the enclosure. Place barriers in service equipment such that no uninsulated, ungrounded service busbar or service terminal is exposed.

Furnish NEMA 3R meter base rated 100 A minimum that meets the requirements of the local utility. Provide meter base with ampere rating of meter sockets based on sockets being wired with insulated wire rated at least 167°F.

Furnish four terminal, 600 volt, single phase, 3 wire meter base with the following:

(1) Line, Load and Neutral Terminals accept #8 to 2/0 AWG Copper/Aluminum wire,

(2) Ringed or Ringless Type, with or without bypass,

(3) Made of galvanized steel,

(4) Listed as meeting UL Standard UL-414, and

(5) Overhead or underground service entrance as specified.

Ensure meter bases have electrostatically applied dry powder paint finish, light gray in color, with minimum thickness of 2.4 mils.

Furnish 1 inch watertight hub for threaded rigid conduit with meter base.

If meter base and electrical service disconnect are supplied in the same enclosure, ensure assembly is marked as being suitable for use as service equipment. Ensure combination meter and disconnect mounted in a pedestal for underground service is listed as meeting UL Standard UL-231. Otherwise, ensure combination meter and disconnect is listed as meeting UL Standard UL-67.

(I) Painting

Where painting of signal equipment cabinets, signal heads, signal poles, and pedestals is required, apply paint at the factory. No field painting will be allowed except when paint has been scratched or marred. In such cases, apply two field coats of the same color and grade enamel as the original paint to the scratched or marred portions.

(J) Performance of Warranty Repair and Maintenance

Provide authorization to the Traffic Electronics Center of the NCDOT to perform all warranty repairs after project acceptance. The decision to perform warranty work at the Traffic Electronics Center by NCDOT electronics technicians or to have warranty work performed by the vendor shall be at the discretion of the State. Provide any training required by the manufacturer to authorize the Traffic Electronics Center to perform warranty work and ensure manufacturer will furnish parts to the Traffic Electronics Center for all warranty repairs at no cost to the State. In addition, ensure the manufacturer agrees to provide prompt technical support to the NCDOT electronics technicians for a period of one year after the end of the warranty period at no cost to the State. Defective parts replaced under warranty by the Traffic Electronics Center will be returned to the vendor at the vendor's request. Provide schematics, part lists, and other documentation to perform bench repair to the Traffic Electronics Center within 2 weeks upon request. The Department agrees not to divulge any proprietary information in the schematics, part lists and other documentation upon request from the vendor. After project acceptance and at the request of the State, manufacturer shall perform warranty repairs to equipment which fails during the warranty period at no cost to the State including freight costs to ship repaired equipment back to the Traffic Electronics Center. Ensure all equipment is repaired and returned to the Traffic Electronics Center within 21 calendar days of receipt by the manufacturer.

1098-2 SIGNAL CABLE

Furnish 16-4 and 16-7 signal cable that complies with IMSA specification 20-1 except provide the following conductor insulation colors:

(A) For 16-4 cable: white, yellow, red and green.

(B) For 16-7 cable: white, yellow, red, green, yellow with black stripe tracer, red with black stripe tracer, and green with black stripe tracer. Apply continuous stripe tracer on conductor insulation with a longitudinal or spiral pattern.

Provide a ripcord to allow the cable jacket to be opened without using a cutter. IMSA specification 19-1 will not be acceptable. Provide a cable jacket labeled with the IMSA specification number and provide conductors constructed of stranded copper.

1098-3 BACKPLATES

Comply with ITE standard *Vehicle Traffic Control Signal Heads*. Provide backplates specific to the manufacturer of the vehicle signal heads. Provide stainless steel fasteners and hardware for attachment to signal head. Provide backplates that extend at least 5 inches from the vehicle signal head outline. Ensure the backplate fills in the gaps between cluster-mounted vehicle signal sections (5-section vehicle signal heads). A 1/4 inch maximum gap between vehicle signal head and backplate, as viewed from the front, will be allowed.

Fabricate metallic backplates for vehicle signal heads from sheet aluminum at least 0.05 inch thick. Provide backplates painted an alkyd urea black synthetic baking enamel with minimum gloss reflectance that meets Federal Specification MIL-E-10169, Instrument Black.

Provide polycarbonate or vacuum formed ABS plastic or composite material backplates that are black on both the front and back sides with a consistent color throughout the entire piece for each backplate. Provide backplates that contain UV inhibitors and stabilizers for protection against UV degradation. Provide backplates that have a minimum tensile stress at yield of 5,300 psi at 73°F and meet UL Standard 94. Ensure polycarbonate backplates have a minimum thickness of 0.100 inch with one side dull black and the other side semi-gloss black. Ensure vacuum formed ABS plastic backplates have a minimum thickness of 0.125 inch with a hair cell finish on the front side and a smooth finish on the back side. Ensure composite material backplates have a polyethylene core with a minimum thickness of 0.074 inch surrounded by 2 aluminum sheets with each aluminum sheet at a minimum of 0.010 inch. Ensure the 2 aluminum sheets and the polyethylene core are bonded together with fluoropolymer or polyester coating on both outer sides for the composite material backplates.

Provide backplates with a florescent yellow retroreflective sheeting strip 2 inches wide, placed along the perimeter of the face of the signal backplate to reflect the profile of the signal head in low-light and darkness. Ensure connecting corner sections of the retroreflective sheeting strips are butt spliced with a minimum gap of 30 mil to a maximum gap of 45 mil. The sheeting strip shall meet the performance requirements of AASHTO M 268 Type D and ASTM D4956 Type X1 sheeting material. Ensure the retroreflective sheeting strip is applied in accordance with manufacturer's guidelines.

1098-4 MESSENGER CABLE

Comply with ASTM A475 for extra high strength grade wire strand, Class A zinc coating. Fabricate messenger cable from seven steel wires twisted into a single concentric strand.

1098-5 RISER SEALING DEVICES

Furnish appropriately sized clamp-on aluminum weatherheads for electrical control and power cables.

Furnish heat shrink tubing for the installation of fiber-optic or coaxial cable in a new riser. Ensure the heat shrink tubing is made of modified polyolefin and includes a hot-melt adhesive. Provide tubing that has a length of at least 5 inches before heating. Ensure the heat shrink tubing will provide a watertight fit around individual cables and outer wall of the riser after heat is applied in accordance with the manufacturer's instructions.

Furnish heat shrink tubing retrofit kits for the installation of fiber-optic cable or coaxial cables to an existing riser with existing cables. Ensure the heat shrink material is made of modified polyolefin and is supplied in a flat sheet design. Ensure the kit contains an apparatus to secure

both ends of the flat sheet together to form a tube shaped cylinder. Ensure the securing apparatus is flexible to the point that it will allow the heat shrink material to conform to the shape and dimensions of the riser and cables once heat is applied and will not separate during the heating process. Provide heat shrink tubing retrofit kits with a hot-melt adhesive. Provide the flat sheet heat shrink material that has a minimum length of 5 inches prior to heating. Ensure the heat shrink tubing retrofit kit provides a watertight fit around individual cables and outer wall of the riser after heat is applied in accordance with the manufacturer's instructions.

1098-6 JUNCTION BOXES

(A) General

Comply with Article 1091-5.

(B) Standard Size Junction Boxes

Provide standard size junction boxes and covers with minimum inside dimensions of 16" (l) x 10" (w) x 10" (d).

(C) Oversized Junction Boxes

Provide oversized junction boxes and covers with minimum inside dimensions of 28" (l) x 15" (w) x 22" (d).

1098-7 POLE LINE HARDWARE

Provide universal grade strandvises used for extra high strength steel messenger cable.

Provide other pole line hardware constructed of hot-dipped galvanized steel conforming to ASTM A153.

Provide machine bolts, eyebolts and thimble eye bolts with minimum tensile strength of 12,400 lb. Provide hot-dipped galvanized nuts, 3 inches x 3 inches curved square washers and thimble eyelets.

Provide suspension clamp fabricated from hot-dipped galvanized steel with minimum length of 5 3/4 inches. Ensure clamp has a groove rated for the messenger cable size it is intended to secure. Provide J-hook fabricated from 3/8 inch thick hot-dipped galvanized steel flat or oval stock with sufficient hook radius to cradle 11/16 inch diameter cable. Provide two 1/2 inch diameter hot-dipped galvanized bolts and nuts to tighten the clamp around the messenger cable. Provide one 5/8 inch diameter hot-dipped galvanized bolt of sufficient length to attach J-hook and clamp to the wood pole with a 3 inch x 3 inch curved square washer and double nuts.

Provide 3-bolt clamp fabricated from hot-dipped galvanized steel with minimum length of 5 3/4 inches. Ensure clamp has two parallel grooves rated for the messenger cable size it is intended to secure. Provide three 5/8 inch diameter hot-dipped galvanized bolts and nuts to tighten the clamp around the messenger cable.

Provide parallel groove clamp consisting of high strength, high conductivity non-copper bearing aluminum alloy clamp halves with interlocking fingers to prevent mismatch. Ensure clamp halves have molded grooves to secure #8-1/0 AWG stranded copper wires. Provide clamps with grooves prefilled with antioxidant joint compound. Provide 3/8 inch hex head, square shank, galvanized steel bolt with galvanized steel lock washer and nut.

Provide 1/2 inch and 3/4 inch wide, .030 inch thick Type 316 stainless steel straps with Type 316 stainless steel buckles.

Provide either 0.05 inch x 0.30 inch aluminum wrapping tape or 0.06 inch diameter Type 316 stainless steel lashing wire for lashing cables to messenger cable. Ensure aluminum wrapping tape is 1350 alloy, O-temper, with 12,800 psi tensile strength. Use 0.045 inch diameter Type 316 stainless steel lashing wire to lash fiber-optic communications cable to messenger cable.

Provide hot-dipped galvanized steel clamp with groove sized for 1/4 inch to 3/8 inch messenger cable for securing lashing wire(s) to messenger cables at ends of each spiraled run. Ensure clamp hardware is hot-dipped galvanized steel.

1098-8 GUY ASSEMBLIES

Furnish guy assemblies with anchor assemblies, guy cable and guy cable guard.

Provide anchor assemblies with all miscellaneous hardware consisting of either expanding anchor with rod and triple-eye attachment, screw anchor with extension rod and triple-eye attachment, or expanding rock anchor with triple-eye attachment. Ensure anchor assembly size is adequate for site conditions. Provide rods constructed of hot-dipped galvanized steel sized according to the soil bearing conditions in the area. Provide triple-eye guy attachments constructed of hot-dipped galvanized steel. Anchor assemblies with double-strand eyes may be used instead of those with the triple-eye feature when only one guy cable is to be attached. Ensure anchor assemblies are 7 feet minimum in length.

For type of anchor assembly furnished, ensure the following:

(A) Expanding Anchor

Provide steel construction with protective paint or heat shrink of 6 mil plastic to protect metal during shipping and storage.

(B) Screw Anchor

Provide hot-dipped galvanized steel construction.

(C) Expanding Rock Anchors

Provide malleable iron and rust-resisting paint construction.

Provide 3-bolt clamp to match messenger cable size.

Provide full round guy cable guards that are 8 feet in length and constructed of UV stabilized, high impact, bright yellow HDPE.

Provide guy cables consisting of messenger cable of the same size as the largest sized messenger cable to be guyed. Comply with Article 1098-4.

1098-9 INDUCTIVE DETECTION LOOPS

(A) Loop Sealant

Provide loop slot sealant that completely encapsulates loop wire when installed according to manufacturer's instructions. Provide loop sealant that does not generate temperatures greater than 220°F. Ensure sealant bonds with asphalt and concrete pavement saw slots so sealant and encapsulated loop wire do not come out of slot. Ensure sealant is self-leveling, but with sufficient viscosity to prevent exit from saw slot when installed along a 10% grade.

Provide sealant that protects loop wire by preventing the entrance of dirt, water, rocks, sticks, and other debris into saw slot, and is resistant to traffic, water, gasoline, chemical and chemical fumes, mild alkalis, oils and mild acids. Ensure sealant will not be affected by water and sealant does not chemically interact with pavement and loop wire insulation.

Ensure loop sealant has sufficient flexibility to permit expected pavement expansion and contraction due to weather and to permit pavement movement due to traffic without cracking for a temperature range of -40 to 160°F.

Provide sealant with a usable life of at least ten minutes once mixed, when the ambient temperature is 75°F. Ensure sealant dries to tack free state in less than 2 hours, and does not flow within or out of saw slot after exposed surface has become tack free. Tack free

time will be determined by testing with a cotton ball until no sealant adheres to cotton ball and no cotton adheres to sealant.

Ensure 2 part sealant cures within 48 hours to attain 95% of published properties for the cured material.

Ensure one part sealant cures within 30 days to attain 95% of published properties for the cured material.

(B) Loop Wire

Provide loop wire composed of 19-strand conductor insulated by a cross-linked polyethylene compound. Ensure insulated conductors are completely encased in tubes of low density polyethylene compound. Print manufacturer's name, manufacture year and any applicable part number on encasing tube at intervals of 2 feet or less.

Provide number 14 AWG copper conductors fabricated from 19 strands that comply with ASTM B3 before insulating. Ensure stranded conductors use either concentric or bunch stranding and comply with circular mil area and physical requirements of ASTM B8 or ASTM B174 for bunch stranding.

Provide insulating compound that is cross-linked thermosetting black polyethylene in accordance with ASTM D2655. Ensure insulation is applied concentrically about conductor. Provide insulation thickness not less than 0.026 inch at any point and minimum average thickness of 0.030 inch as measured by UL Standard 62.

Ensure insulation of finished conductor will withstand application of a 60 Hertz or 3,000 Hertz, 7,500 volt (RMS) essentially sinusoidal spark test potential as specified in UL Standard 83.

Provide insulated conductors that are factory-installed in a protective encasing tube that complies with the following:

Encasing tube fabricated of polyethylene compound conforming to ASTM D1248 for Type I, Class C, Grade E5. Provide a minimum inside diameter of 0.150 inch. Provide a wall thickness of 0.040 inch ± 0.010 inch. Provide an outside diameter of 0.240 inch ± 0.010 inch.

(C) Conduit

Comply with Subarticle 1091-3(C) for PVC conduit.

1098-10 LEAD-IN CABLE

Furnish lead-in cable with two conductors of number 14 AWG fabricated from stranded tinned copper that complies with IMSA Specification 50-2 except as follows:

(A) Ensure conductor is twisted with a maximum lay of 2.0 inches resulting in at least six turns per foot.

(B) Provide a ripcord to allow cable jacket to be opened without using a cutter.

Provide length markings in a contrasting color showing sequential feet and within 1% of actual cable length. Ensure character height of the markings is approximately 0.10 inch.

1098-11 FIBER-OPTIC CABLE

(A) SMFO Communications Cable

Furnish single mode fiber-optic cable manufactured into a loose buffer tube design, installed around a central strength member where the cable complies with RUS CFR 1755.900 and ICEA 640 requirements. Ensure the Manufacture is ISO 9001 and TL9000 registered and that the manufacturer's cable is RUS listed. The operating temperature range of the cable shall be -40°F to +158°F.

Furnish individual fibers manufactured from silica and dopant materials with each fiber having a color coated finish that is compatible with local injection detection (LID) devices. Distinguish each fiber from others by color coding that meets EIA/TIA-598. Furnish single mode fiber that does not exceed attenuation ratings of 0.25 dB/km at 1550 nm and 0.35 dB/km at 1310 nm and complies with ITU G.652D and IEC 60793-2-50 Type B.1.3 industry standards for low water peak, single mode fiber. Provide fibers that are useable and with a surface, sufficiently free of imperfections and inclusions to meet optical, mechanical and environmental requirements.

Ensure the core central strength member is a dielectric glass reinforced rod and that the completed cable assembly has a maximum pulling rating of 600 lbf during installation (short term) and 180 lbf long term installed.

Construct buffer tubes (nominal size of 2.5 mm) manufactured from a polypropylene copolymer material to provide good kink resistance and allows the buffer tube to maintain flexibility in cold temperature over the expected lifetime of the cable. Ensure that buffers tubes contain no more than 12 fibers per buffer tube unless specified otherwise, and that all buffer tubes are filled with a water blocking gel or water swellable material. Construct the cable such that the buffer tubes are stranded around the central strength member in a reverse oscillating arrangement to allow for mid-span entry. Distinguish each buffer tube from others by color coding that meets EIA/TIA-598. Use filler tubes to maintain a circular cross-section of the cable. Ensure the filler tubes are the same nominal size as the buffer tubes of 2.5 mm. Apply binders (water swellable yarn, kevlar, etc.) with sufficient tension to secure buffer tubes and filler tubes to the central member without crushing the buffer tubes. Ensure that binding material is non-hygroscopic, non-wicking and dielectric with low shrinkage. Ensure the binders are of a high tensile strength that is helically stranded evenly around cable core.

Ensure the cable core is protected from the ingress of moisture by a water swellable material or that is filled with a water blocking compound that is non-conductive. Ensure the water swellable material (when activated) or the water blocking compound is free from dirt and foreign matter and is removable with conventional nontoxic solvents. Furnish at least one ripcord to aid in the process of removing the outer jacket. Furnish the outer jacket constructed of a medium-density polyethylene material to provide reduced friction and enhanced durability. Ensure the polyethylene material contains carbon black to provide UV protection and does not promote the growth of fungus. Ensure the cable jacket is free of slits, holes or blisters and the nominal outer jacket thickness is $\geq 0.050''$.

Ensure the completed cable assembly contains identification markings printed along the outside cover of the jacket every 2 feet. Ensure the character height of the markings is approximately 0.10 inch. Provide length markings in sequential feet and within 1% of actual cable length.

Mark each cable with the following:

(1) Sequential length marks in feet as specified
(2) The name of the manufacturer
(3) “OPTICAL CABLE”
(4) Month/year of manufacture
(5) Number(s) of and type(s) of fibers
(6) Cable ID Number for product traceability

(B) Drop Cable

Furnish drop cable meeting the material requirements listed in Subarticle 1098-11(A) with the exceptions herein to provide communications links between splice enclosures and through interconnect centers. Furnish drop cable containing at least 6 individual fibers.

Furnish drop cable that complies with RUS-CFR 1755.900 and is RUS listed. Ensure each drop cables has the same operating characteristics as the SMFO cable it is to be coupled with.

On one end of cable furnish six approved connectors for termination on connector panel in equipment cabinet. Provide either factory assembled drop cables with the approved connectors or field installed connectors. No connectors are required for drop cables running from one splice enclosure directly to another splice enclosure.

Ensure attenuation of drop cable at 1310 nm does not exceed 0.4 dB/km and the attenuation at 1550 nm does not exceed 0.3 dB/km. Ensure attenuation loss for complete drop cable assembly does not exceed a mean value of 1.5 dB.

(C) Communications Cable Identification Markers

Furnish yellow communications cable identification markers that are resistant to fading when exposed to UV sources and changes in weather. Use markers designed to coil around fiber-optic cable that do not slide or move along the surface of the cable once installed. Ensure exposure to UV light and weather does not affect the markers natural coiling effect or deteriorate performance. Provide communications cable wraps that permit writing with an indelible marking pen and contain the following text in black:

WARNING

NCDOT FIBER-OPTIC CABLE

CONTACT TELEPHONE NUMBER:

_____

WARNING

NCDOT FIBER-OPTIC CABLE

Figure 1098-1. Communication Cable Identification Marker.

Overall Marker Dimensions: 7 inches (l) x 4 inches (w)

Lettering Height: 3/8 inch for WARNING, 1/4 inch for all other lettering

Submit a sample of proposed communications cable identification markers to the Engineer for approval before installation.

(D) Fiber-Optic Cable Storage Racks

Furnish fiber-optic storage racks (snowshoes) that are non-conductive and resistant to fading when exposed to UV sources and changes in weather. Ensure snowshoes have a captive design such that fiber-optic cable will be supported when installed in the rack and the minimum bending radius will not be violated. Provide stainless steel attachment hardware for securing snowshoes to messenger cable and black UV resistant tie-wraps for securing fiber-optic cable to snowshoe. Ensure snowshoes are stackable so multiple cable configurations are possible.

1098-12 FIBER-OPTIC SPLICE CENTERS

(A) Interconnect Center

Furnish compact, modular interconnect centers designed to mount inside equipment cabinets. Design and size interconnect centers to accommodate all fibers entering cabinets.

Provide splice trays that hold, protect, and organize optical fibers, and secure fibers inside splice tray. Design and size splice trays to be dielectric, to accommodate all fibers entering splice tray, and to provide sufficient space to prevent microbending of optical fibers. Provide connector panels with approved connectors.

Furnish SMFO pigtails with each interconnect center. Provide pigtails containing connector panels that are no more than 6 feet in length with approved factory assembled connector on one end. Ensure SMFO pigtails meet the operating characteristics of the SMFO cable with which it is to be coupled.

Furnish SMFO jumpers that are at least 3 feet in length with approved factory assembled connectors on each end. Ensure SMFO jumpers meet the operating characteristics of the SMFO cable with which it is to be coupled.

(B) Splice Enclosure

Furnish splice enclosures that are re-enterable using a mechanical dome-to-base seal with a flash test valve, and are impervious to the entry of foreign material (water, dust, etc.). Ensure enclosures are manufactured so as to be suitable for aerial, pedestal, buried, junction box and manhole installation.

Provide enclosures with at least one over-sized oval port that will accept two cables and with at least four round ports (for single cables) that will accommodate all cables entering enclosure. Provide heat shrink cable shields with enclosure to ensure weather tight seal where each cable enters enclosure.

Within enclosures, provide enough hinged mountable splice trays to store the number of splices required, plus the capacity to house six additional splices. Provide a fiber containment basket for storage of loose buffer tubes expressed through the enclosure. Ensure enclosures allow sufficient space to prevent microbending of buffer tubes when coiled.

Provide splice trays that hold, protect, and organize optical fibers, and secure fibers inside splice tray. Provide splice trays that are dielectric.

1098-13 FIBER-OPTIC TRANSCEIVERS

Furnish shelf-mounted, modular, single mode fiber-optic transceivers that transmit and receive optical signals over a fiber-optic communications medium of two fibers and interface with equipment cabinets (signal controller, dynamic message signs, etc.). Ensure transceivers are asynchronous in operation. Ensure transceivers are capable of operating up to 5 miles without boosting signal and without distortion. Ensure transceivers are switch selectable for either local or master operation.

Do not provide transceivers internal to system equipment. Provide identical transceivers at all locations capable of being interchanged throughout system.

Provide LEDs on the front panel of transceivers for power, and transmitting and receiving indications. Comply with the following:

TABLE 1098-1
PROPERTIES OF FIBER-OPTIC TRANSCEIVER

Property	Requirement
Input Power	115 VAC
Minimum Loss Budget	12 dB with corresponding receiver
Operating Wavelength	1310 or 1550 nm
Optical Connector	ST
Signal Connector	Female Plug Type DB9 or DB25
Temperature Range	0 to 150°F

Ensure modems operate in one of the following topologies:

Drop and Repeat Transceivers: Furnish transceivers that transmit and receive data in drop-and-repeat poll-response data network mode with EIA/TIA-232, EIA/TIA-422 and EIA/TIA-485 protocols.

Self-Healing Ring Transceivers: Furnish transceivers that transmit and receive data in a drop-and-insert poll-response data network mode with EIA/TIA-232, EIA/TIA-422 and EIA/TIA-485 protocols. Ensure transceiver operates in a Self-Healing Ring Network Architecture.

1098-14 DELINEATOR MARKERS

Furnish tubular delineator markers, approximately 6 feet long, and constructed of Type III HDPE material. Provide delineator assemblies that are ultraviolet stabilized to help prevent components from color fading, warping, absorbing water, and deterioration with prolonged exposure to the elements. Provide delineators designed to self-erect after being knocked down or pushed over. Provide orange delineator posts.

Provide text, including division contact number, hot stamped in black on a yellow reflective background material that will not fade or deteriorate over time. Provide delineator markers with nominal message height of 15 inches that contain the text in Figure 1098-2 visible from all directions approaching the assembly.

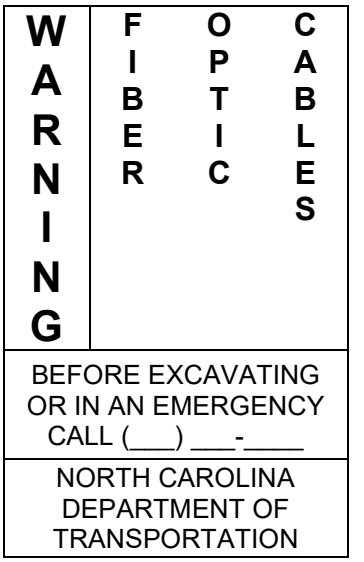


Figure 1098-2. Delineator Marker.

1098-15 PEDESTALS

Furnish pedestal assemblies with foundations that conform to the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, and the Interim Specifications as shown on the plans. Refer to *Roadway Standard Drawings* No. 1743 for structural design specifications for each type of pedestal.

(A) Pedestal Shaft

Furnish one piece pedestal shafts fabricated from either aluminum or galvanized steel pipe with a uniform pipe outer diameter of 4.5 inches and of the lengths specified for the type of pedestal shown on *Roadway Standard Drawing No.* 1743. Refer to Article 1743-2 for pedestal type descriptions.

For Type I (pedestrian pushbutton pedestals) and Type II (normal-duty pedestals), furnish shafts constructed from schedule 40 extruded aluminum pipe that conforms to Aluminum Association Alloy 6061-T6 with a tensile strength of 30 KSI and a minimum wall thickness of 0.237 inch. Aluminum conduit will not develop the necessary strength required and is not allowed. Thread and deburr in accordance with American National Standard Pipe Threads, NPT (ANSI B2.1). Finish the exterior with a rough surface texture consisting of a uniform grain pattern that is perpendicular to the axis of the pipe along the full pipe

length. Unless otherwise specified, do not use galvanized steel pipe for Type I and Type II pedestal shafts.

For Type III (heavy-duty pedestals), furnish schedule 120 galvanized steel pipe that conforms to ASTM A53. Provide an 11 inches square by 1 inch thick steel base plate with minimum yield strength of 36 ksi that conforms to ASTM A36. Fabricate the base plate with four equally spaced bolt holes on an 11 inches bolt circle. Orient the bolt holes in the corners of the plate. Size the holes to accommodate 1 inch diameter machine bolts. Weld the pedestal shaft to the center of the base plate using a socket connection. Provide circumferential fillet welds at the top and bottom of the base plate. Perform all welding in accordance with AWS Code on the plans. Hot-dip galvanize the pedestal shaft and base plate assembly after fabrication in accordance with ASTM A123. Unless otherwise specified, do not use aluminum pipe for Type III pedestal shafts.

(B) Transformer Bases

Furnish transformer bases for each type of pedestal shown on *Roadway Standard Drawings* No. 1743 fabricated from aluminum that meets Aluminum Association Alloy 356 or equivalent, and that are designed to break upon impact in accordance with AASHTO requirements. For each type of transformer base use products as found on the ITS and Signals QPL. For use in grounding and bonding, provide a 0.5 inch minimum diameter, coarse thread hole cast into transformer base located inside base and oriented for easy access.

Provide a minimum access opening for all transformer bases of 8 inches x 8 inches with an access door that is attached with a 1/4 inch x 3/4 inch long stainless steel vandal proof screw to secure access door.

For Type I (pedestrian pushbutton pedestals) and Type II (normal-duty pedestals), provide overall base dimensions of 15" (l) x 13 3/4" (w) x 13 3/4" (d) for square bases and 14" (l) x 16 1/2" (w) x 16 1/2" (d) for octagonal bases. Provide a threaded opening at the top of the base to receive a 4 inch NPT pipe shaft. Include a set screw prep and 3/8 inch-16 x 1 inch stainless steel set screw to secure the pedestal post to the pedestal base. Fabricate the bottom of the transformer base with four equally spaced holes or slots for a 12 inches bolt circle to secure the entire assembly to the concrete foundation.

For Type III (heavy-duty pedestals), provide square bases with overall dimensions of 17" (l) x 13" (w) x 13" (d). Fabricate the top of the transformer base with four equally spaced holes or slots for an 11 inches bolt circle to attach the pedestal shaft. Size the holes or slots to accommodate 1 inch diameter machine bolts. Fabricate the bottom of the transformer base with four equally spaced holes or slots for a 12 inch bolt circle to secure the entire assembly to the concrete foundation. Size the holes or slots to accommodate 1 inch diameter anchor bolts. Provide the following mounting hardware for heavy-duty pedestals:

(1) Four 1 inch diameter by 3 1/2 inches long machine bolts (ASTM F593), with heavy hex nuts (ASTM A563 Grade DH, or A 194 Grade 2H), and thick flat washers, and lock washers (ASTM F436) per pedestal assembly. Galvanize in accordance with ASTM A153.

(2) Three heavy hex nuts (ASTM A563 Grade DH, or A194 Grade 2H), 2 thick flat washers, and one lock washer (ASTM F436) for each anchor bolt. Galvanize in accordance with ASTM A153.

(3) Six minimum slotted stainless steel shims of necessary thickness for leveling per pedestal assembly.

(C) Anchor Bolts

For each pedestal, provide four anchor bolts in accordance with ASTM F1554, Grade 55, of the size and length specified in *Roadway Standard Drawings* No. 1743. Provide anchor

bolts with coarse threads meeting the bolt/thread criteria specified by AISC. Provide threads for a minimum length of 4 inches on each end of the bolt. All thread anchor rods may be used. Ensure anchor bolts are hot-dipped galvanized in accordance with ASTM A153.

For each anchor bolt:

(1) Provide three heavy hex nuts; one at the top, and two at the bottom (embedded end) of the anchor bolt. Provide hex nuts with coarse threads that match the anchor bolt thread requirements above. Provide hex nuts that meet the requirements of ASTM A563 Grade DH, ASTM A194, Grade 2H or equivalent. Galvanize all heavy hex nuts in accordance with ASTM A153.

(2) Provide one standard size washer that meets the requirements of ASTM F436 for use between the two heavy hex nuts on the embedded end of the anchor bolt. Galvanize in accordance with ASTM A153.

(3) Provide one extra thick, oversized washer for use over the slotted opening of the pedestal base. Fabricate washer to meet the chemical, physical, and heat treating requirements of ASTM F436. Fabricate the washer to the diameter and thickness needed. Galvanize fabricated washer in accordance with ASTM A153. Heat treat to the same requirements as F436 (i.e. 26 to 45 HRC).

For a 3/4 inch diameter anchor bolt mounted in a 1 1/2 inch slotted opening, the dimensional requirements for an extra thick, oversized washer are as follows:

(a) The minimum Outside Diameter (OD) required is 2 3/4 inch.
(b) The hole Inside Diameter (ID) = Nominal Bolt Diameter + 1/16 inch = 0.812 inch.
(c) The minimum washer thickness required is 3/8 inch.

If anchor bolts less than 3/4 inch in diameter are proposed for use to anchor pedestal bases, provide a washer calculation to ensure the washer thickness is adequate. To account for any pedestal manufacturing differences, verify the actual slotted opening width of the pedestal base anchoring points, and include it in the calculation. Anchor bolts that are less than 1/2 inch in diameter may not be used as they are not structurally adequate to support the pedestal and may inhibit the performance of the breakaway base.

The fabrication process for thick washers makes the washer slightly tapered (i.e. the top OD and the bottom OD are not the same). Install thick washers with the larger diameter face down against the pedestal base casting.

Do not use standard washers over the slotted opening of the pedestal base. Do not substitute or stack thin washers to achieve the required thickness specified or required.

In addition to the submittal requirements of Section 1098-1(B), provide Mill Certifications, Galvanization Certifications, and Heat Treating Certifications for all anchor bolts, fabricated washers, and structural hardware

(D) Pedestal Cap

Furnish a 4 1/2 inch outside diameter slip fit domed pedestal top cap for each pedestal assembly designed to fit over the outside of the pedestal shaft. Fabricate the cap from aluminum that meets Aluminum Association Alloy 356. Ensure the cap provides 3 equally spaced stainless steel set screw fasteners to secure the cap to the pedestal shaft.

(E) Pole Flange Base for 4 1/2 Inches Pipe

Furnish a flange base with cover for use with Type I (pedestrian pushbutton pedestals) and Type II (normal-duty pedestals) only. Flange bases are non-breakaway supports that are to be used with a breakaway bolt system for AASHTO compliance for breakaway

structures. Provide aluminum or steel flange bases with a minimum 7.5 inches diameter bolt circle. Ensure bases are either continuously welded to shafts or threaded to receive shafts. Each base should be designed to accommodate either three or four 1/2 inch bolts equally spaced on the bolt circle to receive breakaway anchors. Provide NPT threads on the internal opening of the flange base through the full length of the flange base with locking set screws at the top of the base to receive a 4 inch NPT pipe shaft.

Fabricate aluminum flange bases that meet Aluminum Association Alloy 356 requirements for architectural bases. Fabricate steel flange bases that meet ASTM A36.

Do not use flange bases for Type III pedestals.

(F) Breakaway Anchors

Furnish single or double neck omni-directional breakaway anchor bolt coupling systems for use with Type I (pedestrian pushbutton pedestals) and Type II (normal-duty pedestals) only. Use breakaway anchors as an alternative to transformer bases as approved by the Engineer. Use with non-breakaway pole flange bases. Use 1/2 inch diameter bolts for pushbutton posts and 3/4 inch bolts for normal-duty pedestals. Fabricate from steel with a minimum yield strength of 55 KSI. Galvanize in accordance with ASTM A153. Do not use breakaway anchors with Type III pedestals, or in conjunction with breakaway transformer bases.

(G) Foundation

Install pedestal foundations of the type and size shown on *Roadway Standard Drawings* No. 1743.04 Furnish Class A minimum concrete that conforms to Article 1000-4.

Provide reinforcing steel that conforms to the applicable parts of Section 1070.

(H) Screw-In Helical Foundation Anchor Assembly

Furnish and install screw-in helical foundation as an alternative to the standard reinforced concrete foundation specified in Section 1743, for supporting Type I and Type II Pedestals. Do not use for Type III Pedestals.

(1) Type I – Pedestrian Pushbutton Post:

Fabricate pipe assembly consisting of a 4 inch diameter x 56 inch long pipe, single helical blade and square fixed attachment plate. Furnish pipe in accordance with ASTM A53 ERW Grade B and include a 2 inch x 3 inch cable opening in the pipe at 18 inches below the attachment plate. Furnish steel attachment plate and helical blade in accordance with ASTM A36. Include four slotted mounting holes in the attachment plate to fit bolt circles ranging from 7 3/4 inches to 14 3/4 inches diameter. Furnish additional 3/4 inch keyholes at slotted holes to permit anchor bolt installation and replacement from top surface. Include combination bolt-head retainer and dirt scrapers at the attachment plate underside to allow for a level or flush-mount plate installation with respect to the finished grade. Galvanize pipe assembly components in accordance with AASHTO M 111 or an approved equivalent.

Furnish four 3/4 inch 10NC x 3 inch square head anchor bolts to meet the requirements of ASTM F3125. Provide four 3/4 inch plain flat galvanized washers, four 3/16 inch thick galvanized plate washers and four 3/4 inch galvanized hex nuts. Galvanize in accordance with AASHTO M 111 or an approved equivalent.

(2) Type II – Normal-Duty Pedestal:

Fabricate pipe assembly consisting of a 6 inch diameter x 60 inch long, single helical blade, 1 1/4 inch diameter stinger rod and square fixed attachment plate. Furnish pipe in accordance with ASTM A53 ERW Grade B using schedule 40 wall thickness and include a 2 inch x 3 inch cable opening in the pipe at 18 inches below the attachment plate. Furnish steel attachment plate, helical blade and stinger rod in accordance with

ASTM A36. Include four slotted mounting holes in the attachment plate to fit bolt circles ranging from 10 inches to 15 inches in diameter. Furnish additional 1 1/4 inch keyholes at slotted holes to permit anchor bolt installation and replacement from top surface. Include combination bolt-head retainer and dirt scrapers at the attachment plate underside to allow for a level or flush-mount plate installation with respect to the finished grade. Galvanize pipe assembly components in accordance with AASHTO M 111 or an approved equivalent.

Furnish four 1 inch 8NC x 4 inch galvanized Grade 5 square head anchor bolts. Provide four 1 inch plain flat galvanized washers and four 1 inch galvanized hex nuts. Galvanize in accordance with AASHTO M 111 or an approved equivalent.

1098-16 SIGNAL CABINET FOUNDATIONS

Provide foundations with a minimum pad area that extends 24 inches from front and back of cabinet and 3 inches from sides of cabinet.

Furnish cabinet foundations with chamfered top edges. Provide minimum Class B concrete.

Provide preformed cabinet pad foundations with 7" (l) x 18" (w) minimum opening for the entrance of conduits. For precast signal cabinet foundations, include steel reinforcement to ensure structural integrity during shipment and placing of item. Include four 3/4 inch coil thread inserts for lifting. Comply with Article 1077-16.

1098-17 CABINET BASE ADAPTER/EXTENDER

Fabricate base adapters and extenders from the same materials and with the same finish as cabinet housing. Fabricate base adapter and extender in the same manner as controller cabinets, meeting all applicable specifications called for in Section 6.8 of CALTRANS TEES. Provide base adapters and extenders a height of at least 12 inches.

1098-18 BEACON CONTROLLER ASSEMBLIES

(A) General

Furnish all cabinets with a solid state flasher that meets NEMA TS-2-2003. Encapsulate flasher components as necessary. Connect flasher to provide beacon operation as specified.

Submit drawings showing dimensions, location of required equipment and mechanisms, cabinet electrical diagrams, part numbers and descriptions of required equipment and accessories to the Engineer. Provide certification to the Engineer that materials used in cabinet construction meet these specifications.

Furnish unpainted, natural, aluminum cabinet shells that comply with Section 7 of NEMA TS-2-2003. Ensure all non-aluminum hardware on cabinet is stainless steel or Department approved non-corrosive alternate. Provide roof with slope from front to back at a minimum ratio of 1 inch drop per 2 feet. Ensure each exterior cabinet plane surface is constructed of a single sheet of seamless aluminum. Ensure all components are arranged for easy access during servicing. When modular in construction, provide guides and positive connection devices to ensure proper pin alignment and connection.

Provide 20 mm diameter radial lead UL-recognized metal oxide varisters (MOV) between each field terminal and ground bus. Electrical performance is outlined in Table 1098-2.

TABLE 1098-2 PROPERTIES OF SURGE PROTECTOR	
Property	**Requirement**
Maximum Continuous Applied Voltage at 85°C	150 VAC (RMS) 200 VDC
Maximum Peak 8x20µs Current at 85°C	6500 A
Maximum Energy Rating at 85°C	80 J
Voltage Range 1 mA DC Test at 25°C	212 - 268 V
Max. Clamping Voltage 8x20µs, 100A at 25°C	395 V
Typical Capacitance (1 MHz) at 25°C	1,600 pF

Provide beacon controller assemblies equipped with terminal blocks (strips) for termination of all field conductors and all internal wires and harness conductors. Terminate all wires at terminals. Ensure all field terminals are readily accessible without removing equipment and located conveniently to wires, cables, and harnesses to be connected. Ensure terminals are not located on underside of shelves or at other places where they are not readily visible or where they may present a hazard to personnel who might inadvertently touch them. Provide terminal blocks made of electrical grade thermoplastic or thermosetting plastic. Ensure each terminal block is of closed back design and has recessed-screw terminals with molded barriers between terminals. Ensure each terminal consists of two terminal screws with removable shorting bar between them. Ensure each terminal block is labeled with a block designation and each terminal is labeled with a number. Ensure all terminal functions are labeled on terminal blocks. Provide labels that are visible when terminal block is fully wired. Show labels on cabinet wiring diagrams. Ensure terminals serving similar functions are grouped together.

Connect each conductor, including unused conductors, within or entering cabinet to a terminal using crimped spade lugs. Place no more than two conductors on any single terminal screw. Terminations to back panel may be soldered. Do not use quick connectors or barrel connectors. Make all connections at terminals. Do not make in-line splices.

Ensure outgoing circuits have same polarity as line side of power supply. Ensure common return has same polarity as grounded conductor (neutral) of power supply.

Neatly package all wiring. Dress harnesses by lacing, braiding, or tying with nylon tie wraps at closely spaced intervals. Attach wires, cables, or harnesses to cabinet walls for support or to prevent undue wear or flexing. Use nylon tie straps or metal clamps with rubber or neoprene insulators. Screw these attachment devices to cabinet. Do not use stick-on clamps or straps.

Tag AC+, AC-, chassis ground, and flasher circuit conductors with non-fading, permanent sleeve labels at conductor ends at terminals or use color-coded wire. Ensure sleeve labels tightly grip conductors. Alternatively, use hot stamped labels on internal conductor insulation at intervals of no greater than 4 inches. Ensure label legends are permanent.

Ensure all jumpers are wire conductors or metal plates. Do not use printed circuit back panels or back panels using wire tracks as jumpers.

Lay out all equipment and components for ease of use and servicing. Ensure equipment controls can be viewed and operated without moving or removing any equipment. Ensure there is access to equipment or components for servicing without removing any other equipment or components. Removal of equipment is acceptable to access fan or thermostat. Ensure equipment can be removed using only simple hand tools. Ensure layout of equipment and terminals within the various cabinets furnished is identical from cabinet to cabinet, unless otherwise approved by the Engineer.

Mount equipment using harnesses with suitable multipin (or similar) connectors. Design or key all equipment to make it physically impossible to connect unit to wrong connector.

Ensure that functionally equivalent equipment is electrically and mechanically interchangeable.

Equip vents with standard-size, replaceable filters or, if located where they can easily be cleaned, permanent filters.

(B) Type F1 Cabinet

Provide dual-circuit flasher and 20-amp inverse time circuit breaker with at least 10,000 RMS symmetrical amperes short circuit current rating. Install one insect-resistant vent on bottom and one on top on opposite wall to facilitate airflow.

(C) Type F2 Cabinet

Provide 20 inches high x 16 inches wide x 12 inches deep cabinet, dual-circuit flasher, 20-amp inverse time circuit breaker with at least 10,000 RMS symmetrical amperes short circuit current rating, and solid state time switch. Provide filtered power to time switch. Install one insect-resistant vent on each side of cabinet at the bottom to facilitate airflow.

(D) Type F2 and F3 Cabinet – Surge Protection and Documentation

Furnish and install a power line surge protector in the service power. Provide a 2-stage power line surge protector that allows connection of the radio frequency interference filter between stages of the device. Ensure device has a maximum continuous current rating of at least 10 A at 120 V. Ensure device can withstand at least 20 peak surge current occurrences at 20,000 A for an 8x20 microsecond waveform. Provide maximum clamp voltage of 395 V at 20,000 A with a nominal series inductance of 200 µh. Ensure voltage does not exceed 395 V. Provide devices that comply with Table 1098-3.

TABLE 1098-3
INSERTION LOSS OF SURGE PROTECTOR

Frequency (Hz)	Minimum Insertion Loss (dB)
60	0
10,000	30
50,000	55
100,000	50
500,000	50
2,000,000	60
5,000,000	40
10,000,000	20
20,000,000	25

Install surge protector in circuit breaker enclosure in a manner that will permit easy servicing. Ground and electrically bond surge protector to cabinet within 2 inches of surge protector.

Furnish and install a suitably sized plastic envelope or container in cabinet for holding cabinet wiring diagrams and equipment manuals. Locate envelope or container so it is convenient for service personnel. Furnish two sets of non-fading cabinet wiring diagrams in a paper envelope or container and place them in the plastic envelope or container.

(E) Type F3 Cabinet

Provide 25 inches high x 22 inches wide x 15 inches deep cabinet, dual-circuit flasher, fan, thermostat and switch-controlled cabinet light (15 watt minimum, incandescent).

Install a vent or vents at or near the cabinet bottom to permit the intake of air sized for the rated flow of air from the fan, but no smaller than 20 square inches. Install fan with a minimum 100 CFM rating.

Equip cabinet with two inverse time circuit breakers (20A & 15A) with at least 10,000 RMS symmetrical amperes short circuit current rating installed to ensure personnel

servicing the cabinet, including rear of back panel, cannot inadvertently be exposed to a hazard. Install a terminal block that will accommodate service wire as large as number 4 AWG, and connect it to the circuit breaker. Install circuit breakers in addition to any fuses that are a part of the individual control equipment components. Wire switch-controlled cabinet light and thermostatically-controlled fan to the 15A circuit breaker. Provide thermostat with a minimum range of 90° F to 130° F and with a rating sufficient for fan load.

Equip cabinet with a duplex receptacle that is connected to the AC out and neutral out terminals of the surge protector.

1098-19 SPREAD SPECTRUM RADIO

(A) General

Furnish 900 MHz Serial and 900 MHz Serial/Ethernet spread spectrum radio systems with field set-up software and all necessary hardware and signage in accordance with the plans and specifications to provide a data link between field devices (i.e. Traffic Signal Controllers, Dynamic Message Signs, etc.).

Provide a radio system with license free 902 – 928 MHz Serial Spread Spectrum transceivers that are capable of Bi-Directional, Full Duplex communications. Furnish material conforming to the National Electrical Code (NEC), the National Electrical Safety Code (NESC), Underwriter's Laboratories (UL) or a third-party listing agency accredited by the North Carolina Department of Insurance, and all local safety codes in effect on the date of advertisement. Comply with all regulations and codes imposed by the owner of affected utility poles.

(B) 900 MHz Radio

Furnish license free 902 - 928 MHz Serial Spread Spectrum Radios that comply with Table 1098-4.

TABLE 1098-4 SERIAL SPREAD SPECTRUM RADIO REQUIREMENTS	
Frequency Range	902 – 928 MHz
Technology	Frequency Hopping Spread Spectrum
Operational Modes	master; repeater; repeater/slave; slave; point-to-point; point-to-multipoint; peer-to-peer
Operating Voltage	Power Cube: 6 – 30 VDC
Operating Temperature/Humidity	-40°C to +75°C; 0 to 95% non-condensing
Transmitter	
Output Power	1 Watt (Max)
Modulation	Frequency Shift Keying
Hopping Patterns/Channels	Minimum of 50/minimum of 110
Data Rate(over the air)	1,200 to 115,200 bps
Receiver	
Sensitivity	-108 dBm @ 10^-6 BER
Data Transmission	
Error Detection	32 Bit CRC, Automatic Repeat Request (ARQ)
Data Encryption	128 bit
System Gain	140 dB
LED's	
Signal Strength Indicators	Data Port Indicators consisting of a minimum of 3 LED's grouped together representing a Low, Medium or High Signal Strength with regards to the communications link with another targeted radio. Units must be supplied with external labels to identify how to interpret the Signal Strength. OR Combinations of the Front Panel LED indications with flashing rates and LED Colors can be used to identify the signal strength. Units must be supplied with external labels to identify how to interpret the Signal Strength.
Front Panel Indicators	Power (Optional) Transmit Data Receive Data OR Carrier Detect Transmit Clear to Send
Data Interface	
Interface Cable	Type 1 or Type 2 or Type 3 (If not specified in the Plans, furnish a Type 1 Data Interface Cable)
Antenna Connectors	Threaded Connector (Nickel and/or Silver Plated Brass)
Port to connected device	Serial - DB 9 Female Port; RS232 Asynchronous
Programming Port	DB9 Female or USB/Mini B
Radio Frequency Signal Jumper	RG-58 coaxial cable (6' long) with one end supplied with RF Threaded Connector that is compatible with the supplied radio. The other end furnished with a Standard N-Type Male Connector to mate with the lightning arrestor.
Mounting Style	Shelf
Certification	FCC

(C) 900 MHz Serial/Ethernet Spread Spectrum Radio

Furnish 902 – 928 MHz Serial/Ethernet Spread Spectrum Radios with built-in web-based setup and that comply with Table 1098-5.

TABLE 1098-5 SERIAL/ETHERNET SPREAD SPECTRUM RADIO REQUIREMENTS	
Frequency Range	902 – 928 MHz
Technology	Frequency Hopping Spread Spectrum
Operational Modes	base; remote; repeater; remote/repeater; point-to-point; point-to-multipoint; peer-to-peer
Operating Voltage	Power Cube: 6 – 30 VDC
Operating Temperature/Humidity	-40°C to +75°C; 0 to 95% non-condensing
Transmitter	
Output Power	1Watt (Max)
Modulation	2 level GFSK, 4 and 8-ary Frequency Shift Keying
Hopping Patterns /Channels	Minimum of 15
Occupied Bandwidth	402.8 kHz
Data Rate(over the air)	Up to 4 Mbps
Receiver	
Sensitivity	-105 dBm @ 115Kbps OR -83 dBm Mbps
Data Transmission	
Error Detection	CRC & ARQ, retransmit on error, FEC
Data Encryption	128-bit and 256-bit AES CCM
Authentication	Radius Compliant
System Gain	135 dB
LED's	
Signal Strength Indicators	Data Port Indicators consisting of a minimum of 3 LED's grouped together representing a Low, Medium or High Signal Strength with regards to the communications link with another targeted radio. Units must be supplied with external labels to identify how to interpret the Signal Strength. OR Combinations of the Front Panel LED indications with flashing rates and LED Colors can be used to identify the signal strength. Units must be supplied with external labels to identify how to interpret the Signal Strength.
Front Panel Indicators	Power COM 1 COM 2 OR Carrier Detect Transmit Clear to Send
Management & Network Protocols	HTTP, SNMP, Local Console, IP Auto Discover

	Data Interface
Antenna	Threaded Connector (Nickel and/or Silver Plated Brass)
Port to Connected Devices	Serial - Dual - DB 9 Female Ports: RS232/422/485 Ethernet: RJ-45 (10/100 BaseT, auto crossover)
Network Protocols	IEEE 802.3; HTTP, TCP, UDP, ARP, IMCP, FTP
Radio Frequency Signal Jumper	RG-58 coaxial cable (6' long) with one end supplied with RF Threaded Connector that is compatible with the supplied radio. The other end furnished with a Standard N-Type Male Connector to mate with the lightning arrestor.
Certification	FCC

(D) Software for 900Mhz Serial Spread Spectrum Radios

Furnish units with a Field Set-up Software. The Field Set-up Software shall be a Window Based™ software program that uses a GUI (Graphical User Interface) to provide the following features at a minimum: remote programming, remote radio configuration, remote maintenance, remote diagnostics and a spectrum analyzer.

Furnish software supplied with drivers to allow easy set-up with all industry standard traffic signal controllers, including approved controllers containing custom software written specifically for the North Carolina Department of Transportation. Manufacturer is required to develop additional drivers (at no charge) for other equipment not supported by their existing pre-written Driver Package when needed. Drivers may be needed for other equipment such as industry standard radar and video detection packages, and Dynamic Message Sign controllers.

(E) 900 MHz Serial Data Interface Cables

Furnish "Data Interface Cables" for installation with approved controllers for the following applications:

900 MHz Data Interface Cable (Type 1)
Application: Standard RS-232 data interface cable to be installed between the Controller's RS-232 interface and the radio modem. Radio Modem can be programmed as either a Master of Local Radio.

900 MHz Data Interface Cable (Type 2)
Application: Master Controller's RS-232 data interface connected to a fiber system modem and Radio Modem with master programing

900 MHz Data Interface Cable (Type 3)
Application: Local Controller's RS-232 data interface connected to a fiber system modem and Radio Modem with master programming.

Ensure that each Data Interface Cable is a minimum of 6 feet long and compatible with approved controllers.

(F) Directional Antenna (Yagi)

Furnish a directional antenna of welded construction that allows for vertical and horizontal polarization.

Furnish mounting hardware with the antenna that will secure the antenna to a mounting pipe that has a 1 1/2 inch Nominal Pipe Size (approximately 2 inches OD pipe diameter), as recommended by the manufacturer of the antenna and as approved by the Engineer.

Furnish an 8.5 dBd. (11 dBi) Gain or 13 dBd (15.1 dBi) Gain antenna that complies with Table 1098-6 and Table 1098-7:

TABLE 1098-6 900 MHz - YAGI ANTENNA - (8.5 dBd / 11 dBi Gain)	
Property	**Requirement**
Frequency Range	896 - 940 MHz
Nominal Gain	8.5 dBd / 11 dBi
Front to Back Ratio	18 dB
Horizontal Beamwidth (at half power points)	65 degree
Vertical Beamwidth (at half power points)	55 degree
Power Rating, UHF Frequency	200 Watts
Lightning Protection	DC Ground
Termination	Coaxial pigtail with a Standard N-Type Female Connector
Impedance	50 Ω
Rated Wind Velocity	125 mph
Rated Wind Velocity (with 0.5" radial ice)	100 mph
Projected Wind Surface Area (flat plane equivalent)	0.26 ft/sq
Number of Elements	6
Allows for vertical or Horizontal polarization	Yes
Welded construction	Yes

TABLE 1098-7 900 MHz - YAGI ANTENNA – (13 dBd / 15.1 dBi Gain)	
Property	**Requirement**
Frequency Range	902 - 928 MHz
Nominal Gain	13 dBd / 15.1dBi
Front to Back Ratio	20 dB
Horizontal Beam width (at half power points)	40 degree
Vertical Beam width (at half power points)	35 degree
Power Rating, UHF Frequency	200 Watts
Lightning Protection	DC Ground
Termination	Coaxial pigtail with a Standard N-Type Female Connector
Impedance	50 Ω
Length (approx..)	53"
Rated Wind Velocity	125 mph
Rated Wind Velocity (with 0.5" radial ice)	100 mph
Projected Wind Surface Area (flat plane equivalent)	0.46 ft/sq
Number Elements	13
Allows for Vertical or Horizontal polarization	Yes
Welded construction	Yes

(G) Omnidirectional Antenna

Furnish an omnidirectional antenna of a solid, single piece construction.

Furnish mounting hardware with the antenna that will secure the antenna to a mounting pipe that has a 1 1/2 inch Nominal Pipe Size (approximately 2 inches OD pipe diameter), as recommended by the manufacturer of the antenna and as approved by the Engineer.

Furnish a 3 dBd (5 dBi) Gain or 6 dBd (8.1 dBi) Gain antenna that complies with Table 1098-8 and Table 1098-9:

TABLE 1098-8 900 MHz – OMNI ANTENNA - (3 dBd / 5 dBi Gain)	
Property	**Requirement**
Frequency Range	902 - 928 MHz
Nominal Gain	Typical gains of 3 or 6 dBd (dependent upon gain needed for application)
Termination	Standard N-Type Female Connector
Impedance	50 ohms
VSWR	1.5:1
Vertical Beam Width	33 degrees (3dBd Gain), 17 degrees (6dBd Gain)
Lightning Protection	DC Ground
Power Rating, UHF Frequency	100 Watts
Length	25" (3dBd Gain), 65" (6dBd Gain)
Rated Wind Velocity	125 mph

TABLE 1098-9 900 MHz – OMNI ANTENNA - (6 dBd / 8.1 dBi Gain)	
Property	**Requirement**
Frequency Range	902 - 928 MHz
Nominal Gain	6 dBd / 8.1dBi
Termination	Standard N-Type Female Connector
Impedance	50 Ω
VSWR	1.5:1
Vertical Beam Width	17 degrees
Lightning Protection	DC Ground
Power Rating, UHF Frequency	100 Watts
Rated Wind Velocity	125 mph
Solid, single piece construction	Yes
Mount in a vertical direction and limit to vertically polarized RF systems	Yes

(H) Antenna Mounting Hardware Kit

Furnish an antenna mounting kit to support the antenna when attached to a metal pole, mast arm or wood pole.

Ensure the Antenna Mounting Hardware Kit includes at least one 96 inch galvanized steel cable with a stainless steel bolt, nut and lock washer assembly on each end. Ensure the pole base plate accepts a 1 1/2 inch NPT aluminum pipe, and provides a surface that is at least 6 3/4 inches long x 4 1/4 inches to provide contact with the pole. Ensure the pole base plate is designed to allow both ends of the 96 inch galvanized cables to be secured and tightened to the base plate. Provide a 90 degree elbow with internal threads on both ends to accommodate 1 1/2 inch NPT aluminum pipes. Provide a 1 1/2 inch x 18 inch long aluminum pipe threaded on both ends and a 1 1/2 inch x 24 inch aluminum pipe threaded on one end with an end cap.

(I) Coaxial Cable

Furnish 400 Series coaxial cable to provide a link between the antenna and the lightning arrestor that comply with Table 1098-10.

TABLE 1098-10 PROPERTIES AND REQUIREMENTS OF COAXIAL CABLE	
Property	**Requirement**
Attenuation (dB per 100 ft) @ 900 MHz	3.9 dB
Power Rating @ 900 Mhz	0.58 kW
Center Conductor	0.108" Copper Clad Aluminum
Dielectric: Cellular PE	0.285"
Shield (approx.)	Aluminum Tape - 0.291" Tinned Copper Braid - 0.320"
Jacket	Black UV protected polyethylene
Bend Radius	1"
Impedance	50 Ω
Capacitance	23.9 pf/ft
Water Blocking	Yes
Supply Coaxial Cable on 500 ft Reel	Yes

(J) Standard N-Type Male Connector

Furnish Standard N-Type Male Connector(s) of proper sizing to mate with the 400 series coaxial cable and use a crimping method to secure the connector to the coaxial cable. Furnish a connector that complies with Table 1098-11.

TABLE 1098-11 REQUIREMENTS OF STANDARD N-TYPE MALE CONNECTOR	
Description	**Requirement**
Center Contact	Gold Plated Beryllium Copper (spring loaded – Non-solder)
Outer Contact	Silver Plated Brass
Body	Silver Plated Brass
Crimp Sleeve	Silver Plated Copper
Dielectric	Teflon PTFE
Water Proofing Sleeve	Adhesive Lined Polyolefin – Heat Shrink
Attachment Size	Crimp Size 0.429” (minimum) hex
Electrical Property	**Requirement**
Impedance	50 Ω
Working Voltage	1000 vrms (max)
Insertion loss	0.1 x √ FGHz
VSWR	1.25:1 (max) up to 2.5GHz

(K) Coaxial Cable Shield Grounding and Weatherproofing Kits

(1) Furnish a Coaxial Cable Shield Grounding Kit containing components that will adequately bond and ground the cable shield to the pole ground. Ensure the grounding kit complies with MIL-STD-188-124A for coaxial cable and protects the cable from lightning currents of at least 200kA. Ensure each kit is supplied, as a minimum, with the following:

(a) Preformed Strap: 24 Gauge copper strap that is at least 1 5/8 inch long and is sized to mate with the 400 series coaxial cable

(b) Tensioning Hardware: Copper nuts and lock washers

(c) Grounding Lead Cable: #6 AWG, stranded, insulated copper wire

(2) Furnish a Weatherproofing Kit containing components that will protect the coaxial cable shield grounding system against the ingress of moisture and prevent vibrations from loosening the connections. Ensure the weatherproofing kit is supplied, as a minimum, with the following:

(a) Butyl Mastic Tape: 3 3/4 inches wide by 24 inches long (approximately)

(b) Electrical Tape: 2 inches wide by 20 inches long (approximately)

(c) Instructions on properly installing the weatherproofing system.

(L) Lightning Arrestor

Furnish a lightning arrestor installed in line between each antenna and its designated radio modem inside the equipment cabinet in accordance with Table 1098-12. Furnish lightning arrestor with multistrike capability, low strike throughput energy, flange mount and bulkhead mount options and a standard N-Type female connector on both the surge-side and protected-side connectors.

TABLE 1098-12
PROPERTIES OF LIGHTNING ARRESTOR

Property	Requirement
Surge (8/20µs Waveform) Maximum Strike Multiple Strike	 40kA Max 20kA Multiple
Frequency Range	698MHz to 2.7GHz
Return Loss/VSWR	≤-26dB (VSWR≤ 1.11:1)
Insertion Loss	≤0.1 dB over frequency range
Continuous Power	500 w @ 920MHz (750 W at 122° F)
Let Through Voltage	≤± 200m Volts for 3kA @ 8/20 µs Waveform
Throughput Energy	≤0.5 nJ for 3kA @ 8/20 µs Waveform
Temperature	-40 to 185° F Storage/Operating 122° F
Vibration	1G at 5 Hz up to 100Hz
Unit Impedance	50 Ω
Standard N-Type Female Connector	On both the surge side and protected side connectors
Installation	Bi-Directional
Mounting	Bulkhead bracket with O-Ring, Lock Washer and Nut

(M) Coaxial cable – Power Divider (Splitter)

Furnish a coaxial cable power divider for repeater radio sites in accordance with Table 1098-13. Ensure the power divider accommodates a single primary input RF source and divides/splits the signal (power) equally between two output ports.

TABLE 1098-13
PROPERTIES OF COAXIAL CABLE - POWER DIVIDER

Property	Requirement
Power Division	2 - Way
Frequency	900 - 1100 MHz
Insertion Loss	0.22 dB
Impedance	50 Ω
VSWR ref. to 50 Ohm (max)	1.3:1
Max. Input Power	500 Watts
Connectors	Standard N-Type Female

(N) Disconnect Switch

Furnish a double pole, single throw snap switch in a weatherproof outlet box with cover, suitable for use in wet locations. Ensure outlet box and cover supports a lockout tag device. Ensure outlet box includes one 1/2 inch diameter hole in back of box. Furnish mounting hardware, sealing gaskets and lockout tag.

(O) Warning Signs and Decal

Furnish “RF Warning Sign” and “Decal” at locations called for in the plans. Furnish mounting hardware to secure the sign to either metal or wood poles."

DIVISION 11
WORK ZONE TRAFFIC CONTROL

SECTION 1101
WORK ZONE TRAFFIC CONTROL GENERAL REQUIREMENTS

1101-1 TRANSPORTATION MANAGEMENT PLAN (TMP)

Maintain traffic through work zones in accordance with these Specifications, the MUTCD, *Roadway Standard Drawings,* 23 CFR 630 Subparts J and K and the Transportation Management Plan (TMP).

Below is a list of the possible TMP components:

(A) Temporary Traffic Control Plan (TTC),

(B) Transportation Operations Plan (TO), and

(C) Public Information Plan (PI).

A TMP will always have a TTC component. The TTC will contain the project notes, phasing, detail sheets and other supporting information.

1101-2 TEMPORARY TRAFFIC CONTROL PLAN (TTC)

(A) General

Typically, phasing and drawings govern over project notes, and local notes govern over general notes. If a conflict arises in the TTC, refer to Article 105-4.

(B) Phasing

Complete the requirements of each phase before proceeding to the next phase and the requirements of each step before proceeding to the next step unless the plans permit work to be performed concurrently.

If a TTC phasing is broken into areas, work may be performed in more than one area simultaneously as described in the plan.

(C) Project Notes

Two types of project notes may be included in the TTC:

(1) General Notes apply at all times during the project, and

(2) Local Notes apply only for the specific times and locations that they are referred to in the phasing and detail sheets.

(D) Alternate to Transportation Management Plan

If desired, submit an alternate TMP a minimum of 30 calendar days in advance of the anticipated implementation to allow for adequate review time. Do not implement alternate plans for traffic control until approved in writing and properly sealed. No adjustment in compensation or extension of the completion date(s) will be allowed due to the review time of the alternate. If an alternate TMP is implemented, the Contractor shall be responsible for any unanticipated changes to subsequent phases and steps.

(E) Temporary Traffic Control Plan Not Fully Covered in the Contract

When the TTC does not cover a particular work function, notify the Engineer to allow for the development or modification of a sealed set of the Temporary Traffic Control Plans.

1101-3 BLASTING ZONE

When blasting operations are within 1,000 feet of a travelway, provide the appropriate traffic control as shown in the plans and/or the *Roadway Standard Drawings*.

1101-4 CONSTRUCTION VEHICLE CROSSINGS

Do not cross the median, ramps or loops with vehicles or equipment unless a specific location for crossing is approved and required traffic control devices are used as shown in the *Roadway Standard Drawings*.

1101-5 ON-ROAD CONSTRUCTION VEHICLES

When operating outside of a closed lane or haul road crossing in a work zone, on-road construction vehicles are subject to the Department's Division of Motor Vehicle weight and safety regulations as commercial vehicles. Work vehicles must always use warning lights with at least 50% being amber in color attached to the vehicle as high as possible and in a manner such that they are not obscured by equipment or supplies. Vehicle hazard signals or lights may be used to supplement this requirement. This requirement applies to all work vehicles and equipment not inside lane closures or behind barriers. This requirement does not apply to dump trucks but it is encouraged.

1101-6 EXCAVATIONS WITHIN TRAVELWAY

During the process of excavating in a travelway where traffic is to be later maintained, make provisions to backfill and repair any excavated or damaged pavement before allowing traffic to proceed over the affected lanes. In low speed areas (35 mph or less), metal plates may be used to cover excavated areas.

1101-7 HAULING OPERATIONS

Comply with the multiple and single vehicle hauling restrictions as shown in the TMP when performing hauling of equipment or materials to or from the project.

Define "Multiple Vehicle Hauling" as the hauling of equipment or materials to or from the project with delivery at intervals of less than 5 minutes or results in more than one vehicle at a particular work site at a time.

Define "Single Vehicle Hauling" as the hauling of equipment or materials to or from the project with delivery at intervals of more than 5 minutes and results in no more than one vehicle at a particular work site at a time.

Do not conduct any hauling operations against the flow of traffic of an open travelway unless an approved temporary barrier or guardrail separates the traffic from the hauling operation.

On multi-lane, controlled access roadways, haul vehicles shall not enter/exit an open travel lane at speeds more than 10 mph below the posted speed limit. Haul vehicle acceleration to within 10 mph of the posted speed limit shall only occur on paved surfaces.

1101-8 MATERIAL AND EQUIPMENT STORAGE

When work is not in progress, keep all personnel, equipment, machinery, tools, construction debris, materials and supplies away from active travel lanes that meets Table 1101-1.

TABLE 1101-1 MATERIAL AND EQUIPMENT STORAGE FROM ACTIVE TRAVEL LANES	
Posted Speed Limit (mph)	**Distance (ft)**
40 or less	≥ 18
45-50	≥ 28
55	≥ 32
60 or higher	≥ 40

When vehicles, equipment and materials are protected by concrete barrier or guardrail, they shall be offset at least 5 feet from the barrier or guardrail.

1101-9 PARKING OF PERSONAL VEHICLES

Provide staging areas for personal vehicle parking in accordance with Article 1101-8 or as directed by the Engineer before use.

1101-10 PROTECTION OF HAZARDS

Mark all hazards with signs, barricades, drums or other warning devices.

At each location where work is started which creates a safety hazard, continue the work until completed to the extent that the safety hazard is eliminated. If the work is not pursued in a continuous manner the Engineer will not allow any other work on the project to be performed until the existing safety hazard is eliminated.

1101-11 TEMPORARY LANE CLOSURES

(A) General

Operate all equipment and personnel within the designated work area during lane closures. Do not impede or stop traffic for the purpose of performing construction related work on the traffic side of the lane closure, except when called for in the TMP.

Install lane closures with the traffic flow, beginning with devices on the upstream side of traffic. Remove lane closures against the traffic flow, beginning with devices on the downstream side of traffic.

Vehicles used to install or remove lane closures shall have vehicle warning lights as described in Article 1101-5.

(B) Intersections

When construction proceeds through an intersection, provide flaggers and all other necessary traffic control as required by the TMP to direct the traffic through the intersection. When an intersection is signalized, place the signal in flash mode and provide law enforcement or other adequate traffic control measure to direct traffic through the intersection before beginning work in the intersection.

1101-12 TEMPORARY ROAD CLOSURES

(A) Traffic Pattern Alterations

Notify the Engineer 30 calendar days before altering the existing traffic pattern, unless otherwise stated in the TMP.

Plan all traffic pattern alterations and meet with the Engineer to discuss the implementation strategy before altering traffic. The Engineer will notify the proper authorities and other affected parties as necessary.

(B) Detour

Ensure that all required detour signing and delineation, including work done by others, are in place before placing traffic onto a detour.

(C) Traffic Stoppage

Limit the stoppage of traffic to times specified in the TMP. Provide time between consecutive stoppages to allow the traffic queue to deplete.

1101-13 TRAFFIC CONTROL SUPERVISION

Provide the service of at least one qualified work zone supervisor. The work zone supervisor shall have the overall responsibility for the proper implementation of the TMP and ensure all employees working inside the NCDOT right of way have received the proper training appropriate to the job decisions each individual is required to make.

The work zone supervisor is not required to be on site at all times but shall be available to address concerns of the Engineer. The name and contact information of the work zone supervisor shall be provided to the Engineer prior to or at the preconstruction conference.

Qualification of work zone supervisors shall be done by an NCDOT approved training agency or other approved training provider. For a complete listing of approved training agencies, see the Work Zone Safety Training webpage.

Coordinate with and cooperate with work zone supervisors of adjacent or overlapping construction projects to ensure safe and adequate traffic control is maintained throughout the projects at all times including periods of construction inactivity in accordance with Article 105-7.

All certification records for qualified work zone supervisors shall be uploaded by the approved training agency or other approved training provider to the Department's Work Zone Education Verification App (WZ-EVA) prior to the qualified work zone supervisor performing any work zone supervisor duties on the project. For more information about WZ-EVA, see the Work Zone Safety Training webpage.

1101-14 WORK ZONE INSTALLER

Provide the service of at least one qualified work zone installer during the setup, installation, and removal of temporary traffic control within the highway right of way. The qualified work zone installer shall serve as crew leader and shall be on site and directing the installation and removal of temporary traffic control. If multiple temporary traffic control installations or removals are occurring simultaneously, then each shall have a qualified work zone installer.

The work zone installer shall be qualified by an NCDOT approved training agency or other NCDOT approved training provider in the safe and competent set up of temporary traffic control. For a complete listing of approved training agencies, see the Work Zone Safety Training webpage.

A work zone supervisor, in accordance with Article 1101-13 of the Standard Specifications, may fulfill the role of the work zone installer during the setup, installation, and removal of temporary traffic control within the highway right of way provided they are on site and directing the installation and removal of temporary traffic control.

All other individuals participating in the setup, installation, and removal of temporary traffic control within the highway right of way shall be certified as a qualified flagger in accordance with Article 1150-3 of the Standard Specifications, even if flagging is not being performed as part of the traffic control.

Provide the name and contact information of all qualified work zone installers to the Engineer prior to or at the preconstruction conference. Additionally, provide a qualification statement that all other individuals participating in the setup, installation, and removal of temporary traffic control are qualified flaggers that have been properly trained through an NCDOT approved training agency or other NCDOT approved training provider.

All certification records for qualified work zone installers and flaggers shall be uploaded by the approved training agency or other NCDOT approved training provider to the

Department's Work Zone Education Verification App (WZ-EVA) prior to the qualified work zone installer or flagger performing any traffic control duties on the project. For more information about WZ-EVA, see the Work Zone Safety Training webpage.

1101-15 VEHICULAR ACCESS

Maintain continuous and safe vehicular access, including but not limited to, all residences, businesses, schools, police and fire stations, hydrants, other emergency services, hospitals and mailboxes. Conduct operations so as to limit the inconvenience to property owners.

1101-16 PEDESTRIAN ACCESS

Maintain pedestrian access at all times as shown in the TMP. When existing continuous pedestrian facilities are disrupted, closed or relocated, provide temporary facilities that are detectable and include accessibility features consistent with the features present in the existing pedestrian facility. Temporary pedestrian facilities constructed for maintaining pedestrian access during construction shall be made of concrete, asphalt or other suitable material as approved by the Engineer. If establishing or maintaining a temporary pedestrian facility is not feasible, alternate methods for providing pedestrian accommodations may be used, such as a pedestrian transport service or a dedicated traffic control employee to assist and direct pedestrians around the work area for short duration disruptions. The work zone supervisor is responsible for the implementation of the TMP, and installation and maintenance of the ADA compliant pedestrian traffic control devices. The work zone shall be inspected weekly or as directed by the Engineer. Do not have any abrupt changes in grade or terrain that could cause a tripping hazard or could be a barrier to wheelchair use. Provide ADA compliant channelizing devices that are detectable to pedestrians who have visual disabilities.

Do not sever or move pedestrian facilities for non-construction activities such as parking for vehicles and equipment. Separate pedestrian movements from both work zone activity and vehicular traffic.

SECTION 1105
TEMPORARY TRAFFIC CONTROL DEVICES

1105-1 DESCRIPTION

Furnish, install, maintain, relocate and remove temporary traffic control devices. All temporary traffic control devices furnished by the Contractor shall remain the property of the Contractor, unless otherwise specified in the contract.

1105-2 MATERIALS

Refer to Division 10.

Provide temporary traffic control devices that are listed on the NCDOT Approved Product List.

1105-3 CONSTRUCTION METHODS

Ensure all temporary traffic control devices are inspected and approved before using them on the project. Install temporary traffic control devices before construction operations begin and during the proper phase of construction. Maintain and relocate temporary traffic control devices during the time they are in use. Keep these devices in place as long as they are needed and immediately remove thereafter. When operations are performed in stages, install only those devices that apply to the present conditions.

1105-4 MAINTENANCE AND INSPECTION

Submit a proposed traffic control device maintenance schedule and checklist for approval before construction. Perform continuous maintenance and daily scheduled inspections of temporary traffic control devices. Review and maintain all traffic handling measures to ensure that adequate provisions are in place for public and workers' safety.

Maintenance activities include cleaning, repair, or replacement, and prompt disposal of temporary traffic control devices that are damaged, torn, crushed, discolored, displaced or deteriorated beyond effectiveness.

Replace work zone traffic control devices deemed unacceptable according to the guidelines set forth in the American Traffic Safety Service Association's (ATSSA) Quality Guidelines for Work Zone Traffic Control Devices.

If the name and telephone number of the agency, Contractor or supplier is shown on the non-retroreflective surface of all channelizing devices, use letters and numbers that are non-reflective and not over 2 inches in height.

1105-5 FAILURE TO MAINTAIN TRAFFIC CONTROL

Failure to maintain acceptable traffic control measures or temporary traffic control devices may result in formal notification of noncompliance. Implement remedial action immediately for imminent danger situations as directed by the Engineer. Implement remedial action within 48 hours after notification of a safety issue that is not an imminent danger. See Articles 107-21 and 108-7.

Failure to comply may result in having the work performed with available forces and equipment. In cases of willful disregard for the safety of the public, the Engineer may proceed immediately to implement the measures necessary to provide the appropriate level of traffic control to ensure that the safety of all concerned parties is maintained.

1105-6 MEASUREMENT AND PAYMENT

Payment at the contract unit prices for the various items in the contract will be full compensation for all work covered by this specification.

If the Contractor fails to maintain acceptable traffic control measures or temporary traffic control devices and the Engineer implements measures necessary to provide the appropriate level of traffic control, the actual cost of performing said work will be deducted from the monies due the Contractor on the contract.

SECTION 1110
WORK ZONE SIGNS

1110-1 DESCRIPTION

Furnish, install, maintain, temporarily cover and uncover, relocate and remove stationary and barricade mounted work zone signs in accordance with the contract.

Furnish, install, maintain and relocate portable work zone signs and portable work zone sign stands in accordance with the plans and the *Standard Specifications*. When portable work zone signs and portable work zone sign stands are not in use for periods longer than 30 minutes, collapse or remove sign stands and reinstall once work begins again.

1110-2 MATERIALS

Refer to Division 10.

Item	Section
Work Zone Signs	1089-1
Work Zone Sign Supports	1089-2

Use portable work zone signs only with portable work zone sign stands specifically designed for one another.

Provide portable work zone sign stands, portable signs and sheeting that are listed on the NCDOT APL.

Provide portable work zone signs and stands that are crash tested together as a system by the manufacturer. Poor performance of portable work zone signs or portable work zone sign stands at any site, whether or not related to a specific contract, will be grounds for non-acceptance of a product on any project under contract.

1110-3 CONSTRUCTION METHODS

(A) Work Zone Signs (Stationary)

All stationary Advance/General warning work zone signs require notification to existing utility owners per Article 105-8 within 3 to 12 working days prior to installation.

Install work zone signs (stationary) to stand within 2° of plumb in all directions and under all conditions. Erect signs per *Roadway Standard Drawings*.

Splicing of work zone sign (stationary) posts is acceptable. Splice work zone sign (stationary) posts according to *Roadway Standard Drawings*. Remove entire post when removing signs with spliced posts.

When required, cover work zone signs with an opaque material that prevents reading of the sign at night by a driver using high beam headlights. Use material that does not damage the sign sheeting.

Any damage incurred from the covering of work zone signs will be determined using Article 901-5. Replace or repair any damaged signs due to the covering.

(B) Work Zone Signs (Barricade Mounted)

Mount approved composite or roll up signs to barricade rails so the signs do not cover more than 50% of the top 2 rails or 33% of the total area of the 3 rails. Mount signs at least one foot from the ground to the bottom of the sign.

(C) Work Zone Signs (Portable)

Install the work zone sign (portable) and sign stand to stand plumb within 10° left and right, within 20° front and back and be capable of standing erect in windy conditions.

Install roll up or approved composite signs at least one foot from the bottom of the sign to the edge of pavement elevation on two-lane two-way roadways. Install roll up or approved composite signs at least 5 feet from the bottom of the sign to the edge of pavement elevation on multi-lane roadways.

Clean the sign face before use.

When not in use for periods longer than 30 minutes, lay the work zone sign (portable) flat on the ground and collapse the sign stand and lay it flat on the ground.

1110-4 MEASUREMENT AND PAYMENT

Nominal dimensions will be used to compute the sign panel areas.

Work Zone Signs (Stationary) will be measured and paid as the actual number of square feet satisfactorily installed at each location and accepted by the Engineer. Where a particular sign is used at more than one location, measurement will be made at each location. Payment for *Work Zone Signs (Stationary*) will be limited to a maximum of 90% of the total installed quantity. The remaining 10% will be paid once all signs have been removed.

Work Zone Signs (Barricade Mounted) will be measured and paid as the actual number of square feet satisfactorily installed on barricades and accepted by the Engineer. Payment will

be made for the initial installation only. Relocation of signs will be incidental to the measurement of the quantity of signs.

Work Zone Signs (Portable) will be measured and paid as the actual number of square feet satisfactorily installed and accepted by the Engineer. Payment will be made for the initial installation only. Relocation of signs will be incidental to the measurement of the quantity of signs.

No direct payment will be made for stationary work zone sign supports or portable work zone sign stands. All stationary work zone sign supports or portable work zone sign stands will be incidental to the work of providing work zone signs.

Payment will be made under:

Pay Item	Pay Unit
Work Zones Signs (Stationary)	Square Foot
Work Zones Signs (Barricade Mounted)	Square Foot
Work Zones Signs (Portable)	Square Foot

SECTION 1115
FLASHING ARROW BOARDS

1115-1 DESCRIPTION

Furnish, install, operate, maintain, relocate and remove arrow boards.

1115-2 MATERIALS

Refer to Division 10.

Item	Section
Flashing Arrow Boards	1089-6

Provide arrow boards listed on the NCDOT APL.

Poor performance of arrow boards at any site, whether or not related to a specific contract, will be grounds for non-acceptance of a product on any project under contract.

1115-3 CONSTRUCTION METHODS

Use arrow boards that have the capability to display mode selections.

Do not use straight-line caution or chevron displays.

Mount flashing arrow boards on trucks, trailers or other mobile units.

Expedite repairs due to failure, malfunction or damage to an arrow board. Furnish another arrow board approved by the Engineer during the repair time. Repair or replace arrow boards immediately; otherwise, suspend all construction activities requiring the use of the arrow board until the arrow board is restored to operation.

Perform all maintenance operations recommended by the manufacturer of the arrow board.

When arrow boards are not in use for 72 or more hours, they shall be relocated such that they are outside of the clear zone or shielded behind a traffic barrier and turned away from traffic.

1115-4 MEASUREMENT AND PAYMENT

Flashing Arrow Board will be measured and paid as the maximum number of arrow boards satisfactorily placed and accepted by the Engineer in use at any one time during the life of the project as required by the contract.

Flashing arrow boards installed on truck mounted attenuators (TMAs) will not be paid for separately as they are incidental to the cost of the TMA.

Replacement, repair and maintenance of arrow boards will be incidental to the work of this section.

Payment will be made under:

Pay Item	Pay Unit
Flashing Arrow Board	Each

SECTION 1120
PORTABLE CHANGEABLE MESSAGE SIGNS

1120-1 DESCRIPTION

Furnish, install, operate, maintain, relocate and remove portable changeable message signs.

1120-2 MATERIALS

Refer to Division 10.

Item	Section
Portable Changeable Message Signs	1089-7

Provide portable changeable message signs listed on the NCDOT APL.

Poor performance of portable changeable message signs at any site, whether or not related to a specific contract, may be grounds for non-acceptance of a product on any project under contract.

1120-3 CONSTRUCTION METHODS

Mount all portable changeable message signs on a trailer or truck so as to support the message board in a level position and in accordance with the plans. Align and sight the portable changeable message sign to provide optimal driver visibility. Messages on a portable changeable message sign shall consist of no more than 2 phases, and a phase shall consist of no more than 3 lines of text. Each phase shall be capable of being understood by itself, regardless of the order in which it is read. Messages shall be centered and uppercase within each line of the legend. If more than one portable changeable message sign is simultaneously legible to road users, then only one of the signs shall display a sequential message at any given time. As guidance, the display time for each phase shall be at least 2 seconds, and the sum of the display times for both of the phases shall be no more than 8 seconds. Sign operator will adjust the display rate so the 2 phase message can be understood by the motorist twice when approaching the sign at the posted speed limit. Relocate the units for the various stages of construction as shown in the plans or as needed to inform the motorists.

Provide an experienced operator for the portable changeable message sign during periods of operation to ensure that the messages displayed on the sign panel are in accordance with the plans and Subarticle 1089-7(D). Change the controller password from the factory default and periodically change the controller password to deter unauthorized programming of the controller. Using two levels of password security is recommended such that operators at one level may only change message sequences displayed using preprogrammed sequences and operators at a higher level may create and store messages or message sequences. Lock the controller in a weather and vandal resistant box when not in use and after changes to the messages are made.

Ensure that the message sign is illuminated properly to meet the existing light conditions, and that all adjustments for operation of the sign are made as needed to properly guide motorists.

Expedite repairs due to failure, malfunction or damage to a portable changeable message sign. Furnish another changeable message sign during the repair time. Repair or replace portable changeable message sign immediately; otherwise, suspend all construction activities requiring the use of the sign until the sign is restored to operation.

Perform all maintenance operations recommended by the manufacturer of the sign. Periodically clean or replace the sign face panels and associated solar panels.

Each portable changeable message sign should be placed off the shoulder of the roadway and behind a traffic barrier, if practical. Where placement of a traffic barrier is not practical to shield the message sign, the message sign should be placed off the shoulder and outside of the clear zone. If a message sign must be placed on the roadway shoulder or within the clear zone, it shall be delineated with a minimum of three (3) drums. When message signs are not being used to display messages for 72 or more hours, they shall be relocated such that they are outside of the clear zone or shielded behind a traffic barrier and turned away from traffic.

1120-4 MEASUREMENT AND PAYMENT

Portable Changeable Message Signs will be measured and paid as the maximum number of portable changeable message signs acceptably placed and in operation, at any one time during the life of the project. Payment for *Portable Changeable Message Signs* will be made on the following schedule:

(A) 70% of the unit bid upon placing the unit in service,

(B) 20% of the unit bid when the project is 50% complete, and

(C) 10% of the unit bid when the project is 100% complete.

Portable Changeable Message Signs (Short Term) will be measured and paid as the actual number of days the portable changeable message sign (short term) is used on a project for a specific work operation, removed from the project after the specific operation is complete and remains in use on the project no longer than 30 days.

Replacement, repair and maintenance of changeable message signs will be incidental to the work of this section.

Payment will be made under:

Pay Item	Pay Unit
Portable Changeable Message Sign	Each
Portable Changeable Message Sign (Short Term)	Day

SECTION 1130
DRUMS

1130-1 DESCRIPTION

Furnish, install, maintain, relocate and remove drums with ballast.

1130-2 MATERIALS

Refer to Division 10.

Item	Section
Drums	1089-5

Provide drums listed on the NCDOT APL.

1130-3 CONSTRUCTION METHODS

Use the same type of retroreflective sheeting on all drums installed at any one time during the life of the project. Spacing of these devices is equal in feet to the speed limit in the taper and twice the speed limit in the tangent sections.

Use a ballasting method in accordance with manufacturer's specification. When using a tire ballasting method, use approved manufacturer's tires and place the tires flush with the ground.

Do not intermix with skinny drums or cones in either the taper or the tangent sections.

Immediately replace and dispose of any drum, ballast or reflective sheeting that are torn, crushed, discolored or otherwise damaged.

1130-4 MEASUREMENT AND PAYMENT

Drums will be measured and paid as the maximum number of drums acceptably placed and in use at any one time during the life of the project.

Relocation, replacement, repair or disposal of drums, ballasts or reflective sheeting will be incidental to the work of this section.

Payment will be made under:

Pay Item	Pay Unit
Drums	Each

SECTION 1135
CONES

1135-1 DESCRIPTION

Furnish, install, relocate, maintain and remove cones and reflective cone collars.

1135-2 MATERIALS

Refer to Division 10.

Item	Section
Cones	1089-5

Provide cones listed on the NCDOT APL.

1135-3 CONSTRUCTION METHODS

Use retroreflective adhesive sheeting on all cones used between dusk and dawn. Use the same type of retroreflective sheeting on all cone collars installed at any one time during the life of the project. Do not use cones in the upstream taper of lane or shoulder closures for multi-lane roadways. Do not use cones for longer than 3 consecutive days.

Use ballasting methods in accordance with manufacturer's specification.

Cones may be used on all facilities using the following requirements:

(A) For facilities with speed limits below 45 mph cones shall be spaced at 20 feet in the taper and 40 feet in tangent sections.

(B) For facilities with speed limits of 45 mph or higher, drums shall be used in the taper spaced in accordance with Article 1130-3 and cones shall be spaced at 80 feet in the tangent sections.

Do not intermix with drums or skinny drums in either the taper or the tangent sections.

Immediately replace and dispose of any cone that is torn, crushed, discolored or otherwise damaged.

1135-4 MEASUREMENT AND PAYMENT

Cones will be measured and paid as the maximum number of cones acceptably placed and in use at any one time during the life of the project.

Relocation, replacement, repair, maintenance or disposal of cones will be incidental to the work of this section.

Payment will be made under:

Pay Item	Pay Unit
Cones	Each

SECTION 1140
SEQUENTIAL FLASHING WARNING LIGHTS

1140-1 DESCRIPTION

Furnish, install, relocate, maintain and remove sequential flashing warning lights on drums used for the merging tapers of nighttime lane closures.

1140-2 MATERIALS

Refer to Division 10.

Item	Section
Sequential Flashing Warning Lights	1089-4

Provide sequential flashing warning lights listed on the NCDOT APL.

1140-3 CONSTRUCTION METHODS

Use sequential flashing warning lights on all multilane roadways with speed limits of 55 mph or greater.

These lights shall flash sequentially beginning with the first light and continuing until the final light.

The sequential flashing warning lights shall automatically flash in sequence when placed on the drums that form the merging taper.

The number of lights used in the drum taper shall equal the number of drums used in the taper.

Drums are the only channelizing device allowed to mount sequential flashing warning lights.

The sequential flashing warning lights shall automatically sequence when placed in line in an open area with a distance between lights of 10 to 100 feet.

If one light fails, the flashing sequence shall continue. If more than 1 light fails, all of the lights are to be automatically turned to the “off” mode. Non-sequential flashing is prohibited.

When lane closures are not in effect, the sequential flashing warning lights shall be deactivated.

1140-4 MAINTENANCE

Periodically inspect sequential flashing warning lights. Replace any sequential flashing warning lights as needed.

1140-5 MEASUREMENT AND PAYMENT

Sequential Flashing Warning Lights will be measured and paid as the maximum number of sequential flashing warning lights satisfactorily installed and properly functioning at any one time during the life of the project.

This includes all materials and labor to install, maintain and remove all the *Sequential Flashing Warning Lights*.

Payment will be made under:

Pay Item	Pay Unit
Sequential Flashing Warning Lights	Each

SECTION 1145
BARRICADES

1145-1 DESCRIPTION

Furnish, install, maintain, relocate, ballast and remove barricades.

1145-2 MATERIALS

Refer to Division 10.

Item	Section
Barricades	1089-3

Provide barricades that are listed on the NCDOT APL.

1145-3 CONSTRUCTION METHODS

Install Type III barricades of sufficient length to close the entire roadway. Reposition the devices as necessary to completely close the roadway to traffic at the end of the workday.

Use sandbags or other approved ballasting methods to prevent overturning of barricades by the wind. If needed, place sandbags or other acceptable ballasting on the feet of the frame. Do not ballast barricades with objects such as rocks or chunks of concrete.

Do not anchor barricades to any pavement surfaces unless such anchoring method has been crash tested by approved methods.

Point the striped diagonals on the barricade rails in the direction of traffic flow.

1145-4 MAINTENANCE

Periodically inspect barricades and ballast. Replace any ballast as needed, including sandbags that have loose sand outside the bag.

1145-5 MEASUREMENT AND PAYMENT

Barricades (Type III) will be measured and paid as the maximum number of linear feet of barricades acceptably placed and in use at any one time during the life of the project. Measurement will be made of the total length of each barricade along one rail.

Relocation, replacement, repair, maintenance or disposal of barricade will be incidental to the work of this section.

Payment will be made under:

Pay Item	Pay Unit
Barricades (Type III)	Linear Foot

SECTION 1150
FLAGGERS

1150-1 DESCRIPTION

Furnish, relocate and maintain the flaggers, hats, vests, STOP/SLOW paddles and any other incidentals necessary to control traffic.

1150-2 MATERIALS

Refer to Division 10.

Item	Section
Flagger	1089-10

Refer to *Roadway Standard Drawings*.

1150-3 CONSTRUCTION METHODS

Provide the service of properly equipped and qualified flaggers (see *Roadway Standard Drawings*) at locations and times for such period as necessary for the control and protection of vehicular and pedestrian traffic. All flaggers shall be qualified by an NCDOT approved training agency in the set-up and techniques of safely and competently performing a flagging operation. For a complete listing of approved training agencies, see the Work Zone Traffic Control's webpage.

Prior to beginning work on the project, a Qualification Statement that all flaggers used on the project have been properly trained through an NCDOT approved training resource shall be provided to the Engineer.

Use flagging methods that comply with the guidelines in the MUTCD.

1150-4 MEASUREMENT AND PAYMENT

Flagging conducted for the convenience of the Contractor's operations is not compensated. The Department will pay for flaggers, including those used at Y-lines that are used in conjunction with a lane closure. Flaggers used for operations not involving a lane closure will be incidental to that operation and no payment will be made. Flaggers used for hauling operations, where the only need for a lane closure is due to the hauling operation, will be incidental to that operation and no payment will be made.

Any flagger used for less than one hour will be incidental to that operation.

Flagger (Day) will be measured and paid as a half day or full day. To constitute a full day, the flagger must work a minimum of 4 consecutive hours up to 14 consecutive hours. Any shift less than 4 consecutive hours will be paid as a half day. On any calendar day that more than one flagger is used, the quantity to be paid on that calendar day will be the maximum number of flaggers used at one time on that calendar day.

Payment will be made under:

Pay Item	Pay Unit
Flagger	Day

SECTION 1160
TEMPORARY CRASH CUSHIONS

1160-1 DESCRIPTION

Furnish, install, maintain, reset and remove temporary crash cushions.

1160-2 MATERIALS

Refer to Division 10.

Item	Section
Temporary Crash Cushions	1089-8

Provide temporary crash cushions that are listed on the NCDOT APL. Provide redirective temporary crash cushions or non-redirective temporary crash cushions that capture errant vehicles without complete penetration through the device. Use a redirective temporary crash cushion when adequate space for the lateral displacement of the crash cushion is not available.

Historical performance of the temporary crash cushions will help determine the future use of the material by the Department, even if the temporary crash cushion has been approved. Poor performance of temporary crash cushions at any site, whether or not related to a specific contract, may be grounds for non-acceptance of a product on any project under contract.

1160-3 CONSTRUCTION METHODS

Before use, furnish the Engineer detailed brochures, specifications and other manufacturer's data that completely describe the performance criteria, installation and instructions for the crash cushion. Ensure that the crash cushion is rated for at least the same speed as the facility on which it will be used.

The Contractor may provide a portable base for installation. When a portable base is used, provide one that is designed or approved by the manufacturer of the temporary crash cushion.

Install temporary crash cushions in accordance with the manufacturer's specifications.

Use a yellow reflective end treatment to delineate the approach end of the crash cushion facing oncoming traffic.

Repair any pavement damaged by the installation or removal of a temporary crash cushion.

Repair or replace, within 24 hours, any temporary crash cushion that becomes crushed or otherwise damaged to the point that it will not perform its intended purpose. If the cushion cannot be repaired within 24 hours, a truck mounted attenuator may be used for up to 72 hours if the space allows; otherwise, all construction activities shall be suspended until the temporary crash cushion is repaired or replaced. Provide safe control of traffic until the temporary crash cushion has been repaired or replaced using approved methods.

1160-4 MEASUREMENT AND PAYMENT

Temporary Crash Cushion will be measured and paid as the actual number of crash cushions furnished, satisfactorily installed and accepted by the Engineer.

Remove and Reset Temporary Crash Cushion will be measured and paid as the number of crash cushions moved from one location on the project to another location on the project. Measurement will be made by counting the number of crash cushion units moved during any one move. Where barrier units are moved more than one, each move will be measured separately. Whenever the Engineer directs the Contractor to move a crash cushion from an installed location to a stockpile either on or off the project and then back to another installed location, the complete move from the first installed location to the next installed location will be measured as 2 moves.

Repair or replace damaged temporary crash cushions at no cost to the Department. Repair or replace damaged pavement at no cost to the Department.

Payment will be made under:

Pay Item	Pay Unit
Temporary Crash Cushion	Each
Remove and Reset Temporary Crash Cushion	Each

SECTION 1165
TRUCK MOUNTED ATTENUATORS

1165-1 DESCRIPTION

Furnish, install, operate, maintain and relocate truck mounted attenuators (TMA).

1165-2 MATERIALS

Refer to Division 10.

Item	Section
Truck Mounted Attenuators	1089-9

Provide chassis mounted or trailer mounted TMAs that are listed on the NCDOT APL.

Historical performance of the TMA will help determine the future use of the material by the Department, even if the TMA has been approved. Poor performance of TMA at any site, whether or not related to a specific contract, may be grounds for non-acceptance of a product on any project under contract.

1165-3 CONSTRUCTION METHODS

Before use, furnish the Engineer detailed brochures, manufacturer's specifications and other data that completely describes the performance criteria, installation and instructions for the TMA.

Do not park TMAs against rigid objects (i.e., bridge piers or portable concrete barrier) except as a temporary safety measure and in no case for longer than 72 hours. Install the TMA on a truck that is fully operational, in good running order and in accordance with the manufacturer's specifications.

Use the appropriate lighting as described in Article 1101-5 and delineation on the truck and TMAs as shown in the *Roadway Standard Drawings*. TMA trailer lighting systems shall be activated in the flash mode while deployed.

Repair or replace within 24 hours any attenuator that becomes crushed or otherwise damaged so that it will perform its intended purpose. Suspend all construction activities until the attenuator is repaired or replaced. Provide safe control of traffic until the attenuator has been repaired or replaced using approved methods.

1165-4 MEASUREMENT AND PAYMENT

TMA will be measured and paid as the maximum number of TMAs acceptably placed and in use at any one time during the life of the project for all operations other than Moving and Mobile Operations. TMAs will be incidental to all moving and mobile operations. In the case of emergency situations, TMAs will not be paid when payment has already been made for a stationary unit.

Relocation of TMAs will be incidental to the measurement of the quantities of TMAs and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
TMA	Each

SECTION 1170
POSITIVE PROTECTION

1170-1 DESCRIPTION

Furnish, install, secure, maintain, remove and reset portable concrete barrier or water filled barrier.

1170-2 MATERIALS

Refer to Division 10.

Item	Section
Anchor Bolts	1072-4
Anchor Bolt Adhesive	1081
Concrete Barrier	854
Grout, Type 3	1003
Guardrail and Barrier Delineators	1088-2
Portable Concrete Barrier	1090

Provide barrier and delineators that are listed on the NCDOT APL.

Historical performance of the barrier will help determine use of the material by the Department, even if the barrier has been approved. Poor performance of the barrier at any site, whether or not related to a specific contract, may be grounds for non-acceptance of a product on any project under contract.

1170-3 CONSTRUCTION METHODS

(A) General

Place all types of barrier as shown in the plans and per manufacturer specifications.

Use one type of barrier on any continuous run of barrier within the project.

Barrier shall be placed on an asphalt or concrete surface. Barrier should not be placed on cross slopes steeper than 6:1.

Use barrier that avoids trapping water in sags, vertical curves, areas of wedging and paving where super-elevations have been changed and other low spots. Provide adequate drainage behind the portable concrete barrier.

Do not use any barrier units that are cracked, damaged, chipped or otherwise nonfunctional.

Once temporary barrier is installed at any location and no work is performed behind the temporary barrier for a period longer than 2 months, remove or reset temporary barrier at no cost to the Department unless otherwise stated in the TMP, temporary barrier is protecting a hazard, or as directed by the Engineer. Follow the manufacturer's specifications and recommendations.

(1) Portable Concrete Barrier

Lift, place and reset portable concrete barrier units using a two-point pick up, or other acceptable method, which does not over-stress, damage or mar the surface of the roadway. Do not use connection points for lifting purposes.

Use approved anchoring methods shown in *Roadway Standard Drawings*.

(a) Anchoring Method for Asphalt Pavements

Drill anchor holes normal to the surface of installation using a pneumatic drill with a depth indicator, unless another drilling method is allowed. Make sure that the diameter of the hole is in strict conformance with the *Roadway Standard Drawings* or the manufacturer's recommendations. When directed, use a jig or fixture to ensure correct positioning of the holes and proper alignment during the drilling process. Adjust hole locations, as necessary, to avoid encountering reinforcing steel. Immediately after drilling, brush the holes with a stiff-bristled brush of a sufficient size to effectively remove dust from the sides of the hole, and blow all holes free of all dust and debris using oil free compressed air. Repeat this procedure until the hole is completely clean.

Inspect each hole immediately before placement of the anchor. Rework any hole found to deviate from these requirements to ensure that an acceptable hole is achieved.

Check each hole with a depth gauge to ensure proper embedment depth, if required.

Satisfactorily repair all spalled or damaged pavement.

Once the barrier and anchors are removed, fill the holes with grout. These requirements may be waived if the bridge or roadway will no longer be used by traffic.

(b) Adhesive Anchoring Method for Concrete Surfaces

Comply with Subarticle 1170-3(A)(1)(a).

Mix adhesives in strict conformance with the manufacturer's instructions.

Pour the mixed adhesive into the hole. Agitate or rotate anchors to ensure complete wetting and encapsulation. Insert the anchors to the specified depth. Completely fill the anchor hole with adhesive and remove any excess adhesive flush with the pavement. Do not disturb any anchors while the adhesive is hardening.

Coat all anchors to be adhesively bonded with a debonding agent to ease removal. Formulate the debonding agent such that it does not reduce the strength of the anchor system.

(c) Through the Deck Anchoring Method

Comply with Subarticle 1170-3(A)(1)(a).

Anchor barrier to bridge decks as shown in *Roadway Standard Drawings*. Do not use this method on prestressed concrete bridge deck panels.

(2) Water Filled Barrier

Provide water filled barrier that acts as its own free standing, non-redirective end treatment or has an attached end treatment that completely captures the impacting vehicle without full penetration of the device.

Water filled barriers shall not be placed such that fixed objects (including curbs) are within the lateral displacement area of the barrier according to the manufacturer's specifications.

Use environmentally safe anti-freezing agent in the water per manufacturer specifications and recover agent when the barrier is drained. Dispose of water and agent properly. Do not drain water filled barrier into or across an existing travel lane. Provide barrier units that are capable of being lifted and moved when filled if draining is not possible.

For work zones on facilities with a posted speed limit greater than 45 mph, water filled barrier that meets Test Level III may be used only if there is adequate space for the lateral displacement of the barrier according to the manufacturer's specifications.

Alternatively, for work zones on facilities with a posted speed limit of 45 mph or less, provide water filled barrier that meets Test Level II or Test Level III.

Water filled barrier at a 36-inch height is preferred to limit sight distance impairment. If devices taller than 36 inches are used in this situation, transition down to 36 inches or shorter on the intersection approaches to provide proper sight distance.

(B) Resetting Barrier

Reset portable concrete barrier or water filled barrier as defined by the TMP.

(C) Stockpiling

Stockpile the portable concrete barrier when the barrier is not used on the project or it becomes necessary to stockpile units between 2 separate installations. Stockpile the barrier at a location off the project of your choosing, unless otherwise noted in the TMP, or to a location within the project limits, if provided.

(D) Barrier Delineators

Furnish barrier delineator for portable concrete and water filled barrier. Top mount delineators for barrier throughout the project. Side mounted delineators may be used to supplement the top mounted delineators. Attach the delineator to the barrier using methods and spacing as shown in the *Roadway Standard Drawings*.

The delineators consist of a reflector and base or casing.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in the median and on the left side of one-way ramps, loops or other one-way facilities. Use white delineators on the right side of divided highways, ramps, loops and all other one-way or two-way facilities. In all cases, the color of the delineator shall supplement the color of the adjacent edgelines.

1170-4 MEASUREMENT AND PAYMENT

Portable Concrete Barrier (____) will be measured and paid as the maximum number of linear feet furnished, satisfactorily installed, accepted by the Engineer, maintained and removed, at any one time during the life of the project. Measurement will be made by counting the number of barrier units used and multiplying by the length of a unit.

Water Filled Barrier will be measured and paid as the maximum number of linear feet furnished, satisfactorily installed, accepted by the Engineer, maintained and removed, at any one time during the life of the project. Measurement will be made by counting the number of barrier units used and multiplying by the length of a unit.

Remove and Reset Portable Concrete Barrier (____) will be measured and paid as the number of linear feet of barrier moved from one location on the project to another location on the project. Measurement will be made by counting the number of barrier units moved during any one move and multiplying by the length of a unit. Where barrier units are moved more than once, each move will be measured separately. Whenever the Engineer directs the Contractor to move barrier units from an installed location to a stockpile either on or off the project and then back to another installed location, the complete move from the first installed location to the next installed location will be measured as 2 moves.

Remove and Reset Water Filled Barrier will be measured and paid as the actual number of linear feet of barrier moved from one location on the project to another location on the project. Measurement will be made by counting the number of barrier units moved during any one move and multiplying by the length of a unit. Where barrier units are moved more than once, each move will be measured separately. Whenever the Engineer directs the Contractor to move barrier units from an installed location to a stockpile either on or off the project and then back to another installed location, the complete move from the first installed location to the next installed location will be measured as 2 moves.

Provide barrier stockpile areas at no cost to the Department. Barrier delineators will be incidental to these pay items.

Payment will be made under:

Pay Item	Pay Unit
Portable Concrete Barrier	Linear Foot
Portable Concrete Barrier (Anchored)	Linear Foot
Water Filled Barrier	Linear Foot
Remove and Reset Portable Concrete Barrier	Linear Foot
Remove and Reset Portable Concrete Barrier (Anchored)	Linear Foot
Remove and Reset Water Filled Barrier	Linear Foot

SECTION 1180
SKINNY DRUMS

1180-1 DESCRIPTION

Furnish, install, maintain, relocate and remove skinny drums with ballast.

1180-2 MATERIALS.

Refer to Division 10.

Item	Section
Skinny Drums	1089-5

Provide skinny drums listed on the NCDOT APL.

1180-3 CONSTRUCTION METHODS

All skinny drums used shall have retroreflective adhesive sheeting. Use the same type of retroreflective sheeting on all skinny drums installed at any one time during the life of the project.

Use ballasting methods in accordance with manufacturer's specification.

Skinny drums may be used on all facilities using the following requirements:

(A) For facilities with speed limits below 45 mph skinny drums shall be spaced at 20 feet in the taper and 40 feet in tangent sections.

(B) For facilities with speed limits of 45 mph or higher, drums shall be used in the taper spaced in accordance with Article 1130-3 and skinny drums shall be spaced at 80 feet in the tangent sections.

Do not intermix with drums or cones in either the taper or the tangent sections.

Immediately replace and dispose of any skinny drum, ballast or retroreflective sheeting that are torn, crushed, discolored or otherwise damaged.

1180-4 MEASUREMENT AND PAYMENT

Skinny Drums will be measured and paid as the maximum number of skinny drums satisfactorily placed, accepted by the Engineer and in use at any one time during the life of the project.

Relocation, replacement, repair, disposal and maintenance of skinny drums will be incidental to the work of this section.

Payment will be made under:

Pay Item	Pay Unit
Skinny Drum	Each

SECTION 1190
LAW ENFORCEMENT

1190-1 DESCRIPTION

Furnish Law Enforcement Officers and official Law Enforcement vehicles to direct traffic in accordance with the contract.

1190-2 CONSTRUCTION METHODS

Use off duty uniformed Law Enforcement Officers and official Law Enforcement vehicles equipped with blue lights to direct or control traffic as required by the plans or by the Engineer.

Law Enforcement vehicles shall not be parked within the buffer space on any roadway. Law Enforcement vehicles shall not be used to close or block an active travel lane on multilane roadways with a posted speed limit of 45 MPH or higher, except as allowed during rolling roadblock operations as shown in the *Roadway Standard Drawings* or while responding to an emergency.

1190-3 MEASUREMENT AND PAYMENT

Law Enforcement will be measured and paid for in the actual number of hours that each Law Enforcement Officer provides during the life of the project as approved by the Engineer. There will be no direct payment for official Law Enforcement vehicles as they are considered incidental to the pay item.

Payment will be made under:

Pay Item	Pay Unit
Law Enforcement	Hour

DIVISION 12
PAVEMENT MARKINGS, MARKERS AND DELINEATION

SECTION 1205
PAVEMENT MARKING GENERAL REQUIREMENTS

1205-1 DESCRIPTION

Furnish, install and remove pavement markings in accordance with the contract.

1205-2 MATERIALS

(A) General

Refer to Division 10.

Item	Section
Pavement Markings	1087

(B) Material Qualifications

Use pavement marking materials that are on the NCDOT APL.

(C) Performance

Poor performance of pavement marking materials at any site, whether or not related to a specific contract may be grounds for nonacceptance of a product on any project under contract.

1205-3 CONSTRUCTION METHODS

Do not use handliners or any other non-truck mounted pavement marking machine to install pavement markings for long line applications of any one line longer than 1,000 feet.

Use heated-in-place thermoplastic with skid resistant media for bike lane symbols.

(A) Testing Procedures

All pavement marking materials and placement will be tested by the Department. Install pavement markings in order to meet the retroreflectivity requirements as measured by a Department approved mobile or handheld retroreflectometer that is on the NCDOT APL.

(B) Application Equipment

(1) General for all Application Equipment

Use pavement marking application equipment such that all parts that come in contact with pavement marking material are constructed for easy accessibility during cleaning and maintenance.

Keep the marking guns of the application device in full view of the operators at all times. Use applicators that are mobile and maneuverable to the extent that straight lines can be followed and all standard curves can be made in true arcs.

(2) Reflective Media Dispensing Equipment

Apply reflective media to the surface of pavement long line markings using an automatic high pressurized bead and media dispenser or a pressurized mechanical feed, attached to the marking equipment. Hand liner type equipment is exempt from this requirement. Locate the reflective media applicator at the proper distance behind the application of pavement marking material to provide the proper amount

of retroreflectivity. Equip the reflective media applicator with an automatic cut-off control synchronized with the cut-off control of the marking material.

Spread the reflective media uniformly over the entire surface of the pavement marking material such that they are partially embedded in the pavement marking. A 60% reflective media embedment depth provides optimum retroreflectivity.

(C) Weather Limitations and Seasonal Limitations for All Markings

Do not place pavement markings when moisture tests conducted on the pavement show signs of moisture presence on the pavement or when it is anticipated that damage caused by moisture may occur during the installation and drying periods.

(D) Time Limitations for Replacement

TABLE 1205-1
TIME LIMITATIONS FOR REPLACEMENT

Facility Type	Marking Type	Replacement Deadline
Full-control-of-access multi-lane roadway (4 or more total lanes) and ramps, including Interstates	All markings	By the end of each workday's operation if the lane is opened to traffic
Multi-lane roadways (3 or more lanes) and ramps	Center Line, Lane Line, Railroad symbols, Stop bars, and school symbols	By the end of each workday's operation if the lane is opened to traffic (temporary paint with beads may be used)
	Edge Lines, gore lines and all other symbols	By the end of the 3rd calendar day after obliteration
Two-lane, two-way roadways	All centerline markings, railroad, Stop bars and school symbols	By the end of the 5th calendar day after obliteration
	Edge Lines and all other symbols	By the end of the 15th calendar day after obliteration

A multilane facility is defined as any roadway having more than two lanes to include a two-lane / two-way roadway with a center two-way left turn lane. Apply center line markings prior to edge line markings.

(E) Premarking/Interim/Temporary Markings

Premarking (or layout markings) are small paint spots used by striping contractors to establish locations of pavement markings. Premark each installation of the final pavement marking materials before application on new pavement and when required to replace existing pavement marking, except when existing markings are visible. Get the premarking inspected and approved by the Engineer before placing the pavement marking materials.

Interim paint is a thin layer of pavement marking paint applied at the striping contractor’s option to maintain traffic, instead of durable pavement markings. Apply interim paint to comply with time limitations for placement if final pavement markings cannot be placed. Interim markings shall be no more than 1/4 inch less than the specified line width of the existing markings.

Place temporary paint markings for detours, lane shifts, milled surfaces and lifts of asphalt other than the final pavement surface.

Review and record the existing pavement markings before resurfacing and reestablish the new pavement markings using the record of existing markings in conjunction with the *Roadway Standard Drawings*, unless otherwise directed by the Engineer. Submit the record of the existing pavement markings 7 calendar days before the obliteration of any pavement markings.

(F) Surface Preparation and Curing Compound Removal

Prepare the pavement to accept pavement markings to ensure maximum possible adhesion. Clean, seal and remove curing compound as necessary to ensure that the markings adhere to the pavement. Obtain approval from the Engineer for all surface preparation methods before implementing.

Pavements shall be free of grease, oil, mud, dust, dirt, grass, loose gravel, winter surface treatments and other deleterious material, before applying pavement markings.

Prepare the pavement surface, including removal of curing compound, at least 2 inches wider than the pavement markings to be placed, such that, an additional 1 inch of prepared area is on all sides of the pavement markings after they are applied.

Remove the grooves caused by concrete grinders before installing the polyurea pavement marking.

Remove all curing compound and surface laitance on Portland cement concrete pavements where long-life pavement markings will be placed. Perform curing compound removal by high-pressure water blasting or grinding methods. Ensure that the surface is free of all residue, laitance and debris before applying the pavement marking. When surface preparation and curing compound removal operations are completed, blow the pavement surface clean by compressed air immediately before installing the pavement markings.

If required, apply a primer sealer to pavement surfaces before applying pavement marking material as recommended by the manufacturer. Apply primer sealer in a continuous film at least 2 inches wider than the pavement markings in such a way as not to cause any noticeable change in the appearance of the pavement markings.

Conduct all pavement surface preparation including curing compound removal in such a manner that the pavement or joint material is not damaged or left in a condition that will mislead or misdirect the motorist. Repair any damage caused to the pavement, or joint materials caused by surface preparation or the removal of curing compound by acceptable methods and at no additional cost to the Department.

Surface preparation and removal of bridge laitance shall be considered incidental to the installation of pavement marking with the exception of curing compound removal.

Where pavement surface preparation results in obscuring existing pavement markings of a lane occupied by traffic, immediately remove the residue, including dust, by approved methods.

(G) Application of Pavement Markings

(1) General for all types of Pavement Markings

Install pavement marking material that has a uniform thickness, smooth surfaced cross section throughout its entire length, width and length not less than the dimensions specified in the plans and that does not exceed the dimension by more than 1/2 inch.

Do not apply pavement marking materials over a longitudinal joint. Mask all bridge joints for removal of surface laitance, existing markings and application of new markings as directed by the Engineer. This work will be incidental to the installation of the pavement markings.

Install pavement marking lines that are straight or have uniform curvature and conform to the tangents, curves and transitions as specified in the plans.

Produce finished lines that have well defined edges and are free of horizontal fluctuations. Do not exceed 1/2 inch in lateral deviation from the proposed location alignment at any point. Any greater deviations may be cause for requiring the material to be removed and replaced at no additional cost.

Apply all longitudinal pavement marking lines 8 inches or less in width with one pass of the pavement marking equipment. Pavement marking lines greater than 8 inches in width and pavement marking symbols may be applied with multiple passes of the pavement marking equipment.

Install all pavement marking lines, stop bars, characters and symbols that require multiple passes of the application equipment such that there are no gaps separating the application passes.

Install characters and symbols so that they conform to the sizes and shapes shown in the plans.

Protect the pavement markings until they are track free. If required by the Engineer, repair any markings tracked by a vehicle by acceptable methods.

Remove all pavement marking materials spilled on the road surface by acceptable methods.

Use yellow, white and black pavement markings, without reflective media that visually match the color chips that correspond to the AMS-STD-595 for these colors. Use markings that when subjected to accelerated weathering as described in U.S. Federal Specification No. TTP-1952 are within the tolerance limits of the color chips listed below:

White: Color No. 17886
Yellow: Color No. 13538
Black: Color No. 37038

(2) Reflective Media Application

"Drop-on" is the method where reflective media are dispensed by a pressurized mechanical feed or high pressure means onto the pavement marking as it is applied to the pavement. Reflective media dispensing for symbols stop bars and characters may be accomplished by gravitational methods.

(H) Observation Period

Maintain responsibility for debonding and color of the pavement markings during a 12 month observation period beginning upon final acceptance of the project as defined under Article 105-17. Guarantee the markings under the payment and performance bond in accordance with Article 105-17.

During the 12 month observation period, provide pavement marking material that shows no signs of failure due to blistering, chipping, bleeding, discoloration, smearing or spreading under heat or poor adhesion to the pavement materials. Pavement markings that bonded during application and were approved by the Engineer, but debond due to snowplowing will not be considered a failed marking. Replace, at no additional expense to the Department, any pavement markings that do not perform satisfactorily under traffic during the 12 month observation period.

(I) Removal of Pavement Markings

This work includes the removal of all types of pavement marking lines, symbols and characters including removal for long life marking preparation. This work does not

include removal of removable tape pavement markings.

Remove pavement marking lines, characters and symbols by acceptable methods to the Engineer that will not materially or structurally damage the surface or the texture of the pavement. Leave the pavement surface in a condition that will not mislead or misdirect the motorist.

Where existing pavement markings are to be removed and replaced by other pavement markings, do not begin removal until adequate provisions have been made to complete the installation of the replacement markings. Remove pavement markings such that the surface is in proper condition for adequate bonding of the new markings. Promptly remove any material deposited on the pavement as a result of removing pavement markings as the work progresses by acceptable methods. Provide the equipment necessary to control dust and the accumulation of debris resulting from the removal process. The removal equipment shall provide dust control and the capture of the removed material shall be done using a separate vacuum equipped vehicle or other approved system. Perform the recovery process within the same operation as the removal. Do not let traffic use the lane where the removal is taking place until the recovery system is finished. Should the recovery system fail, cease removal operations until the recovery system is properly operating. The Contractor is responsible for all cleanup and proper disposal of all removed debris from the project site.

When using a grinding method for pavement marking removal, the equipment shall have multiple heads working in tandem or have a removal head with operator dialed controls to result in a planed surface and provide adequate preparation of the surface to accept the new marking material.

Do not use high pressure water blasting on asphalt.

Application of polyurea over existing pavement marking materials will require at least 95% of the existing pavement marking material to be removed; however, if one 15 mil application of paint was placed on asphalt pavement less than 6 months old, do not remove the existing paint pavement markings.

Thermoplastic may be installed over existing thermoplastic on asphalt. Application over existing pavement marking materials other than thermoplastic will require the existing pavement marking material to be removed so that at least 85% of the existing pavement marking surface is removed. Before applying thermoplastic pavement markings over the existing thermoplastic pavement markings, remove at least 25% of the oxidized existing thermoplastic. On newly installed failed thermoplastic that is to be removed and replaced, remove a minimum of 85% of the existing thermoplastic. However, if one 15 mil application of paint was placed on asphalt pavement less than 6 months old, do not remove the existing paint pavement markings.

Use black color #37038 in paint or tape, as determined by Contractor, to cover any remaining conflicting pavement marking after removal from asphalt pavement surfaces. Do not use black paint or tape on concrete pavement surfaces. The black paint will not have a defined shape or edges with a width not exceeding double of the existing lines.

When traffic patterns are changed in work zones due to construction or reconstruction, remove all conflicting pavement markings, symbols, and characters that conflict with the new traffic pattern before switching traffic to the new traffic pattern. Unless behind barrier, any pavement marking, symbol, or character not used for the new traffic pattern which is within 6 feet of the new traffic pattern markings shall be considered conflicting.

(J) Pavement Marking Installer Qualifications

Ensure at least one member of every pavement marking crew is certified through the NCDOT Pavement Marking Technician Certification Process. Keep the certification current throughout the life of the project. A certified crew member shall be present

anytime this work is being performed. The certified crew member is not required to be the same person throughout the life of the contract.

1205-4 THERMOPLASTIC

(A) Application Equipment

(1) General

Use application equipment constructed to assure continuous uniformity in the thickness and width of the thermoplastic pavement marking. Use application equipment that provides multiple width settings ranging from 4 inches to 12 inches and multiple thickness settings to achieve the required thickness above the surface of the pavement as shown in Table 1205-3 of the *Standard Specifications*. Special thickness equipment may be required for in lane or shoulder transverse rumble strip pavement markings.

Do not use spray thermoplastic unless approved by NCDOT's Signing and Delineation Unit.

(2) Premelting Kettle

Use equipment to install hot thermoplastic pavement marking material that includes an oil-jacketed or air-jacketed premelt kettle for uniform heating and melting of the thermoplastic material. Use a kettle that is equipped with an automatic thermostat control device to provide positive temperature control and continuous mixing and agitation of the thermoplastic material. Do not premelt thermoplastic material in handliner type equipment.

(3) Applicator Storage Kettle

Equip long line pavement marking vehicles with an automatic thermostat control device to maintain the thermoplastic material at the application temperature and provide continuous mixing and agitation of the thermoplastic material during installation. Construct the equipment so that all mixing and conveying parts, up to and including the application apparatus, maintains the thermoplastic pavement marking material at the specified installation temperature and which has a capacity of at least 1,500 lbs. of molten thermoplastic pavement marking material. Hand transfer is not allowed.

Handliner type application vehicles may contain the premelting and applicator storage functions in the same kettle. Agitation and mixing can be done manually. Drag box type and bucket type application is not allowed.

Use premelting and applicator storage kettles that meet the requirements of the National Board of Fire Underwriters, the National Fire Protection Association and State and local authorities.

(B) Weather Limitations and Seasonal Limitations

Do not apply thermoplastic pavement markings on existing or new pavements unless the ambient air temperature and the temperature of the pavement is 50°F or higher.

Do not apply thermoplastic pavement markings between the dates specified below:

East of I-95	December 15 and the following March 16
East of I-77 to and including I-95	November 30 and the following April 1
West of and including I-77	November 15 and the following April 16

Exception to the above: When traffic is maintained on a portion of roadway and thermoplastic pavement marking will not be placed within 30 calendar days due to seasonal limitations, place pavement marking paint and beads in accordance with Subarticle 1205-8(C).

(C) Application

Use only thermoplastic markings that are of the hot, machine applied type. Apply thermoplastic pavement markings by extrusion methods only. Extrusion may be accomplished using either conventional extrusion equipment or ribbon gun extrusion devices.

The stem portion of straight arrows shall be applied in a single pass and the stem portion of turn arrows is to be applied in no more than 2 passes of the application equipment. Arrowheads may be applied by multiple passes of the application equipment, not to exceed 3 passes.

Apply reflective media uniformly to the surface of the molten thermoplastic material so the beads and highly reflective media are partially embedded and at a rate recommended by the manufacturer to obtain the minimum reflectance values. For highly reflective markings, a double drop system consisting of reflective media is required. Produce in place markings with minimum retroreflective values shown in Table 1205-2, as obtained with a Department approved mobile or handheld retroreflectometer. Retroreflective measurements will be taken within 30 days after final placement of the pavement marking.

TABLE 1205-2
MINIMUM REFLECTOMETER REQUIREMENTS FOR THERMOPLASTIC

Item	Color	Reflectivity
Standard Glass Beads	White	375 mcd/lux/m^2
	Yellow	250 mcd/lux/m^2
Highly Reflective Media	White	800 mcd/lux/m^2
	Yellow	600 mcd/lux/m^2

Ensure that the marking is uniformly retroreflective upon cooling and has the ability to resist deformation caused by traffic throughout its entire length.

A thin layer of interim pavement marking paint at the proper width may be placed before installing the thermoplastic markings. If this option is chosen, when not specified in the plans or by the Engineer, direct payment for the paint will not be made. Cover any such thin layer of pavement marking paint with thermoplastic pavement marking within 30 calendar days of placement. Apply the thin layer of pavement marking paint and beads at the rate necessary to produce a dry film thickness of 5 to 8 mils. Apply reflective media at a rate per manufacturer's recommendation in order to obtain required retroreflectivity shown in Table 1205-6.

Provide drainage openings at intervals of 250 feet in edge lines placed on the inside of curves and in edge lines on the low side of tangents. Provide openings that are no more than 12 inches and at least 6 inches in length.

Produce a cross-sectional thickness of the thermoplastic markings above the surface of the pavement in accordance with Table 1205-3.

TABLE 1205-3
THICKNESS REQUIREMENTS FOR THERMOPLASTIC

Thickness	Location
240 mils	In-lane and shoulder-transverse pavement markings (rumble strips). These markings may be placed in 2 passes.
90 mils	Center lines, skip lines, transverse bands, mini-skip lines, characters, bike lane symbols, crosswalk lines, edge lines, gore lines, diagonals and arrow symbols.

(D) Observation Period

In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for minimum retroreflective values for a 30-day period beginning upon the Engineer's acceptance of all markings on the project. Guarantee retroreflective values of the markings during the 30-day period under the payment and performance bond in accordance with Article 105-17.

1205-5 POLYUREA

(A) Weather Limitations and Seasonal Limitations

Do not apply polyurea pavement markings on existing or new pavements unless the ambient air temperature and the temperature of the pavement is 40°F or higher.

Do not apply polyurea pavement marking between November 15 and the following February 28 unless the surface is free from winter surface treatment applications.

(B) Application

Install polyurea pavement marking lines that have a minimum dry thickness of 30 mils.

Using the polyurea application equipment, apply the pavement marking materials simultaneously. Apply the polyurea resin, mixed at the proper ratio according to the manufacturer's recommendations, to the pavement surfaces within the proper application temperatures as determined by the material manufacturer. Inject reflective media into the molten (liquid) polyurea pavement markings. For double drop systems the two reflective media shall be dropped separately.

Wait at least 15 days before applying polyurea on new asphalt. Place a thin layer of pavement marking paint at the proper width before applying the polyurea markings during the 15 day waiting period. Apply the thin layer of pavement marking paint and beads at the rate necessary to produce a dry film thickness of 5 to 8 mils. Apply reflective media at a rate per manufacturer's recommendation in order to obtain required retroreflectivity shown in Table 1205-6. Direct payment for the pavement marking paint will not be made. Cover any such thin layer of paint with polyurea pavement marking within 30 calendar days of placement. If paint is placed on concrete before applying polyurea, remove 100% of the paint before installing polyurea.

Apply reflective media uniformly to the surface of the polyurea material so that the reflective media are partially embedded and at a rate recommended by the manufacturer to obtain the minimum reflectance values. Produce in place markings with minimum retroreflective values shown in Table 1205-4, as obtained with a Department approved mobile or handheld retroreflectometer. Retroreflective measurements will be taken within 30 days after final placement of the pavement marking.

Produce marking that, upon curing, is uniformly reflectorized and has the ability to resist deformation caused by traffic throughout its entire length.

(C) Observation Period

In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for minimum retroreflective values for a 30-day period beginning upon the Engineer's acceptance of all markings on the project. Guarantee retroreflective values of the markings during the 30-day period under the payment and performance bond in accordance with Article 105-17.

TABLE 1205-4 MINIMUM REFLECTOMETER REQUIREMENTS FOR POLYUREA		
Item	**Color**	**Reflectivity**
Reflective Media	White	375 mcd/lux/m^2
	Yellow	250 mcd/lux/m^2

The installer may choose to use an AASHTO Type 4/Type 1 or AASHTO Type 3/Type 1 double drop system, but no price adjustment will be made, and these systems will be incidental to the polyurea pavement marking.

1205-6 COLD APPLIED PLASTIC

(A) Application Equipment

Use mechanical application equipment, defined as a mobile pavement marking machine specifically designed for use in applying pressure sensitive pavement marking tape of varying widths up to 12 inches. Use an applicator equipped with rollers to provide initial adhesion of the preformed, pressure sensitive marking tape with the pavement surface. Symbols and legends may be tamped by hand but shall be rolled with a weighted roller as per the manufacturer's recommendations. Tamp the cold applied plastic pavement marking material with a 200 lb. weighted roller as per the manufacturer recommendations.

Surface preparation adhesive may be required depending on the type of cold applied plastic. Refer to the manufacturers' specifications before applying cold applied plastic.

Most overlay tape installations should be conducted at an ambient air temperature of 60°F and rising and a surface temperature of 70° F with an overnight temperature at least 40°F the night before application. Check the manufacturer's specifications for actual requirements. Install cold applied plastic pavement markings at ambient air temperature and pavement surface temperature per manufacturer's specifications. Wait at least 24 hours after a rain before applying cold applied plastic pavement marking.

Cold applied plastic pavement markings shall be between 15 to 90 mils thick.

(B) Types of Cold Applied Plastic

At the time of installation, cold applied plastic pavement markings shall meet Table 1205-5.

TABLE 1205-5 REFLECTOMETER REQUIREMENTS FOR COLD APPLIED PLASTIC TAPE		
Type	**Color**	**Reflectivity**
Type 1 - Permanent Standard Tape	White	400 mcd/lux/m^2
	Yellow	300 mcd/lux/m^2
Type 2 - Permanent High Performance Tape	White	500 mcd/lux/m^2
	Yellow	300 mcd/lux/m^2
Type 3 - Permanent Wet Reflective High Performance Tape (Wet)	White	250 mcd/lux/m^2
	Yellow	200 mcd/lux/m^2
Type 3 - Permanent Wet Reflective High Performance Tape (Dry)	White	500 mcd/lux/m^2
	Yellow	300 mcd/lux/m^2
Type 4 - Removable Tape	White	700 mcd/lux/m^2
	Yellow	400 mcd/lux/m^2

Type 3 wet reflective tape shall meet Table 1205-5 retroreflective values, both wet and dry. The value measured under wet conditions shall be measured in accordance with ASTM E1710 when using a portable retroreflectometer and in accordance with ASTM E2177. If the Contractor elects to use Type 3, Type 3 will be paid for as Type 2.

(C) Observation Period

In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for minimum retroreflective values for a 30-day period beginning upon the Engineer's acceptance of all markings on the project. Guarantee retroreflective values of the markings during the 30-day period under the payment and performance bond in accordance with Article 105-17.

1205-7 HEATED-IN-PLACE THERMOPLASTIC

(A) Application Equipment

Apply heated-in-place thermoplastic using a propane blow torch and other material as recommended by the manufacturer.

(B) Weather Limitations

Apply heated-in-place thermoplastic only when ambient air temperature and pavement surface temperature is 40°F and rising.

(C) Applications

Apply heated-in-place thermoplastic on asphalt or concrete per manufacturer's specifications. The manufacturer shall certify the installer of heated-in-place thermoplastic.

Install heated-in-place thermoplastic in lane route shields that are capable of adhering to both asphalt and concrete pavements. Installation shall be in accordance with manufacturer's specifications.

Use a one part primer sealer when installing heated-in-place thermoplastic on concrete.

The Contractor may choose to use heated-in-place thermoplastic symbols, characters and transverse lines instead of molten thermoplastics pavement markings.

Produce a cross sectional thickness of installed heated-in-place thermoplastic markings above the surface of the pavement after installation and upon cooling in accordance with Table 1205-3.

For initial minimum retroreflective value requirements, see Subarticle 1205-4(C).

(D) Observation Period

In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for minimum retroreflective values for a 30-day period beginning upon the Engineer's acceptance of all markings on the project. Guarantee retroreflective values of the markings during the 30-day period under the payment and performance bond in accordance with Article 105-17.

1205-8 PAINT

(A) Application Equipment

The equipment to apply paint to pavements shall be a truck mounted pneumatic or airless spray machine with suitable arrangements of atomizing nozzles and controls to obtain the specified markings. Paint pavement markings application equipment shall be capable of placing double solid lines, single solid lines, intermittent skip lines or a combination of solid and intermittent skip lines in a single pass. This equipment shall also have an internal timing mechanism for measurement and controlled output of required line lengths.

The paint applicator equipment shall have at least two paint tanks with a minimum 60 gal capacity and one tank for glass beads with at least 500 lb. capacity. The spray guns used for hand held paint pavement marking application shall be operable from the application

truck. All metal parts that hold or transfer paint pavement marking material shall be stainless steel. The paint trucks shall be equipped with quick action valves. The required gauges and pressure regulators shall be conveniently located and in full view and reach of the operator. Paint strainers are required in paint supply lines.

The paint applicator shall be equipped with a dispenser for the reflective media as described in Subarticle 1205-3(B)(2). Provide a reflective media dispenser that operates automatically and simultaneously with the paint applicator through the same mechanism and that is capable of adjustment and designed to provide uniform flow over the full length and width of the stripe as specified in Subarticle 1205-3(G)(2).

Provide spray guns for hand application of detail markings, symbols and legends. A hand operated push type applicator with a glass bead dispenser may be used for radii and parking spaces.

(B) Weather Limitations

Apply paint only when the ambient air temperature and pavement surface temperatures are at least 40°F and rising and no more than 160°F.

(C) Application

Final pavement marking applications of paint shall be placed in 2 applications of 15 mils wet each. Apply the second application of paint upon sufficient drying time of the first. Each application of paint shall consist of reflective media applied at a rate to immediately obtain the minimum retroreflective values.

When paint is required by the Engineer or Traffic Control Plan for temporary pavement markings during temporary traffic patterns, apply one application of paint at 15 mils wet. If the temporary traffic pattern will last longer than 6 months, apply a second application of paint 6 months after the initial application. Additional applications of paint at 15 mils wet may be applied every 6 months as directed by the Engineer or Traffic Control Plan.

For each 15 mil application of paint, apply reflective media uniformly to the surface of the paint material at a rate to immediately obtain the minimum retroreflective values. At the time of installation, produce in-place markings with the minimum retroreflective values shown in Table 1205-6, as obtained with a Department approved 30 m mobile or handheld retroreflectometer. Maintain the retroreflective values shown in Table 1205-6 for at least 30 days from the time of placement of the marking material.

TABLE 1205-6
REFLECTOMETER REQUIREMENTS
FOR PAINT

Item	Color	Reflectivity
Standard Glass Beads	White	225 mcd/lux/m^2
	Yellow	200 mcd/lux/m^2

Make sure that the marking is uniformly retroreflectorized upon drying.

(D) Observation Period

In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for minimum retroreflective values for a 30-day period beginning upon the Engineer's acceptance of all markings on the project. Guarantee retroreflective values of the markings during the 30-day period under the payment and performance bond in accordance with Article 105-17.

1205-9 MAINTENANCE

Replace pavement markings that prematurely deteriorate, fail to adhere to the pavement, lack reflectorization or are otherwise unsatisfactory during the life of the project or during the 12 month observation period as determined by the Engineer.

Upon notification from the Engineer, winterize the project by placing an initial or additional application of paint pavement marking lines in accordance with Article 1205-8.

1205-10 MEASUREMENT AND PAYMENT

____ *Pavement Marking Lines* will be measured and paid as the actual number of linear feet of pavement marking lines satisfactorily placed and accepted by the Engineer. In addition, *Paint Pavement Marking Lines* will be paid per linear foot for each 15 mil application placed in accordance with Subarticle 1205-8(C). The quantity of solid lines will be the summation of the linear feet of solid line measured end-to-end of the line. The quantity of skip or broken lines will be the summation of the linear feet derived by multiplying the nominal length of a line by the number of marking lines satisfactorily placed.

____ *Pavement Marking Symbols* will be measured and paid as the actual number of pavement marking symbols satisfactorily placed and accepted by the Engineer. In addition, *Paint Pavement Marking Symbols* will be paid for each 15 mil application placed in accordance with Subarticle 1205-8(C).

____ *Pavement Marking Characters* will be measured and paid as the actual number of characters satisfactorily placed and accepted by the Engineer. A character is considered to be one letter or one number of a word message. In addition, *Paint Pavement Marking Characters* will be paid for each 15 mil application placed in accordance with Subarticle 1205-8(C).

In Lane Route Shields will be measured and paid for in units of each that have been satisfactorily placed and accepted by the Engineer.

Removal of Pavement Marking Lines will be measured and paid as the actual number of linear feet of pavement marking lines satisfactorily removed and accepted by the Engineer. The quantity of solid lines will be the summation of the linear feet of solid line measured end-to-end of the line. The quantity of skip or broken lines will be the summation of the linear feet derived by multiplying the nominal length of a line by the number of marking lines satisfactorily removed. No payment will be made for the removal of removable pavement marking tape.

Removal of Pavement Marking Symbols & Characters will be measured and paid as the actual number of pavement marking symbols and characters satisfactorily removed and accepted by the Engineer.

Curing Compound Removal, Lines will be measured and paid as the actual number of linear feet of pavement surface from which the curing compounds are satisfactorily removed. All other surface preparation will be incidental to the work covered by this section. Measurement will be made along the surface of the pavement.

Curing Compound Removal, Symbols & Characters will be measured and paid as the actual number of symbols and characters for which the curing compound has been satisfactorily removed. All other surface preparation will be incidental to the work covered by this section.

Payment at the contract unit price for the various items in the contract will be full compensation for all the items covered by this section. No direct payment will be made for: the work involved in applying the lines, including surface preparation; reapplication of molten pavement marking crossed by a vehicle; removal of all pavement marking materials spilled on the roadway surface; and repair of markings tracked by a vehicle.

Premarking will be incidental to other items in the contract. Unless directed by the Engineer, there will be no direct payment for interim paint. No direct payment will be made for black paint or tape.

The 5 to 8 mils of paint installed before placing the polyurea will be incidental to the work of this section.

The Contractor may choose to use heated-in-place thermoplastic symbols, characters and transverse lines instead of molten thermoplastics pavement markings and cold applied plastic at no additional cost to the Department.

Replacement of pavement markings that prematurely deteriorated, failed to adhere to the pavement, lacked reflectorization or were otherwise unsatisfactory during the life of the project or during the 12 month observation period as determined by the Engineer will be at no cost to the Department.

Payment for *Paint Pavement Marking Lines* required to winterize the project will be made in accordance with Article 1205-10 except that no payment will be made on resurfacing projects where paving is completed more than 30 days before the written notification by the Department that winterization is required.

Payment will be made under:

Pay Item	Pay Unit
Paint Pavement Marking Lines, __"	Linear Foot
Thermoplastic Pavement Marking Lines, __", __ mils	Linear Foot
Polyurea Pavement Marking Lines; __", __ mils	Linear Foot
Cold Applied Plastic Pavement Marking Lines, Type ____ (__")	Linear Foot
Heated-In-Place Thermoplastic Pavement Marking Lines, __", __ mils	Linear Foot
Paint Pavement Marking Symbols	Each
Thermoplastic Pavement Marking Symbols, __ mils:	Each
Cold Applied Plastic Pavement Marking Symbols, Type ____	Each
Heated-In-Place Thermoplastic Pavement Marking Symbols, __ mils	Each
Paint Pavement Marking Characters	Each
Thermoplastic Pavement Marking Characters, __ mils	Each
Cold Applied Plastic Pavement Marking Characters, Type _____	Each
Heated-In-Place Thermoplastic Pavement Marking Characters __ mils	Each
In Lane Route Shields	Each
Removal of Pavement Marking Lines, __"	Linear Foot
Removal of Pavement Marking Symbols & Characters	Each
Curing Compound Removal, Lines	Linear Foot
Curing Compound Removal, Symbols & Characters	Each

SECTION 1250
PAVEMENT MARKERS GENERAL REQUIREMENTS

1250-1 DESCRIPTION

Furnish and place pavement markers in accordance with the contract.

1250-2 MATERIALS

(A) General

Refer to Division 10.

Item	Section
Pavement Markers	1086

(B) Material Qualifications

Use pavement markers that are on the NCDOT APL.

1250-3 CONSTRUCTION METHODS

(A) Weather Limitations

Do not install pavement markers or replacement reflectors if moisture tests performed on the pavement indicate the presence of moisture on the pavement surface or on the pavement marker. Install all pavement marker adhesives as required by the manufacturer's specifications for weather and temperature limitations.

(B) Preparing for installation

Ensure that the pavement, pavement markers and replacement lens are free of dirt, dust, oil, grease, moisture, curing compound, loose or unsound layers or any other material that would interfere with proper bonding of the marker to the pavement or the lens to the marker. Use methods approved by the Engineer for this preparation.

(C) Removal of Existing Pavement Markers

Remove the existing raised pavement markers or the snowplowable pavement markers including the housings, before overlaying an existing roadway with pavement. Repair the pavement by filling holes as directed by the Engineer.

When traffic patterns are changed in work zones due to construction or reconstruction, remove all raised pavement markers or snowplowable markers including housings that conflict with the new traffic pattern before switching traffic to the new traffic pattern. Unless behind barrier, any pavement marker or snowplowable marker within 6 feet of the new traffic pattern markings shall be considered conflicting. Total housing removal shall occur for snowplowable markers inside or within 2 feet of a travel lane.

Properly dispose of the removed pavement markers. No direct payment will be made for removal or disposal of existing pavement markers or repair of pavement, as such work will be incidental to other items in the contract.

(D) Installation

(1) General

Install all pavement markers and adhesives per manufacturer's specifications.

(2) Color

Ensure that the color of the reflector corresponds to the pavement marking that the marker supplements. Red reflectors may be required in combination with crystal or yellow reflectors to indicate wrong way movement when viewed in the direction opposing the flow of traffic.

(3) Appearance

Remove any adhesive from the reflective lens of the marker; otherwise, replace the reflector lenses of a snowplowable pavement marker or the entire raised pavement marker.

(4) Spacing

Space pavement markers as shown in the plans. Position pavement marker lenses perpendicular to the flow of traffic as shown in the *Roadway Standard Drawings*. Adjust marker longitudinal spacing up to 1 foot in either direction and/or adjust marker lateral spacing up to 3 inches to avoid installation of the marker at a pavement construction joint or surface defect. If a marker cannot be relocated as described above, do not install the affected marker.

(E) Pavement Marker Installer Qualifications

Ensure at least one member of every pavement marker crew is certified through the NCDOT Pavement Marking Technician Certification Process. Keep the certification current throughout the life of the project. A certified crewmember shall be present anytime this work is being performed. The certified crewmember is not required to be the same person throughout the life of the contract.

SECTION 1251
RAISED PAVEMENT MARKERS

1251-1 DESCRIPTION

Furnish, install, maintain and remove temporary and permanent raised pavement markers in accordance with the contract.

1251-2 MATERIALS

Refer to Division 10.

Item	Section
Temporary Raised Pavement Markers	1086-1
Permanent Raised Pavement Markers	1086-2

Use pavement markers that are on the NCDOT APL.

1251-3 CONSTRUCTION METHODS

Install temporary raised pavement markers on the nonfinal pavement surfaces with epoxy, pressure sensitive adhesives or hot bitumen adhesives.

Install permanent raised pavement markers using a hot bitumen adhesive in accordance with Article 1081-3.

On final pavement surfaces, install temporary raised pavement markers using a pressure sensitive adhesive or hot bitumen adhesive. When using a pressure sensitive adhesive, install per the manufacturer's specifications.

1251-4 MAINTENANCE

Maintain all installed temporary raised pavement markers. Replace all damaged or missing temporary raised pavement markers if any of the following occurs:

(A) Three segment failures occur in any roadway section. Three consecutive damaged or missing markers in any group of 7 represents a segment failure.

(B) Twenty percent of the markers in any roadway section are damaged or missing.

(C) Engineer determines replacement is necessary.

Maintain all installed permanent raised pavement markers until final acceptance of the project.

1251-5 MEASUREMENT AND PAYMENT

Temporary Raised Pavement Markers will be measured and paid as the actual number of temporary raised pavement markers satisfactorily placed and accepted by the Engineer.

Permanent Raised Pavement Markers will be measured and paid as the actual number of permanent raised pavement markers satisfactorily placed and accepted by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Temporary Raised Pavement Markers	Each
Permanent Raised Pavement Markers	Each

SECTION 1253
SNOWPLOWABLE PAVEMENT MARKERS

1253-1 DESCRIPTION

Furnish, install and maintain snowplowable pavement markers in accordance with the contract.

1253-2 MATERIALS

Refer to Division 10.

Item	Section
Snowplowable Pavement Markers	1086-3
Epoxy	1081

Use snowplowable pavement markers that are on the NCDOT APL.

1253-3 CONSTRUCTION METHODS

(A) General

Bond marker housings to the pavement with epoxy adhesive. Mechanically mix and dispense epoxy adhesives as required by the manufacturer's specifications. Place the markers immediately after the adhesive has been mixed and dispensed.

Install snowplowable pavement marker castings into slots sawcut into the pavement. Make slots in the pavement to exactly duplicate the shape of the casting of the snowplowable pavement markers.

If saw cutting, milling, or grooving operations are used, promptly remove all resulting debris from the pavement surface. Install the marker housings within 7 calendar days after saw cutting , milling, or grooving the pavement. Remove and dispose of loose material from the slots by brushing, blow cleaning or vacuuming. Dry the slots before applying the epoxy adhesive. Install non-cast iron snowplowable pavement markers according to the manufacturer’s recommendations.

Protect the non-cast iron snowplowable pavement markers until the epoxy has initially cured and is track free.

(B) Reflector Replacement

In the event that a reflector is damaged, replace the damaged reflector by using adhesives and methods recommended by the manufacturer of the markers and approved by the Engineer. This work is considered incidental if damage occurs during the initial installation of the marker housings and maintenance of initial non-cast iron snowplowable markers specified in this section. This work will be paid for under the pay item for the type of reflector replacement if the damage occurred after the initial installation of the non-cast iron snowplowable pavement marker.

If during reflector replacement it is discovered that the housing is missing or broken this will be paid as *Non-Cast Iron Snowplowable Pavement Markers*. Missing housings shall be replaced. Broken housings shall be removed and replaced. In both cases the slot for the housings shall be properly prepared prior to installing the new housing; patch the existing marker slots as directed by the Engineer and install the new marker approximately one foot before or after the patch. Removal of broken housings and preparation of slots will be considered incidental to the work of replacing housings.

(C) Recycled Snowplowable Pavement Marker Housings

Use properly refurbished snowplowable pavement marker housings as approved by the Engineer such that approved new reflectors can be installed inside the housings.

1253-4 MAINTENANCE

Maintain all installed non-cast iron snowplowable raised pavement markers before acceptance by the Engineer.

1253-5 MEASUREMENT AND PAYMENT

Non-Cast Iron Snowplowable Pavement Markers will be measured and paid as the actual number of non-cast iron snowplowable pavement markers satisfactorily placed and accepted by the Engineer.

Replace Snowplowable Pavement Marker Reflector will be measured and paid for in units of each that have been satisfactorily placed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Non-Cast Iron Snowplowable Pavement Marker	Each
Replace Snowplowable Pavement Marker Reflector	Each

SECTION 1264
OBJECT MARKERS

1264-1 DESCRIPTION

Furnish and install object markers in accordance with the contract.

1264-2 MATERIALS

Refer to Division 10.

Item	Section
Object markers	1088-4
U-channel posts	1094-1(B), 1094-1(C)
Hot Applied Joint Sealer	1028-2

Use object markers that are on the NCDOT APL.

1264-3 CONSTRUCTION METHODS

Use Type 1 object markers to mark obstructions within the roadway. Mount on sign supports to supplement a sign, or mount individually on 7 foot U-channel posts, or mount on the actual obstruction.

Use Type 2 object markers to mark obstructions that are not in the roadway. Mount Type 2 object markers on the back of sign supports located in the median of divided roadways, and the outside of two-lane, two-way roadways where the sign is facing the opposing traffic direction. Place Type 2 object markers on the side nearest the traffic approaching the back of the sign supports. If guardrail is used to protect the sign supports, or where 2 signs are mounted back to back, Type 2 object markers are not required.

Use Type 3 object markers to mark larger obstructions within or outside the roadway, such as bridge piers, abutments, rails, culvert headwalls or narrow shoulder drop-offs. Ensure the stripes slope downward toward the side of the obstruction on which traffic is to pass. They may be required to be mounted on the actual obstruction or individually on 7 foot U-channel posts.

Mount end of road object markers on 7 foot U-channel posts at the end of a roadway where there is no alternate vehicular path.

1264-4 MEASUREMENT AND PAYMENT

Object Markers (Type ____) will be measured and paid as the actual number of object markers satisfactorily placed and accepted by the Engineer.

7' U-Channel Posts will be measured and paid as the actual number of 7 foot U-channel posts satisfactorily placed and accepted by the Engineer.

Payment will be made under:

Pay Item	Pay Unit
Object Markers (Type 1)	Each
Object Markers (Type 2)	Each
Object Markers (Type 3)	Each
Object Markers (End of Road)	Each
7' U-Channel Posts	Each

SECTION 1266
TUBULAR MARKERS (FIXED)

1266-1 DESCRIPTION

Furnish, install, relocate, maintain and remove tubular markers in accordance with the contract.

1266-2 MATERIALS

Refer to Division 10.

Item	Section
Tubular Markers	1088-5

Use tubular markers that are on the NCDOT APL.

1266-3 CONSTRUCTION METHODS

Install tubular markers to the pavement surfaces per the manufacturer's specifications.

Use tubular markers affixed to pavement surfaces as a supplement to pavement markings to channelize traffic. Use tubular marker such that the color of the tubular marker and retroreflective sheeting would match the color of the pavement markings they supplement, except as noted below:

(A) Use yellow tubular markers with white retroreflective sheeting on top of asphalt islands as shown in the plans.

(B) Gray or white tubular markers with white retroreflective sheeting may be used to supplement white pavement markings.

1266-4 MAINTENANCE

Inspect and replace any worn out tubular markers at no cost to the Department.

Inspect and replace all damaged or missing tubular markers if any of the following occurs in accordance with Article 1266-5:

(A) Three segment failures occur in any roadway section. Two consecutive damaged or missing tubular markers in any group of 7 represents a segment failure

(B) Twenty percent of the total numbers of tubular markers in any roadway section are damaged or missing.

(C) Engineer determines replacement is necessary.

1266-5 MEASUREMENT AND PAYMENT

Tubular Markers (Fixed) will be measured and paid as the maximum number of tubular markers satisfactorily placed and accepted by the Engineer at any one time during the life of the project.

Payment will be made under:

Pay Item	Pay Unit
Tubular Markers (Fixed)	Each

SECTION 1267
FLEXIBLE DELINEATORS

1267-1 DESCRIPTION

Furnish and install flexible delineators in accordance with the contract.

1267-2 MATERIALS

Refer to Division 10.

Item	Section
Flexible Delineators	1088-6

Use flexible delineators that are on the NCDOT APL.

1267-3 CONSTRUCTION METHODS

Use yellow, red or white retroreflective sheeting as shown in the plans. Place the retroreflective sheeting on the front and back of the delineator post as required by the plans.

Install the delineator post so that the entire width of the retroreflective sheeting is visible to approaching traffic.

Install the delineator post so the top of the reflective sheeting is 48 inches above the near edge of roadway surface.

Install the delineator post and base support according to the manufacturer's specifications.

Install the flexible delineators plumb on all sides.

Provide a post such that both sides of the top of the post accepts and holds securely, retroreflectorized sheeting. The color of the post shall be gray.

Install the post such that the post length provides for adequate ground penetration for proper performance.

Attach the flexible delineator post to the base support using 2 hex head bolts, flat washers, lock washers and deformed thread hex nuts. Tighten the bolts to at least 20 foot-pound torque.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in median and on the left side of one-way ramps, loops or other one-way facilities. Use white delineators on the right side of divided highways, ramps, loops and all other one-way or two-way facilities. In all cases, use delineators whose colored retroreflective sheeting supplements the color of the adjacent edgeline.

Design the delineator post for a permanent installation to resist overturning, twisting and displacement from wind and impact forces.

1267-4 MAINTENANCE

Maintain all installed flexible delineators before acceptance by the Engineer.

1267-5 MEASUREMENT AND PAYMENT

Flexible Delineators (color) will be measured and paid as the actual number of flexible delineators satisfactorily installed and accepted by the Engineer.

Section 1267

1 Payment will be made under:

Pay Item	Pay Unit
Flexible Delineator (White)	Each
Flexible Delineator (Yellow)	Each
Flexible Delineator (White and Red)	Each
Flexible Delineator (Yellow and Red)	Each

DIVISION 14
LIGHTING

SECTION 1400
ROADWAY LIGHTING

1400-1 DESCRIPTION

Furnish, install, connect and place into satisfactory operating condition lighting at locations shown in the plans. Perform all work in accordance with the contract and the National Electrical Code.

This Division is for methods, materials and equipment to construct and put in working order the proposed lighting; however, every fitting, minor detail, or feature may not be fully shown or described. The Contractor shall be an expert in the trade, capable of understanding the intent of the contract and constructing the lighting and electrical system(s) in accordance with the best practice of the trade.

The Contractor actually performing the work described in the contract shall comply with NCGS § 87, Article 4, Electrical Contractors and have a license of the proper classification from the North Carolina State Board of Examiners of Electrical Contractors.

Have the licensed Contractor available on the job site as necessary when work is being performed or when requested by the Engineer. Have this Contractor possess a set of project plans and specifications on the job site and maintain a set of accurate as built plans. This Contractor shall be qualified to responsibly instruct and direct all employees regarding the electrical work.

1400-2 MATERIALS

Refer to Division 10.

Item	Section
Conduit	1091-3
Ground Rod	1091-6
Wire	1091-2

(A) General

All materials used in the work are to be new materials unless noted elsewhere in the contract. Provide materials that are labeled or listed by an acceptable organization that maintains periodic inspection by a qualified testing laboratory, of the production of the materials and verifies, by the labeling or listing procedure, that the materials comply with appropriate standards of performance or are suitable for use in a specified manner. Provide Underwriters' Laboratories (UL) labeled and listed materials when such labeling and listing is available for such materials. Refer to the North Carolina Department of Insurance, Office of State Fire Marshal for other suitable qualified testing laboratories.

Make sure that materials are in compliance with requirements for use of domestic products, as specified in other sections of the *Standard Specifications*.

(B) Conduit

Use conduit and duct that is either metallic (Rigid Metallic Conduit) or non-metallic (PVC or HDPE), as noted in the plans.

(C) Wire

Use wire and cable which conforms to Insulated Cable Engineers Association (ICEA) specifications and has marks for identification (manufacturer's name, type insulation and gauge of conductor) and the UL label.

Use wire insulation rated at 600 VAC or greater.

Use the following types of wiring unless noted otherwise in the plans:

Service Lateral	UL Type USE
Control System	UL Type THW or RHW or THHN
Feeder Circuits in Conduit	UL Type USE
Branch Circuits in Light Standards	UL Type SOOW Cable
Equipment Grounding Conductor	Solid MHD, Bare or Insulated
Grounding Electrode Conductor	ASTM B2

Use #6 AWG for the grounding electrode conductor unless noted larger in the plans.

(D) Grounding and Bonding Equipment

All grounding and bonding equipment shall conform to UL Standard 467. Use ground rods in accordance with Article 1091-6.

(E) Fuseholders

Provide fused overcurrent protection in the base of each light standard and other locations as noted. Use a fuseholder rated at least 600 VAC and 30 A approved for wet locations, constructed so the fuse will be disconnected from the line side power every time the fuseholder is opened. The fuseholder may be made of molded plastic or rubber and have insulating boots. Use terminals which are specifically rated for the size and number of conductors required.

Use fuses which have 5,000 A minimum interrupting capacity at the supply voltage, are rated 10 A or as noted in the plans and are not glass type unless specified different in the contract. Use the same type fuse in all fuseholders on a project unless specified differently at specified locations.

Use fuseholders specifically designed as breakaway devices in fiberglass standards and standards with breakaway bases. Use fuseholders designed to disconnect line side power without damage to the terminals or conductors every time sufficient pulling force is placed on the line and load side conductors. Fuseholders with plastic locking tabs are prohibited.

(F) Hardware

Use mounting or attachment hardware including bolts, nuts, washers, straps, clamps and hangers which is made of stainless steel, hot dipped galvanized or of equal corrosion resistance. Use bolts, which are minimum length and are not less than one nominal size smaller than the opening being used.

(G) Duct and Conduit Sealer

Use duct and conduit sealer or mastic which is a putty-like compound and complies with the following:

(1) Is permanently non-hardening, non-oxidizing and non-corrosive to metals, rubber, plastic, lacquer and paints;

(2) Is readily workable for thumbing into openings and forming into seals around wires inside conduits and openings around conduits;

(3) Has a service temperature range of minus 30°F to 200°F;

(4) Is clean, non-poisonous and non-injurious to human skin; and

(5) Seals against water, dust and air and shall adhere to wood, glass, plastics, metal, rubber and painted surfaces.

(H) Pull Lines

Place pull lines specifically designed for pulling a rope in all empty conduits and electrical duct so that electrical circuits can be installed in the future. Use pull lines which are 2 ply with a tensile strength of at least 240 lb. and resistant to tangling, rot and mildew.

1400-3 SUBMITTALS

(A) Catalog Cuts and Working Drawings

Electronically submit catalog cuts and/or shop drawings for materials proposed for use on the project per Sections 105 and 106. Do not deliver materials which have not been approved to the project. Each material catalog cut and/or shop drawing shall show the description, brand name, stock-number, size, rating, manufacturing specification and the intended use.

The approved submittals will be returned to the Contractor by the Engineer. Present a catalog cut or shop drawing for all components of each contract item. Electronic submittals shall be legible with the intended item clearly marked, and arranged in the same order as the contract bid items.

(B) Certifications

Furnish a Type 3 material certification in accordance with Article 106-3 for light standards, high mounts and lowering devices and a Type 6 material certification for conductors. Submit certifications when the above materials are delivered to the project.

Type 3 or Type 6 material certifications in accordance with Article 106-3 may be requested for any or all of the other material which does not have a name plate showing sufficient information to verify that the material was manufactured to the requirements of this section.

(C) Samples

Random samples may be taken of the various items for the purpose of verifying conformance with the plans and specifications. The selection of the items to be sampled and the taking of the samples will be done by the Engineer.

Failure to meet specification requirements by two samples of any material will be sufficient reason for rejection of all materials from the same lot.

Upon request, there will be reimbursement for the actual verified cost of such material taken as samples, including any handling charges less any discount allowed on the invoice, but with no percentage added, and such material will thereafter become the property of the Department.

(D) As-Built Plans

Submit one complete set of electronic as-built plans to the Engineer for review upon completion of the work, showing the location of all buried electrical circuits, with pavement crossings dimensioned from fixed objects or from survey stations.

Include in the as-built plans the title (No. 1), index (No. 1A), summary of quantities (No. 3) and all of the lighting layout and detail (E) sheets of the project with all changes indicated. After review and approval, place one set of these as-built plans in a waterproof envelope and file in each control panel and submit an electronic copy to the Engineer.

Show the light standard foundations that are relocated on the as-built plans in their final locations.

Keep a daily record of the location of all items in order to ensure the accuracy of the as-built plans.

(E) Warranties

Turn over warranties to the Engineer from each manufacturer of electrical materials and equipment pertinent to the complete and satisfactory operation of the system before the acceptance of the project. Indicate the expiration date on each warranty furnished. The warranty shall not be less than those provided as a customary trade practice.

1400-4 CONSTRUCTION METHODS

(A) Location Surveys

All light standards, high mount foundations and electrical duct will be located unless indicated differently elsewhere in the contract. Mark the proposed location of circuits, circuit markers, control systems, service poles, junction boxes, luminaires and all other components for approval before installation.

The plan locations of the light standards and high mounts may be adjusted to be behind guardrail, to avoid obstructions or to avoid undesirable foundation conditions. Light standards can be moved no more than 10 feet longitudinally and 2 feet laterally unless approved by the Engineer. High mast light standards can be moved no more than 25 feet radially but no closer than 50 feet to the edge of travel unless approved by the Engineer. Ensure location changes are approved by the Engineer before construction. Verify project dimensions on the site with every part of the work fitted to actual conditions at the site. Actual measurement always takes precedence over scaled plan dimensions.

(B) Damage to Facilities

Take all precautions necessary to avoid damage to existing underdrains and other buried facilities. Hand trenching may be required to avoid damage to the underdrains, storm sewer systems and other facilities. Construct light pole foundations with a minimum horizontal clearance of 10 feet to storm sewers or other underground installations. If closer than 10 feet, submit light pole foundation design sealed by an engineer licensed by the State of North Carolina to the Engineer. Make lateral and longitudinal changes in pole locations in the field to provide the required clearance, as directed by the Engineer.

Trenching and construction operations may require the removal of, or result in damage to, existing shoulders and paved ditches. Restore all disturbed portions of the project to their original condition or as approved by the Engineer.

Installation of conductors may require trenching through existing guardrail locations. Trenching may be done beneath the guardrail in a manner that will not disturb the guardrail installation or the Contractor may remove short sections of guardrail to facilitate mechanical trenching. Reinstall all removed guardrail by the end of the day's work. Permission is required from the Engineer before removal of any guardrail. Repair any damage to the guardrail installation or to the galvanizing of the material as directed by the Engineer.

Repair all trenched, excavated, or otherwise damaged earth surface areas by shaping, smoothing, seeding and mulching the damaged areas as required by the specifications and as directed by the Engineer.

(C) Existing Utilities

Water, sewer, telephone, fire alarm, traffic signal and power lines may be located in the same area that light standards and circuits are to be installed.

Prior to beginning operations, locate existing utilities. Field changes approved by the Engineer may be made to provide clearance required by the NESC.

Foundations or other construction which is installed in conflict with existing utilities will not be acceptable. Remove unacceptable conflicting construction and repair damage to utilities at no cost to the Department.

When the work involves replacing or renovating existing lighting, make all reasonable efforts to prevent dark spots in the lighting system. Phase lighting construction to allow existing lighting to remain in operation as long as possible.

(D) Operation of Equipment

Use a bucket truck to raise workers into position to install and/or adjust luminaires after the initial setting of the light standards. Dismounting and lowering the light standard to check or make adjustments at the top is not allowed.

Install all bore pits outside the clear zone.

(E) Conduit Installation

Install conduit continuous, watertight, free of kinks and make all runs with as few couplings as standard lengths will permit. Do not exceed a total angle of 270° between outlets unless otherwise approved by the Engineer. Conduit bodies with covers and neoprene gaskets may be used to facilitate the installation of the wires at locations indicated in the plans.

Provide protection at all times against the entrance of water or other foreign matter into the conduit. Plug or cap conduit when work is temporarily suspended, including nightly stoppage of work.

Clean all conduits before installation and upon completion of the system. Snake an approved cleaner with a diameter not less than 85% of the nominal diameter of the conduit through each conduit before installing the wire.

Install the conduit in such a manner that temperature changes will not cause elongation or contraction that might damage the system. Provide expansion fittings where conduit crosses structure expansion joints and at other locations shown in the plans.

Avoid short radius bends in non-metallic conduit to prevent burn-through of the pulling cable or conductors during pulling operations.

Install caps or plugs on stub-outs for future use. Caps and plugs shall be made of the same material as the conduit. Where non-metallic conduit is joined to metallic conduit, use a transition adapter. Install bushings on all conduit ends projecting into panels, boxes, or other enclosures. Provide pull lines in all conduits for future installation of circuitry. Coat field cut threads and other uncoated metal or damaged galvanizing with organic zinc repair paint in accordance with Section 1076. Securely fasten conduit. Space conduit fasteners per NEC spacing requirements. Use fasteners that are hot dipped galvanized or stainless steel. Provide backs with all conduit straps installed on flat surfaces. Rotary-impact drills may be used for installing expansion anchors in concrete. Do not use powder explosion type units.

Do not install underground conduit until the area has been brought to final earth grade. Give careful attention to the vertical and horizontal alignment of the conduit to provide the smoothest installation.

(F) Wiring Methods

Do not pull wire through a conduit system until the system is complete and has been cleaned. Use lubricant that will not physically or chemically harm cable jacket, wire insulation or conduit. Pull conductors by hand, or use motorized cable-pulling equipment

designed for pulling multiple cables into conduit. Use sheaves or rollers, as required to prevent damage to conductor insulation. Use a dynamometer (clutch device) so as not to exceed maximum allowable pulling tension if conductor is pulled by mechanical means. Do not use a motorized vehicle or heavy equipment to generate pulling forces. Color code all conductors per the NEC (grounded neutral is white, grounding is bare or green) and use phase conductors which are black and red. Approved marking tape, paint, or sleeves may be used instead of continuous colored conductors for No. 8 AWG and larger. Red or black conductor may be stripped at all accessible points and used as a bare equipment grounding conductor.

Joints, taps and splices will only be permitted at locations indicated in the plans and by the following method.

Install UL Listed manufactured set screw type connectors, suitable for connecting multiple wires for all phase conductor splices. These precise fit connectors are insulated with high–strength dielectric material and have removable access plugs over the set screws. Direct buried and/or submersible versions of these connectors (UL486D), equipped with factory made waterproof insulating boots, are required for splicing inside junction boxes. Non-direct buried and/or non-submersible connectors (UL486A and UL486B) may be used for phase conductor splicing in normally dry areas such as inside poles and transformer bases. After tightening set screw, tape down the access plugs to keep them securely in place. Split-bolt connectors may be used for ground wire splicing. Wire nut and compression type connectors will not be allowed. Breakaway fuseholders are not an acceptable means of splicing in junction boxes and are not permitted for this purpose.

Cut conductor so that 3 feet of spare conductor is available for splicing from the end of each respective conduit. Neatly coil extra conductor in junction box. Position splices near the top of the junction box.

All splices inside light standards shall be easily accessible through handholes unless standard is mounted on breakaway transformer base.

(G) Grounding Electrodes

Install grounding electrodes at each light standard, high mast light standard and control system as shown in the plans. The rod shall be driven vertically until the top is 4 inches below the ground surface. The grounding conductor must be connected to the grounding electrode by an irreversible compression ground connector.

Permanently bond grounding conductor to ground rod using an irreversible compression ground connector. Unless the irreversible compression connectors are designed for use with more than one conductor, only one conductor shall be placed under each irreversible compression ground connector. Ensure all connections are made using a hydraulic, power or ratcheting type crimper with appropriate dies. Use of handheld pliers for crimping is prohibited.

For ease of inspection, the top of ground rods shall be no more than 4 inches below finished grade and shall remain exposed until electrical inspection is complete.

(H) Equipment Mounting

Mount equipment securely at locations shown in the plans in conformance with the dimensions shown and make vertically plumb and level. Install fasteners as recommended by the manufacturer and space evenly. Use all mounting holes and attachment points for attaching enclosures to structures.

(I) Base Protection

For median mounted light standards, use a protective metal shroud installed underneath the light standard base plate to protect the exposed anchor bolts and lighting circuitry

segments between the base plate and the top of the concrete median barrier. The metal shroud shall be fabricated of either galvanized steel, minimum gauge 22, or aluminum, minimum gauge 18, to match the material type of the light standard. The metal shroud shall be composed of two overlapping pieces, and attached with two self-tapping stainless steel or galvanized machine screws at each overlap point.

For high mount standard, use galvanized steel welded wire reinforcement between the top of foundation and bottom of mounting base. Attach welded wire reinforcement to anchor bolts with size AWG 14 copper wire or small gauge galvanized wire.

(J) Galvanizing Repair

Repair any damaged galvanized components in accordance with Article 1076-7.

(K) Foundations

Form foundations with prefabricated cardboard forms down to 12 inches minimum below top of ground.

To avoid vehicle undercarriage snagging of any substantial remains of a breakaway support (when it is broken away), the edge of the foundation or top of anchor bolt should not extend more than 4 inches above a 60 inch chord aligned radially to the centerline of the highway, and connecting any point within the length of the chord on the ground surface on one side of the foundation to a point on the ground surface on the other side. If this cannot be achieved due to site conditions, the Contractor shall notify the Engineer.

1400-5 ELECTRICAL INSPECTIONS AND TESTING

Comply with all local ordinances and regulations. Apply for and obtain all permits and/or licenses required by local regulation.

Provide a calibrated MegOhmMeter, with certification that calibration was done within one year of use. Provide a meter manufactured by Fluke, Amprobe, Biddle or Engineer approved equal. Present the meter for inspection, at the Pre-Lighting-Work meeting described in Article 1400-11.

During project construction perform an insulation resistance test on each feeder circuit conductor. The insulation resistance for each conductor shall exceed 5 megaohms after charging for 30 seconds at 500 VAC or 1000 VDC. The *Contractor Meg Circuit Data Form* is available on the Department website. Submit the data form to the Engineer for review before final inspection.

If the insulation resistance test of any conductor indicates a value of less than 5 megaohms, locate the fault. If the fault is in a conductor between terminal connections, replace the conductor. If the fault is at a terminal connection, repair or replace the terminal device.

Removing water from the conduit of a faulty circuit is not considered a repair. If a circuit fails the insulation resistance test and removing water allows the circuit to pass, replace the conductors and re-test the new circuit.

The following electrical inspections and tests are required:

(1) Inspection of the control panel by the authority having jurisdiction

After all control system cabinet wiring has been installed and connected in the proposed permanent manner the Contractor will contact the North Carolina Department of Insurance, Office of State Fire Marshal or local authority having jurisdiction, to perform an electrical inspection of the lighting system. Upon satisfactory testing, the Contractor will be issued a Certificate of Inspection for the lighting system. The Contractor may then arrange with the power company to provide the necessary power service. The Certificate of Inspection will be turned over to the Engineer before project acceptance.

Inspection by local authorities will neither eliminate nor supersede the final inspection by the Engineer to ensure compliance with the contract.

(2) Inspections by the Engineer

Have all work inspected and approved by the Engineer before concealment. An inspection will be made during the progress and after the work has been completed. It will also include an inspection made at night to determine the optical qualities of each luminaire. Adjust all luminaires having unsatisfactory qualities as directed by the Engineer.

Provide the necessary personnel and equipment for aiming luminaires during nighttime inspections by the Engineer.

(3) Final Inspection

Contact the Department to schedule a final inspection of lighting systems at least 2 weeks before the requested inspection date. The Lighting and Electrical personnel will perform an insulation resistance test as described above, inspect the system for adherence to contract requirements and prepare a lighting inspection memo based on the Lighting System Inspection Checklist. The inspection checklist is available on the Department's website. As-built plans are required to be submitted to the Engineer prior to the final inspection. If there is a change to the as-built plans after the final inspection, as-built plans are required to be resubmitted to the Engineer. Provide the personnel and equipment necessary for removing and replacing fuseholders and/or operating circuit breakers to facilitate the insulation resistance test performed by the Lighting and Electrical personnel.

1400-6 BURN-IN TEST

After all the issues mentioned in the lighting inspection punchlist are addressed to the satisfaction of the Engineer, the lighting system will undergo a 2 week burn-in test. The burn-in test consists of normal dusk to dawn operation of all lighting system control equipment and apparatus, without interruption or failure attributable to poor workmanship or defective material. All burn-in testing shall be performed using power from the local utility and not from mechanical generators unless approved by the Engineer. At the end of the burn-in test, all lights and equipment will be inspected for normal operation. The Contractor will make any necessary repairs or replacements at no cost to the Department.

Conduct the burn-in test at the same time for all lights which are energized from the same utility company service point.

Burn-in tests of individual circuits or groups of lights will not be acceptable.

The Contractor is responsible for all maintenance of the lighting system(s) installed or renovated as part of the contract until project final acceptance or in accordance with Article 105-17.

1400-7 IDENTIFICATION

Identify each component of the lighting/electrical system as indicated in the plans. Use a method of identification which includes an approved paint, adhesive label, heat shrink label or embossed concrete. Label conductors on components requiring identification at each terminal, circuit breaker, light standard, high mount standard, control system, junction box and underpass panel.

Identify each circuit conductor using a one piece nylon cable tie with a label at each terminal and access point. Use permanent marker to label the circuit conductor with the circuit number indicated in the plans.

Identify light standards and high mount standards by the control system and location number indicated in the plans. Put the identification on the front side of the standard facing the traffic

at a height of 6 feet above ground level. Identify control systems and underpass panels on the exterior of the front panel.

1400-8 LOCKS AND KEYS

Supply all access doors to control cabinet enclosures and high mount poles with locks that meet the Engineer's approval. Key all locks alike and furnish eight keys to the Engineer.

1400-9 ELECTRICAL SERVICE

Coordinate all work to ensure that electrical power of the proper voltage, phase, frequency and ampacity is available to complete the project. Contact the utility company, make application, pay all deposits and other costs to provide necessary electrical service. The Contractor will be reimbursed for the actual verified cost of any utility company charges.

The Engineer will provide authorization to the Contractor for electrical service to be obtained in the name of the Department and for the monthly power bills to be sent directly from the utility company to the Department. The Department will be responsible for direct payment of monthly power bills received from the utility company.

1400-10 TERMINOLOGY

The terms “High Mast” and “High Mount” are used synonymously in the contract.

The term “By Others” means work to be accomplished and paid under contract items other than those clearly pertaining to the work specified or shown. Work by others may be included in this contract for the Contractor to provide, or it may be provided under another contract or by someone other than the Contractor.

Abandon means that the materials will not be used in the final completed form of the work. Remove all abandoned materials from the project or terminate at least 18 inches below subgrade so they will not be in conflict with the finished project.

1400-11 CONSTRUCTION PHASING

Schedule a Pre-Lighting Work meeting with the Engineer before beginning work on the lighting system. Include staff members from the prime contractor and electrical sub-contractor.

Accomplish lighting work along with other roadway construction in the appropriate phases as indicated in the Transportation Management Plans and these *Standard Specifications*.

1400-12 COORDINATION OF EXISTING LIGHTING WORK

Maintain operation of the existing lighting systems until such time that they become in conflict with the actual construction work, or they become a hazard to traffic as determined by the Engineer.

Use care in working around the lights and circuitry and phase operations so that the disruption of existing lighting systems will be minimized. Make repairs or replacements in conformance with the contract. Should the Contractor fail to make such repairs within the time allowed, the Department will cause the necessary repairs to be made by others. The costs of such repairs will be deducted from any monies due the Contractor on the next subsequent monthly or final payment.

1400-13 MEASUREMENT AND PAYMENT

There will be no direct payment, except where specifically noted in Subarticle 1400-3(C) and Article 1400-9 for the work required in the preceding sections of this Division. Payment of the contract unit prices for the various items in the contract will be full compensation for all work required.

SECTION 1401
HIGH MOUNT STANDARD

1401-1 DESCRIPTION

Design, furnish and install a high mount standard 60 feet or greater in height with a top-latched lowering device and portable drive unit including the drive, winch, wiring, cables, brackets, hardware, transformer, power cord, storage case and operating manuals.

1401-2 MATERIALS

(A) High Mount Standard

Provide certified computations and fabrication drawings by an engineer licensed by the State of North Carolina.

Design the support including base plate and anchorage in conformance with the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, and the Interim Specifications as shown on the plans. Design and fabricate welds in accordance with Article 1072-18. Design the support for the wind velocity shown in the plans.

Have the drawings show all details relating to pole, access hole, base, anchorage and lowering device. Show references to ASTM specifications or to other material specifications for each type of material used on the drawings. Note the total weight in pounds on the drawings for each component and the total assembly. Make sure that all drawings are clearly identified with a drawing number and signed and dated by the manufacturer's authorized representative.

Clearly identify all welds on the working drawings utilizing welding symbols and provide all information regarding location, type, size and extent of all welds. For groove welds, indicate complete joint penetration (CJP) or partial joint penetration (PJP) groove weld requirements. Prequalified joint designations shall be in accordance with the AWS D1.1 Structural Welding Code - Steel, for the welding process to be employed during production. Submit welding procedures and procedure qualification records to the Engineer for approval before fabrication.

The standard may be either a multisided or round tubular member.

The criteria listed below shall apply to 60 feet, 80 feet, 100 feet and 120 feet high mount light poles:

(1) Provide eight or more anchor rods for each pole.

(2) Provide base plate thickness of at least 2.5 inches.

(3) Provide welded wire reinforcement for base protection that meets Subarticle 1400-4(I).

Electronically submit complete working drawings and complete design computations for each height of standard for approval by the Engineer before fabrication.

Fabricate the support in accordance with the details shown on the approved shop drawings and the specifications.

Test all base plate to upright welds using magnetic particle testing (MPT) before galvanizing. All base plates must be tested at 100%. Radiographically test the longitudinal seam welds within 6 inches of the base plate and within 6 inches of the larger end of the outer tube of the slip fit joint area.

Hot dip galvanize metalwork after fabrication has been completed. Ensure the galvanization conforms to ASTM A153 for fasteners and ASTM A123 for other

structural steel. All welds shall be abrasive blasted to an SSPC SP6 condition before galvanizing.

Partial penetration longitudinal groove welds on shaft sections, having a minimum throat of 60% of the thickness of material being joined, will be acceptable provided the qualification requirements of the Structural Welding Code - Steel, AWS D1.1 are met. However, full penetration will be required on longitudinal groove welds within 6 inches of circumferential welds and in areas where a shaft section telescopes over another shaft section. No field welding of any part of the assembly will be permitted.

Allow easy access to all components in the base of the standard with a hand hole with a hinged and lockable door. Allow for opening of the door without the use of special tools or wrenches. Make the hand hole large enough for removal of the circuit breaker and the hoist gearbox and winch assembly (at least 9 inches x 18 inches.) Make the door hinge and lock mechanism sturdy enough to prevent vandalism and to prevent freeze-up or binding due to corrosion or too tight fit. Provide locks and keys in accordance with Article 1400-8. Built-in locks or latching mechanism for the door will not be acceptable.

(B) Lowering Device

Electronically submit complete detailed drawings of the lowering device with manuals describing the assembly, erecting and operating procedures. Include precise instructions on stringing the cables and leveling the carrier ring.

Each high mount light standard shall have a device to lower the luminaires from the operating position at the top of the standard to a service position approximately 3 feet above the base of the standard. Include on the device a head-frame, top latching carrier ring and winch assembly. Design the lowering device for the number of luminaires as shown in the plans. Maximum high mast luminaire weight and effective projected area are shown in the specifications.

Mount the head frame on the standard with a slipfitter and set screws, and have sheaves or rollers for the lifting and power cables. Ensure sockets automatically secure the carrier ring at the top in the raised position and provide a hood on the entire assembly for protection from the weather. Attain latching and unlatching by alternately raising and lowering the carrier ring. Use sheaves that are non-corrosive materials with bronze bushings and stainless steel shafts. Provide suitable retainers to assure that the cables stay in correct position.

Have slipfitter tenons equally spaced for mounting the luminaires on the carrier ring. The tenons shall be a suitable length to allow the installation of the LED luminaires. Have the carrier ring automatically latched to the head frame when raised into position by suitable pins and sockets which will prevent the luminaires from swaying, turning, vibrating, or otherwise moving out of proper position. Include on the carrier ring spring loaded roller arms to guide the ring during raising and lowering operations. Use springs made of stainless steel and rollers made of nylon. Mount a metal NEMA 3R weatherproof junction box on the ring for connection of individual luminaire circuits to the electrical power supply cable. Include in the junction box a flanged inlet for connection of the power supply cable. Use an inlet and cable connector which are of the locking type and weatherproof.

Use a winch assembly that is a self-locking worm gear type designed for operation with a portable power unit. Have the winch drum automatically reverse the lay of the hoist cable and prevent uneven build-up or tangling.

Provide a terminator for joining the hoist cable and three suspension or lifting cables. Provide the means to compensate for variations in the lengths of the 3 lifting cables. Use hoist and lifting cables made of stranded high strength stainless steel extra flexible aircraft type. Use hoist and lifting cables that meet structural requirements of Military

Specification MIL-DTL-83420 and have the center strand not protruding more than 0.06 inch after the cable is cut.

Use a power supply cable that is rated for suspension and has approved strain relief fittings at each end. At the base of the standard, provide a locking type plug with waterproof cover to connect to a short power supply cable stubbed from the circuit breaker panel.

(C) Portable Drive

Supply a portable drive unit with a heavy duty reversible electric motor with torque limiter type drive of adequate capacity, complete with a grounding type cord, suitable couplings for attaching the unit to the winch assembly, and a sturdy storage container for the unit and accessories involved. Provide one portable drive unit for the completed project. Provide a drive unit with a lever switch controller with clearly marked up and down positions. Connect the controller to the drive unit with a cord of sufficient length to let the operator stand a minimum of 15 feet from the base of the high mount during lowering or raising operations.

Shop assemble the portable drive unit and remove all rough edges. Use mounting or adjustment bolts which allow hand tightening.

Provide a complete unit that includes a durable metal storage case with all equipment and instructions for operation. Use a case which is the approximate size as shown in the plans, has a continuous hinge on the lid, and has sturdy carrying handles on each end. Furnish a hasp with padlock as shown in the plans. Construct the case with 16 gauge formed and welded steel with bracing to prevent warping. Paint the inside and outside with a durable quality paint. Provide an identification label as noted in the plans on the storage case.

(D) Circuitry

Install an enclosed circuit breaker in the base of the high mount standard. Use a breaker which is rated 480 VAC, 2 pole, 30 A, and a minimum interrupting capacity of 14,000 A unless noted otherwise in the plans.

Provide a supply cord originating from the circuit breaker with a female twist lock connector for testing the luminaires at ground level, during lowering operation using the portable drive unit and when in the raised position during normal night operation.

Provide a metal NEMA 3R weatherproof junction box mounted on the lowering ring with a flanged inlet to accept the female twist lock connector from the supply cord. Use plugs, flanged inlets and connectors for the supply cable and drive unit which allow grounding and are weatherproof.

Install the wiring for each high mount luminaire separately from the luminaire to the junction box. Series or loop circuitry is not allowed.

Provide a transformer, branch circuit breaker or minimum 5A fuse and GFCI receptacle as a power source for the portable drive.

Provide an equipment grounding conductor in the supply cable. Include an equipment grounding conductor in the wiring for each luminaire.

Provide a High Mount Junction Box sized as shown in the plans and meeting the requirements of Section 1411.

Provide a ground rod in accordance with Subarticle 1400-2(D).

(E) Operation

Demonstrate the operation of the lowering device by raising and lowering the carrier ring with luminaires a minimum of five times for each high mast. Include in this

demonstration latching and unlatching at the top and connection of test cables at the bottom. Twisting of the cables, failure of the carrier ring to latch or unlatch, unlevelness of the carrier or hang-up of guide arms will be sufficient reason not to accept the lowering device.

1401-3 CONSTRUCTION METHODS

Use suitable blocking and slings to prevent warping of the high mount standard during storage and transportation. Assemble all parts and string all cables in strict accordance with the manufacturer's instructions.

Make sure that the top of the standard is not out of plumb more than 0.5% of its height.

Include assembly instructions and any special tools, blocks, washers, etc. in the portable drive storage case.

Remove all dirt, stains, marks, etc. before erecting the high mount.

Install a High Mount Junction Box with ground rod as shown in the plans. See Section 1411 for junction box construction methods.

1401-4 MEASUREMENT AND PAYMENT

High Mount Standards with lowering devices to be paid will be the actual number of standards installed and accepted. High mount light standards with lowering device, measured as provided above, will be paid at the contract unit price each for ____ *High Mount Standard* of the appropriate height. The *High Mount Junction Box* will be paid under Section 1411. The ground rod in the High Mount Junction Box is incidental to the *High Mount Standard.*

Portable Drive Units with storage cases to be paid will be the actual number of portable drive units furnished and accepted. Portable drive units with storage case, measured as provided above, will be paid at the contract unit price each for Portable Drive Unit.

Payment will be made under:

Pay Item	**Pay Unit**
____ High Mount Standard	Each
Portable Drive Unit	Each

SECTION 1404
LIGHT STANDARDS

1404-1 DESCRIPTION

Furnish and install light standards less than 55 feet high complete with bracket arm(s), when required, and an AASHTO approved breakaway support (slip base, frangible base adapter, breakaway base), when required, as shown on the plans.

1404-2 MATERIALS

Provide certified computations and fabrication drawings by an engineer licensed by the State of North Carolina.

Provide a standard that meets the design criteria of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and the Interim Specifications as shown on the plans. The support is to be designed for the wind velocity shown in the plans.

Provide a standard designed to support a luminaire, which has a center of gravity not more than 18 inches from the end of the support, with a minimum weight and projected area and, if required, a bracket arm length as indicated in the contract.

Make sure that each light standard has a grounding lug in the standard located within 6 inches of the handhole or in the transformer base.

Deliver standards with a smooth uniform finish, free of disfiguring scratches or dents and with suitable protection for further handling during erection.

Wrap or package each light standard as recommended by the manufacturer to prevent damage during shipping and handling. Repair or replace, at the option of the Engineer, any standards with abraded finishes or other damage.

Furnish aluminum or steel standards and bracket arms (when required); however, use the elected material throughout the project.

Galvanize steel components after fabrication. Use galvanization which conforms to the requirements of ASTM A123 for tubes, plates and bars and to ASTM A153 for hardware.

Use connecting bolts, washers and nuts compatible with the transformer base as recommended by the light standard manufacturer and which comply with the contract.

Use anchor bolts, washers, nuts and shims which comply with the specifications and details shown in the plans as recommended by the light standard and transformer base manufacturer(s).

Furnish anchor and/or connecting bolt covers and pole top caps with standards as indicated in the plans.

Provide pole hardware such as nuts, bolts and washers for aluminum standards from 18-8 stainless steel or aluminum alloy 2024-T4. Provide nuts, bolts and washers for steel standards from 18-8 stainless steel or steel conforming to ASTM A307. Submit drawings for approval which show material specifications for each component.

Luminaires may be either direct pole mounted or mounted to a bracket arm. Where bracket arms are required, use bracket arms for each standard which are the length shown in the plans and of the same material as the standard. For direct pole mounted luminaires, minimum setback distances shown in the *Roadway Standard Drawings* must be maintained.

Refer to specifications for luminaire weight and effective projected area (EPA).

For light standards installed on the shoulder or in a grassy median, provide these light standards with an approved breakaway support that complies with *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* and the Interim Specifications as shown on the plans and one of the following descriptions:

(A) A cast aluminum transformer base with an aluminum door,

(B) A frangible base insert or adapter, or

(C) A slip base.

Use the same type of breakaway support throughout the entire project. All breakaway supports shall be FHWA approved. When frangible base adapters are used, include a shroud between the base plate and the foundation for protection for exposed wiring and conduit at the base of the standard. Secure the shroud in place in at least two locations.

Provide Light Standard Junction Box sized as shown in the plans and meeting the requirements of Section 1411.

1404-3 CONSTRUCTION METHODS

Locate and number the light standards as shown in the plans.

Do not lay the standards on the ground without proper blocking and protection to prevent warping and discoloration. Protect the standards from damage by other construction work, including landscape mulching and fertilizing operations.

Securely mount the standards on the anchor bolts, and plumb with nuts torqued according to the manufacturer's recommendation.

Mounting height is defined as vertical distance from luminaire to surface of pavement of heaviest traveled lane in area illuminated by the luminaire. A tolerance of ± 1.5 feet from the required mounting height will be permitted. If this tolerance is exceeded, furnish and install an acceptable standard within this tolerance.

Install a Light Standard Junction Box as shown in the *Roadway Standard Drawings*. See Section 1411 for junction box construction methods.

1404-4 MEASUREMENT AND PAYMENT

Light Standards, ____ will be measured and paid as be the actual number of light standards with bracket arm assemblies, when required, and breakaway supports, when required, of each appropriate mounting height and bracket arm type and length, when required, that have been installed and accepted. The Light Standard Junction Box will be paid under Section 1411. The ground rod in the Light Standard Junction Box is incidental to the light standard.

Payment will be made under:

Pay Item	Pay Unit
Light Standards, ____	Each

SECTION 1407
ELECTRIC SERVICE POLE AND LATERAL

1407-1 DESCRIPTION

Furnish and install wood service poles, wire, conduit, bushings, fittings, connectors, meter base and weatherhead from the service point to a control system.

1407-2 MATERIALS

Refer to Division 10.

Item	Section
Conduit	1091-3
Type USE Wire	1091-2, 1400-2
Wood Poles, Class 4	1082

1407-3 CONSTRUCTION METHODS

Prior to installation of a service pole, the Contractor shall confirm the need for a service pole with the Engineer and the utility company. Upon approval from the Engineer, the proposed service pole will be deleted from the contract if the utility company:

(A) Provides a pad mount transformer,

(B) Allows attachment of the riser and weatherhead to their pole, or

(C) Provides underground service from their pole.

When a service pole is determined to be required and utility power is available from outside the right of way, the service pole shall be located no more than 10 feet inside the right of way. Set the service pole at a depth of at least 5.5 feet unless otherwise shown on the plans. Dig a hole large enough to permit the proper use of tampers to the full depth of the hole. Install the service pole plumb, place backfill in the hole in 6 inch maximum layers and thoroughly tamp backfill. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.

The utility company will install overhead conductors from their facilities to the service pole. Make connections at the service head at the bottom of the drip loop to prevent siphoning of water through the cable. Install an underground service lateral from the service pole to the lighting control system.

Provide for a meter in accordance with the requirements of the utility company's condition of service. A meter base for a self-contained meter may be mounted on the service pole or back of the control enclosure as indicated in the plans. A current transformer (CT) cabinet and meter base may be mounted in either location if requested by the utility company. Do not install CT cabinet or meter base prior to coordination with the utility company.

Use stranded copper Type USE conductors sized as shown in the plans for the service lateral. Install conductors in rigid galvanized steel (RGS) conduit above ground and PVC conduit below ground.

1407-4 MEASUREMENT AND PAYMENT

Electric Service Pole ____ will be measured and paid as the actual number of the appropriate length and class electric service poles installed and accepted.

Electric Service Lateral ____ from service pole to control panel will be measured and paid as the actual number of linear feet of the appropriate size and type service lateral installed and accepted. Measurement will be along the longest conductor from electrical terminal to electrical terminal.

Payment will be made under:

Pay Item	Pay Unit
Electric Service Pole ____	Each
Electric Service Lateral ____	Linear Foot

SECTION 1408
LIGHT CONTROL EQUIPMENT

1408-1 DESCRIPTION

Furnish and install an entire control system, including enclosure, control panel, photocell, switches, contactors, breakers, terminal blocks, wiring, concrete foundation and surge protection device. Furnish and install current transformer cabinet when required by the utility company. The control system will be standard electrical components in a stainless steel enclosure mounted on a metal pole with a concrete foundation as shown in the contract.

1408-2 MATERIALS

Refer to Division 10.

Item	Section
Conduit	1091-3
Ground Rod	1091-6
Portland Cement Concrete, Class A	1000-3
Wire and Cable	1091-2, 1400-2

Provide concrete foundations and wire in accordance with the *Standard Specifications*.

Use a piece of 4 inch rigid galvanized steel conduit with galvanized steel threaded conduit cap, embedded in concrete as shown in the plans for mounting the control system.

Provide a NEMA type 3R stainless steel enclosure with external stainless mounting flanges, drip shield, back panel and continuous hinge door with a print pocket. Provide a door closing mechanism interlocked with a flange mounted operator handle to prevent the opening of the door with the service circuit breaker in the ON position, except by use of safety override devices.

Provide an enclosure approximately 36 inches (h) x 30 inches (w) x 10 inches (d) unless noted otherwise in the plans. Provide only openings necessary for the entrance of conduits as shown in the plans. Do not use knockouts. Ensure the enclosure conforms to NEC Article

312 and mount the devices so the NEC clearances will be provided, except use 1 1/2 inches where not specified or noted in the tables for minimum wire bending space.

Use galvanized slotted steel framing channel with straps and bolts, sized as shown in the plans for the mounting brackets and hardware for attaching the enclosure to the pole. Use galvanized finish on the brackets and hardware and coat all field cuts or scratches with organic zinc repair paint meeting Article 1080-9.

Perform all galvanizing in accordance with Section 1076.

Provide a neutral bar bonded to the panel with sufficient box lug type terminals to accept the required number of wires.

Mount components to the back panel with manufacturer supplied mounting brackets or permanently attached screw studs.

Use a service circuit breaker providing a minimum interrupting rating of 22,000 A. Provide a thermal magnetic, molded case, permanent trip breaker. Provide multi-tap, solderless, load side box lugs or distribution terminal blocks of the appropriate size. Use insulating material approved for NEMA 3R applications. Provide a service barrier as required by NEC Article 230-62(C) for the line side lugs. Provide a breaker with a voltage and amperage rating as indicated in the plans.

Provide a single pole, open type control circuit breaker rated for the voltage shown in the plans with a minimum current interrupting capacity of 5,000 A and a high magnetic trip setting of 15 A.

Provide three 60 A, 4 pole mechanically held contactors that have coil clearing contacts and coil voltage rating as indicated in the plans. Contactor latching with hooks or semi-permanent magnets is unacceptable.

Use a control relay rated for the voltage shown in the plans with one normally open contact and one normally closed contact and has a continuous load rating and inductive make rating greater than that required by the mechanically held contactor. Use a coil rated for the voltage shown in the plans.

Use a heavy duty 3-position maintained contact selector switch in a surface mount (NEMA 1) enclosure with a legend consisting of On-Off-Auto and having continuous current rating of 10 A for the contacts. Selector switch contacts shall be rated for the voltage shown in the plans.

Use feeder circuit breakers which are rated 14,000 A minimum interrupting capacity and have an open type molded case with a non-adjustable thermal magnetic trip setting as noted in the plans.

Use a delayed response encapsulated cadmium-sulfide photo-control, suitable for use on an operating voltage range of 105 V to 285 V and nominal control voltages of 120 V, 208 V, 240 V and 277 V. Ensure the control is rated for 1,000 W resistive load or 1,800 V-A of inductive load. Set the light-level within a range of 1.0 to 3.0 footcandles. Have internal protection for surges in excess of 2,000 V peak for the control. Mount a receptacle directly to the top of the enclosure with a weatherproof fitting. Use controls and receptacles which conform to NEMA Standard C136.10 for roadway lighting equipment.

Use a Type 1 surge protection device (SPD) meeting UL 1449 and UL 96A, designed to contain and arrest an arc of 40,000 A and with a short circuit current rating of 200,000 A. Install the SPD on the load side of the service breaker.

Use terminals and lugs rated for the connection of the appropriate size copper conductors. All conductors shall be made of copper and neatly wrapped in bundles or run in plastic raceways.

Provide a scaled drawing showing the location, brand and catalog number of each component of the control system for approval.

The completed light control system shall be marked "Suitable for Use as Service Equipment", in a prominent location in the enclosure, in accordance with NEC Article 409.110, and shall be marked with an arc flash hazard warning in accordance with NEC Article 110.16. If the control system is not made in a certified UL 508A Panel Shop, a third party, recognized by the Department of Insurance as having the authority, shall label the control systems.

Provide a Control System Junction Box sized as shown in the plans and meeting the requirements of Section 1411.

1408-3 CONSTRUCTION METHODS

Construct the foundation for the control system as shown in the plans with the top of the foundation 3 inches above finished grade.

Fasten the enclosure to the pole by means of a galvanized bracket assembly as shown in the plans. Make all cuts square and remove all rough edges. Have mounting holes match existing mounting holes of the enclosure.

Arrange all conduits entering the enclosure in a neat symmetrical manner and extend directly downward into the foundation. Install six RGS feeder circuit conduits as shown in the plans.

Install a Control System Junction Box as shown in the plans. Stub all feeder circuit conduits and spare conduits from Control System in the Control System Junction Box. See Section 1411 for junction box construction methods. See plans for conduit sizes. Place pull cord in any unused conduits and cap unused conduit in junction box.

Install a bonded conduit choke on the underground termination point of the system grounding conductor conduit in accordance with NEC Article 250.64(E). Do not terminate the system grounding conduit under the concrete foundation pad.

Install a grounding electrode system consisting of a minimum of two ground rods spaced not less than 6 feet apart at all new or relocated lighting control system panels. Connect ground rods with a bonding jumper sized in accordance with NEC Article 250.66.

Apply two coats of organic zinc repair paint to all field cut metal and conduit threads as specified in Article 1076-7.

1408-4 MEASUREMENT AND PAYMENT

Light Control Equipment, (Type) will be measured and paid as the actual number of the appropriate type light control systems completed and accepted. The Control System Junction Box will be paid under Section 1411.

Payment will be made under:

Pay Item	Pay Unit
Light Control Equipment, (Type) ____	Each

SECTION 1409
ELECTRICAL DUCT

1409-1 DESCRIPTION

Furnish and install electrical duct including materials, equipment and labor for trenching, jacking, boring or directional boring and backfilling, so electrical circuits may be easily installed, repaired or replaced, and be protected from traffic loading at locations shown in the plans.

1409-2 MATERIALS

Refer to Division 10.

Item	Section
Conduit	1091-3

Use electrical duct that is non-metallic rigid PVC heavy wall conduit, HDPE Standard Dimension Ratio (SDR) 13.5 or rigid galvanized steel conduit.

1409-3 CONSTRUCTION METHODS

Duct is a passageway for electrical circuits. Install ducts in accordance with NEC requirements for an approved raceway. Locate the duct as shown in the plans and at a depth of at least 30 inches unless indicated otherwise in the plans. Locate bore pits outside the clear zone, as defined in the *AASHTO Roadside Design Guide*.

The lengths noted in the plans are only typical. Make actual field measurements to place the ends of the duct at the required locations. Make up lengths of duct with the minimum number of pieces joined together with couplings and solvent as recommended by the manufacturer.

Clean and plug the duct in accordance with Subarticle 1400-4(E).

Duct shall be installed as buried or trenchless as indicated on the plans.

Place buried duct in a trench with essentially vertical walls and only wide enough for easy installation of the duct. Tunneling by hand or other approved methods may be required to install duct beneath existing walks or paved ditches. Perform backfilling in accordance with Article 300-7.

Trenchless duct may be installed by either of the following methods at the Contractor's option, when placement of electrical duct beneath pavement by trenchless methods is noted in the plans.

(A) Bore and jack in accordance with Subarticle 1550-4(A). Do not install non-metallic conduit by bore and jack method.

(B) Directional drill in accordance with Subarticle 1715-3(D) except use Roadway Standard Drawing 1409.01 for minimum depth requirements .

(C) A bored-opening not more than 1 inch larger than the outside diameter of the duct may be made using an impact mole and a pneumatic or hydraulic percussive hammer.

If installation of a duct is begun and not completed, plug any opening as directed. Installation of duct by water jetting is not acceptable.

At locations where it is indicated in the plans that the duct is to be connected to junction boxes, foundations, or other raceways, install in accordance with Subarticle 1400-4(E) to provide an approved raceway as specified by the NEC.

Unless otherwise noted in the plans, rigid galvanized steel conduit is intended for use in above ground applications only.

1409-4 MEASUREMENT AND PAYMENT

Electrical Duct, Type ____, *Size* ____ will be measured and paid as the actual number of linear feet of duct, measured in place to the nearest whole foot, installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Electrical Duct, Type ____, Size ____	Linear Foot

SECTION 1410
FEEDER CIRCUITS

1410-1 DESCRIPTION

Furnish and install all conductors and conduit, including tools, equipment, trenching and backfilling to provide electrical circuits at locations shown in the plans.

1410-2 MATERIALS

Refer to Division 10.

Item	Section
Conduit	1091-3
Wire and Cable	1091-2, 1400-2

Use UL listed, Type USE wire for feeder circuits in conduit. The equipment grounding conductor may be bare or insulated. Use conductors which are copper and in accordance with Subarticle 1400-2(C). Give careful attention to the required color code. Conductors may be permanently reidentified per Article 200.7 of the NEC.

Provide metallic (rigid galvanized steel) conduit above ground and non-metallic (PVC or HDPE) conduit below ground in accordance with the Subarticle 1400-2(B) with the appropriate type being used at locations as shown in the plans.

1410-3 CONSTRUCTION METHODS

Install feeder circuits in continuous runs. Splicing is only permitted in junction boxes or light standard bases as described in Subarticle 1400-4(F).

Install conductors in accordance with the Subarticle 1400-4(F) and conduit in accordance with the Subarticle 1400-4(E).

Excavate trenches to depths and widths as shown in the plans with essentially vertical walls and as straight as possible, when underground feeder circuits are required. Locate underground feeder circuits a minimum of 15 feet back from the edge of travel lane or as directed by the Engineer. Use care to prevent conflict with existing or future guardrails, sign posts, delineators and similar devices.

Surround the underground feeder circuit in conduit with clean soil and use backfill free of rocks and other objectionable materials which might damage the conduit. This will require partial backfilling by hand in areas where it is likely that objectionable materials will be included if mechanical methods of backfilling are used.

When a feeder circuit in conduit passes through electrical duct (sleeve), make the conduit continuous through the duct unless specifically noted otherwise in the plans.

When only feeder circuits are required, install the load current carrying conductors and grounding conductors in either existing conduit or conduit installed under other contract items.

When more than one feeder circuit is installed in a single raceway, a single equipment grounding conductor sized as required for the largest feeder circuit conductor may be used without change in the contract unit bid prices. Use of a raceway is only permissible under road crossings, unless otherwise indicated on the plans.

Multiple feeder circuits in conduit may be placed in the same trench if the conduits are separated a minimum distance of 3 inches. When more than one feeder circuit in conduit is installed in the same trench there will not be any adjustment of the contract unit bid prices. Feeder circuits must be installed in individual conduits sized as shown on the plans.

1410-4 MEASUREMENT AND PAYMENT

____ *Feeder Circuits* will be measured and paid as the actual number of linear feet of each size and type feeder circuit completed and accepted. Measurement will be to the nearest whole foot from electrical terminal to electrical terminal of the longest load current carrying conductor.

____*Feeder Circuit in* ____ *Conduit* will be measured and paid as the actual number of linear feet of each size and type feeder circuit completed and accepted. Measurement will be to the nearest whole foot from electrical terminal to electrical terminal of the longest load current carrying conductor.

Payment will be made under:

Pay Item	Pay Unit
____ Feeder Circuit	Linear Foot
____ Feeder Circuit in ____ Conduit	Linear Foot

SECTION 1411
ELECTRICAL JUNCTION BOXES

1411-1 DESCRIPTION

Provide a stackable in ground junction boxes made from fiberglass reinforced polymer concrete or thermoplastic materials and provide cast-metal boxes encased in concrete of the appropriate type at locations noted in the plans, complete with all necessary covers, conduits, duct and hardware, in accordance with the contract.

1411-2 MATERIALS

Refer to Division 10.

Item	Section
Backfill	1005
Electrical Junction Boxes	1091-5

Provide an in ground junction box which is open bottom with a foot. Provide a standard "Lighting" logo on the cover unless specifically noted otherwise in the plans. Backfill beneath and around the boxes using #67 washed stone in conformance with Section 1005.

1411-3 CONSTRUCTION METHODS

Install conduits and duct before the in ground (IG) boxes are set in place. Do not rest the bottom of the box directly on conduits, ducts or cables.

Place the top of the box on the same grade as the surrounding area. Perform backfilling with sufficient care that no part of the junction box, conduit or duct is displaced or moved out of alignment. Backfill beneath and around the box to at least 12 inches using #67 washed stone aggregates in conformance with Section 1005.

Locate junction boxes for best routing of conduit and duct and to minimize drainage problems. Any junction boxes which are retaining water as identified by the Project Inspector or the Lighting and Electrical personnel during final inspection shall be corrected to the satisfaction of the Engineer prior to project acceptance.

Do not locate junction boxes in useable shoulders or pavements or other areas where they may be subjected to continuous traffic loadings.

Stub the ends of conduit and duct vertically. Temporarily seal ends of conduit and duct until feeder circuit conductors are installed. Leave approximately 10 inches from the top of the conduit to the junction box lid. Arrange wiring so that splices will not lay in the bottom of the box.

Install cast-metal barrier rail (BR) and/or sidewalk (SW) boxes and arrange conduits and ducts to best fit field conditions. During the construction of the concrete reinforcement, accurately space and securely attach Type BR and Type SW junction boxes and conduits inside the reinforcement. Bond junction box to the reinforcement in accordance with NEC Article 250.52. Place boxes with covers flush with surface of concrete. For median barrier installations, install Type BR junction boxes so that the face of each box is on the same side of the road as the serving lighting control system.

Place mastic between the cast metal box frame and the cast concrete barrier, as shown on plans to allow easy replacement of the frame.

Install a Control System Junction Box (CSJB) meeting the requirements of this section and sized as shown in the plans within 2 feet of the edge of the concrete pad in front of each Control System.

Install a High Mount Junction Box (HMJB) meeting the requirements of this section and sized as shown in the plans 10 feet from each high mount foundation. Position the junction box for best routing of underground circuitry. The HMJB is used as a tee point for circuitry to the high mast standard.

For single arm or twin arm light standards installed in grassy areas, provide a light standard junction box (LSJB) meeting the requirements of this section and sized as shown in the plans. Install the LSJB 5 feet from the standard foundation. The LSJB shall be placed parallel to, or behind the light standard foundation, as viewed from the roadway. The LSJB is used as a tee point for circuitry.

Install a ground rod in the HMJB and the LSJB. Permanently attach grounding conductor from light standard to ground rod in junction box via an irreversible compression ground connector.

Record the precise GPS location of all junction boxes in the junction box summary on the plans. Submit the list of junction box GPS locations to the Engineer and include this list in the print pocket of the lighting control system.

1411-4 MEASUREMENT AND PAYMENT

Electrical Junction Boxes ____ will be measured and paid as the actual number of the appropriate type and size junction boxes installed and accepted. Payment for the conduit, duct and wiring will be paid under other contract items. Covers, washed stone and items used for splicing are incidental to the junction boxes.

Payment will be made under:

Pay Item	**Pay Unit**
Electrical Junction Boxes ____	Each

SECTION 1412
UNDERPASS LIGHTING

1412-1 DESCRIPTION

Furnish and install wall mounted (WM) and/or pendant mounted (PM) luminaires with electrical circuitry, for underpass lighting at locations shown in the plans. Work includes, but is not limited to, furnishing and installing underpass luminaires with LED light sources, internally mounted driver and mounting hardware as well as furnishing and installing circuit breakers and enclosure with photocell receptacle, pull boxes, conduit, conductors, expansion fittings, anchors, straps and ground rod.

1412-2 MATERIALS

Refer to Division 10.

Item	Section
Conduit	1091-3
Wire and Cable	1091-2, 1400-2

Use luminaires that are listed as "Suitable for Wet Locations" according to UL Standard 1598, with sealed LED light engine assemblies. Use electronic drivers that are completely pre-wired integral units, for reliable operation of LED light engine(s) at -40°F ambient temperature. Use the luminaire type, wattage, voltage, correlated color temperature (CCT) and IES illumination distribution pattern as shown in the plans.

Provide Type WM luminaires that are wall mounted, with cast aluminum housing painted with premium quality gray or dark bronze paint. Use the same color Type WM luminaires throughout the project. Provide a prewired driver assembly which is thermally isolated from the LED light engines. Provide factory installed mounting holes in the back and conduit entrances in the sides and top. Provide a cast aluminum hinged door and a sealed glass lens covering the LED light engines. Provide preinstalled, modular LED light engines.

Provide Type PM luminaires that are a pendant mounted assembly of driver, optical and mounting components, including a safety chain and hanging hardware. Provide a die-cast aluminum driver housing with gray paint finish, with a prewired driver assembly and an electrical receptacle for attachment of hanging hardware. Provide sealed, directional LED light engines covered by a glass refractor.

Use a 3/4 inch rigid galvanized steel conduit with a hook and power cord entrance as the pendant. Provide a 3-conductor Type SOOW power cord and a 3/4 inch female threaded wiring compartment to attach the driver housing to the pendant as shown in the plans.

Use galvanized weldless forged steel eye-nuts that comply with Federal Specification WW-H-171E (Type 17), or Manufacturers Standardization Society SP-69-2003 (Type 17). Attach eye nuts to galvanized steel or stainless steel threaded rod anchored to the bridge deck with adhesive anchors. Use galvanized steel or stainless steel safety chain, S-hooks and lock nuts.

Use conduit and wire in accordance with Article 1400-2 and gasketed PVC junction boxes as shown in the plans.

Use a 2-pole, 15 A circuit breaker with an interrupting capacity of at least 14,000 A, installed in a NEMA 3R enclosure. Circuit breaker shall be rated for the voltage shown in the plans. The enclosure should be primed and painted with a premium grade exterior paint before installation to increase corrosion resistance. Install an equipment ground bar and provide a lock in accordance with Article 1400-8. Provide a 7-pin photocontrol receptacle securely mounted to the enclosure.

1412-3 CONSTRUCTION METHODS

Mount luminaires as shown in the plans. Use galvanized steel or stainless steel clamps and attachment hardware.

Install circuitry in accordance with Article 1400-4.

Install the photocontrol receptacle either directly to the top of the enclosure, or use a standoff bracket. If a standoff bracket is used, the conductor from the photocontrol receptacle to the disconnect panel shall be enclosed and secured in liquidtight flexible metallic conduit.

Install a shorting cap on the photocontrol receptacle.

1412-4 MEASUREMENT AND PAYMENT

Underpass Luminaires, Type ____ will be measured and paid as the actual number installed and accepted.

Underpass Circuitry at ____ will be paid at the contract lump sum price for underpass circuitry at the appropriate location.

Payment will be made under:

Pay Item	**Pay Unit**
Underpass Luminaires, Type ____	Each
Underpass Circuitry at ____	Lump Sum

SECTION 1413
PORTABLE CONSTRUCTION LIGHTING

1413-1 DESCRIPTION

Furnish, operate and maintain everything necessary to provide lighting for compliance with Article 105-14 requirement for artificial lighting.

1413-2 MATERIALS

Furnish all lighting equipment as required and remove after the work is completed. Material and/or equipment is not required to be new but shall be in good operating condition and in compliance with applicable safety and design codes.

Submit, for review and approval, catalog cuts giving the specific brand names, model numbers and ratings of the lighting equipment. Include in the submittals power ratings and photometric data. Do not begin night work without approval of the equipment and/or materials.

1413-3 TOWER LIGHT

Use tower lights which consist of mercury vapor, metal halide, high pressure sodium, low pressure sodium or light emitting diode (with correlated color temperature of 4000 Kelvin or less) fixtures mounted on a tower approximately 30 feet in height. Use tower light fixtures which are heavy duty flood, area, or roadway style with wide beam spread, have sufficient output to provide minimum illumination requirements for the Category of work, are weatherproof and supplied with attached waterproof power cord and plug. Use a sturdy tower which is freestanding without the aid of guy wires or bracing. Provide sufficient capacity in the power supply to operate the light(s) and locate it for the shortest safe routing of cables to the fixtures. A tower light consisting of the combined fixture(s), tower and power supply is preferred.

Provide tower lights of sufficient wattage or quantity to provide the minimum average maintained horizontal illuminance over the work area based on the Category of work as shown in Table 1413-1. For any work not covered in Table 1413-1, provide a minimum average maintained horizontal illuminance of 20.0 footcandles over the work area.

TABLE 1413-1
MINIMUM ILLUMINATION REQUIREMENTS FOR PORTABLE CONSTRUCTION LIGHTING

Category	Description of Task	Minimum Average Maintained Horizontal Illumination
I	Excavation; Embankment, Fill and Compaction; Maintenance of Embankment; Asphalt Pavement Rolling; Subgrade, Stabilization and Construction; Base Course Rolling; Sweeping and Cleaning; Landscaping, Sod and Seeding; Reworking Shoulders.	5.0 footcandle
II	Barrier Wall and Traffic Separators; Milling, Removal of Pavement; Asphalt Paving and Resurfacing; Concrete Pavement; Base Course Grading and Shaping; Surface Treatment; Waterproofing and Sealing; Sidewalk Construction; Guardrails and Fencing; Striping and Pavement Marking; Highway Signs; Bridge Decks; Drainage Structures and Drainage Piping; Other Concrete Structures; Repair of Concrete Pavement; Pothole Filling; Repair of Guardrail and Fencing.	10.0 footcandle
III	Traffic Signals; Highway Lighting Systems; Crack Filling.	20.0 footcandle

Aim and position the lights to illuminate the area for construction work. Make sure that there is not any disabling glare to the motorist. In no case should the main beam of the light be aimed higher than 60° above straight down. The lights should be set as far from traffic as practical and aimed in the direction of, or normal to, the traffic flow.

1413-4 MACHINE LIGHTS

Use machine lights which have mercury vapor, metal halide, high pressure sodium, low pressure sodium or light emitting diode (with corelated color temperature of 4000 Kelvin or less) fixtures mounted on supports attached to the construction machine at a height of approximately 13 feet. Use a power supply with sufficient capacity to operate the light(s) and securely mount on the machine. Perform electrical grounding of generators to frames of machines on which they are mounted in conformance with the NEC.

Use machine light fixtures with sufficient wattage and/or quantity to provide an average maintained horizontal illuminance greater than 10 footcandles on the machine and the surrounding work area. Machine lights are in addition to conventional automotive type headlights which are necessary for maneuverability.

Balloon lights are an acceptable alternate luminaire for machine lights.

1413-5 CONSTRUCTION METHODS

Use tower lights when the night work is confined to a fairly small area and is essentially a stationary operation. Space tower lights no closer than 100 feet apart and no further than 300 feet apart. Submit photometric calculations showing the minimum average maintained horizontal illuminance over the work area and the tower spacing to the Engineer for review and approval prior to installation.

Use machine lights when the night work is not confined to a small area and is essentially a continuous moving construction operation. A continuous moving construction operation is one that is either moving at 3 MPH, or greater, or is not occupying a 1,000 foot section of road for more than 10 minutes.

Tower lights may be provided instead of machine lights upon approval by the Engineer. Use of tower lights instead of machine lights will be considered when the number of machines, type of work, or need for inspection justify their use as decided by the Engineer.

Illuminate the work area where traffic control devices are being set up or repositioned at night.

Where night time flagging operations are required, all flagging stations shall be illuminated to a minimum of 5 footcandles.

The work areas to be illuminated are the areas where construction equipment and labor are in operation and may be different from the work areas shown in the plans.

Illuminate a large enough work area so that the movements of all personnel and equipment engaged in the work will be contained in the area.

Provide sufficient fuel, spare lamps, generators and personnel qualified to operate the lights to assure that they will be maintained in operation during night work.

Existing streetlights do not eliminate the requirement for the Contractor to provide lighting. Consideration may be given to the amount of illumination provided by existing lights in determining the wattage and/or quantity of lights to be provided.

1413-6 MEASUREMENT AND PAYMENT

Portable Lighting provided by tower and machine lights will be paid only when a significant amount of nighttime work is explicitly required and a pay item for portable lighting has been included in the contract. Otherwise, portable construction lighting will be incidental to other contract items and no direct payment will be made.

The aggregate amount to be paid on each partial payment estimate will be equal to the percentage that the item of *Portable Lighting* is complete as estimated by the Engineer.

Payment will be made under:

Pay Item	**Pay Unit**
Portable Lighting	Lump Sum

DIVISION 15
UTILITY CONSTRUCTION

SECTION 1500
GENERAL UTILITY REQUIREMENTS

1500-1 DESCRIPTION

Construct various utilities as required by the contract or as directed by the Engineer.

Apply the applicable provisions of the rules and regulations of the NCDEQ to the construction of water lines and sanitary sewer lines. Perform all work in accordance with the applicable plumbing codes.

1500-2 COOPERATION WITH THE UTILITY OWNER

The utility owner owns the existing utility facilities and will own the new utility facilities after acceptance by the Department. The Department owns the construction contract and has administrative authority. Communications and decisions between the contractor and utility owner are not binding upon the Department or this contract unless authorized by the Engineer. Agreements between the utility owner and contractor for work that is not part of this contract or is secondary to this contract are allowed, but are not binding upon the Department.

Provide access for Department personnel and the utility owner's representatives to all phases of construction. Notify the Engineer and the utility owner 2 weeks before commencement of any work and one week before service interruption. Keep utility owners' representatives informed of work progress and provide opportunity for inspection of construction and testing.

Except in an emergency, do not operate any of the controls on the existing systems without prior approval of the utility owner.

Notify the utility owner at least 24 hours in advance of all arrangements for temporary service and for agreement with the utility owner as to the time that service may be interrupted.

1500-3 UTILITY LOCATIONS AND CONTRACTOR'S RESPONSIBILITY

The plans depict the best available information for the location, size and type of material for all existing utilities. Make investigations for determining the exact location, size and type of material of the existing facilities as necessary for the construction of the proposed utilities and for avoiding damage to existing facilities. Repair any contractor caused damage of existing facilities to the original or better condition at no additional cost to the Department.

Exploratory Excavation required to locate a utility not identified in the plans will be paid in accordance with Article 104-7.

1500-4 WEEKEND, NIGHT AND HOLIDAY WORK

Make connections between existing and proposed utilities at times most convenient to the public, without endangering the utility service and in accordance with the utility owner's requirements. Make connections on weekends, at night and on holidays, if necessary.

1500-5 RELATION OF WATER MAINS TO NON-POTABLE WATER LINES AND OTHER UTILITIES

For sanitary sewers, lay water mains at least 10 feet laterally from existing or proposed sanitary sewers. If local conditions or barriers prevent a 10 foot separation, lay the water main with at least 18 inches vertical separation above the top of the sanitary sewer pipe either in a separate trench or in the same trench on a bench of undisturbed earth.

For storm drain pipe, reclaimed water distribution or other utilities, lay the water main with at least 12 inches separation from the outside of the water main and the outside of the other facility.

One full length of water pipe at the point of crossing shall be located so that both joints will be as far from the sanitary sewer as possible. If practicable, the water main shall be located above the sewer.

1500-6 PROTECTION OF PEDESTRIAN AND VEHICULAR TRAFFIC

During the progress of the work, keep sidewalks and crossings open for the passage of pedestrians. Take necessary measures to keep roadways open for traffic unless lane or roadway closures are approved.

Construct and maintain adequate and approved bridges over excavations as necessary for the purpose of accommodating pedestrians or vehicles.

When open cut installation is allowed across a roadway and traffic is to be maintained, construct the installation in sections so that half the width of the roadway will be available to traffic. Provide all traffic control measures necessary to provide for safe traffic passage.

1500-7 SUBMITTALS AND RECORDS

Deliver only approved materials to the project. Provide sufficient information as required under Sections 105 and 106 to demonstrate the materials meet the specifications and intended use. Provide 2 hard copies to the utility owner and an electronic (.pdf) copy to the Engineer and utility owner. Identify each item's intended use. As a minimum, the submitted information shall show the material description, brand name, stock number, size, rating and manufacturing specification.

Provide working drawings of thrust restraint designs and connection details along with schedules for performing the work.

Provide as-built plans of the installed utility. The plans shall include notations of the size and type material installed, coordinates of utility controls and horizontal and vertical locations of the piping sealed by a North Carolina Professional Land Surveyor (PLS). As-built plans provided as PDF formatted files shall be generated from the source electronic files, not scanned facsimiles of paper plan sheets. Provide as-builts as PDF files to the Engineer. Provide 2 hard copies in full-size sheets and PDF formatted files to the utility.

1500-8 LOCATING AND MARKING

Tape a continuous locator wire along the top of all piping. Mechanically fasten locator wire to valve boxes, meter boxes, fire hydrants, manhole covers and other above grade appurtenances. Install marking tape 18 inches to 24 inches below finished grade above all pipelines.

1500-9 PLACING PIPELINES INTO SERVICE

Make final connections of the new work to the existing mains where indicated in the plans, as required to fit the actual conditions or as directed. Provide sufficient work crews, equipment and materials on site to assure quick and efficient connections.

Schedule and notify owners and customers in advance of any interruptions of water service with ample time to make arrangements. Limit interruption of service to water customers to no more than 8 hours. Provide temporary connections as needed to maintain service. Obtain approval from the NCDEQ-Water Resources Section prior to placing a new water line into service. Use backflow prevention assemblies for temporary connections to isolate new water lines from existing water line.

1500-10 MEASUREMENT AND PAYMENT

The general utility construction work will be incidental and will be paid at the contract unit prices of the various utility items included in the contract.

SECTION 1505
EXCAVATION, TRENCHING, PIPE LAYING AND BACKFILLING FOR UTILITIES

1505-1 DESCRIPTION

Perform all excavation, undercut, foundation conditioning, pipe laying, bedding, backfill and pavement, sidewalk and driveway repair necessary for installation of utilities.

1505-2 MATERIALS

Refer to Division 10.

Item	Section
Portland Cement Concrete, Class B	1000
Select Materials	1016

Use Class III, IV, V or VI select material for foundation conditioning and bedding.

1505-3 CONSTRUCTION METHODS

Excavate, trench, lay pipe, bed and backfill utilities in conformance with the applicable requirements of Division 1, Division 2 and Articles 300-1, 300-4, 300-6 and 300-7. Comply with AWWA and ASTM standards along with the product manufacturer requirements for installing utilities.

(A) Shielding and Shoring

Excavate trenches and pits for the installation of utilities that are safe for the workers and roadway users and that protect the roadway and other property from damage. Provide appropriate groundwater and surface water controls to stabilize the excavation and foundation and to provide a clean working area.

(1) Worker Safety

Provide any necessary shielding or shoring to protect workers.

(2) Roadway Users

Provide shielding or shoring as required under Section 150 or as required elsewhere in the contract.

(3) Roadbed and Foundation Protection

Provide shoring of excavations less than one horizontal to one vertical from existing or proposed pavement to prevent failure or weakening of the roadbed. Provide plans and designs demonstrating the methods and techniques proposed and their adequacy to the Engineer. Provide engineered shoring systems as required for the actual conditions.

(4) Building and Structure Protection

Provide shoring of excavations less than one horizontal to one vertical from existing structures and buildings, on or off the right of way, to prevent foundation damage. Provide plans and designs demonstrating the methods and techniques proposed and their adequacy to the Engineer. Provide engineered shoring systems as required for the actual conditions.

(B) Foundation Conditioning

Undercut and replace weak or saturated soils below the pipe trench with select material to provide a firm foundation.

(C) Bedding

Provide excavations with sufficient width for placing and compacting bedding around the utility. Bed utilities in select material. Place bedding material to stable ground on both sides and to at least 2 inches below and above the pipe bells. Provide at least 6 inches of bedding material between rock and piping. Shape the bottom of trenches to fit the pipe. Compact bedding material completely in the pipe haunches. Provide recesses in the bedding to accommodate pipe joints.

(D) Pipe Laying

Lay pipe in accordance with the specifications and the manufacturer's recommendations. Except where necessary in making connections with other lines or as authorized by the Engineer, lay pressurized pipe with the bells facing in the direction of laying.

Where possible, keep joints exposed for visual inspection during testing.

During the progress of the work and until the completion and final acceptance, keep the pipelines and their appurtenances clean throughout and remove any obstructions or deposits. Provide secure watertight seals on pipe when work is not in progress.

Lay gravity sewer pipe upgrade with the spigot ends pointing in the direction of flow. Lay each pipe to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line.

(E) Thrust Restraint

Provide thrust restraint for pressurized pipelines and appurtenances. When shown in the plans, construct as specified with modifications to match the actual field conditions. When not shown, engineer the thrust restraint system with a factor of safety of 1.25 for the test pressure specified and for the actual field conditions.

Provide thrust restraint on the existing piping system as necessary.

Use joint restraint methods, such as integral restraining bells and spigots, restraining retainer glands, restraining gaskets or restraining clamps and lugs with tie rods. Use concrete reaction backing and thrust collars where joint restraint is impractical.

Where any section of a main is provided with concrete thrust restraint for fittings, controls or hydrants, perform the hydrostatic pressure test after the concrete reaches appropriate strength.

(F) Backfilling

Backfill in accordance with Article 300-7 and compact to the density required by Subarticle 235-3(C).

1505-4 REPAIR OF PAVEMENTS, SIDEWALKS AND DRIVEWAYS

Repair sidewalks and driveways that are disturbed by excavation and trenching to an original or better condition in accordance with Section 848.

Use asphalt plant mix to repair or replace pavement damaged by utility work. Perform all work in accordance with Section 654. Immediately upon completion of the utility removal or installation, make repairs to the pavement.

1505-5 CONCRETE ENCASEMENT OF UTILITY LINES

Encase existing or proposed utility lines in concrete for protection in areas as shown on the utility plans or as directed by the Engineer. Place the concrete completely around the line with a minimum thickness of 6 inches.

1505-6 MEASUREMENT AND PAYMENT

Foundation Conditioning Material, Minor Structures and *Foundation Conditioning Geotextiles* will be measured and paid as provided in Article 300-9.

Asphalt Plant Mix, Pavement Repair will be measured and paid as provided in Article 654-4.

Class B Concrete for Encasing Utility Lines will be measured and paid in cubic yards of concrete, measured in place.

__" *Concrete Sidewalk* and __" *Concrete Driveways* will be measured and paid in accordance with Article 848-4.

Trenching, excavation, pipe laying, bedding, backfilling and disposal of unsuitable materials for utility construction are included in the contract price for the applicable utility item and no separate measurement or payment will be made.

The following work and items are included in the contract price for the applicable utility item and no separate measurement or payment will be made for items (A) through (F) below:

(A) Undercut or Wet Excavation,

(B) Dewatering of Excavation,

(C) Shoring and Sheeting (except temporary shoring for maintenance of traffic covered elsewhere in the contract and protection of structures and buildings),

(D) Thrust Restraint,

(E) Bedding Material, or

(F) Select Material for Backfill.

Payment will be made under:

Pay Item	Pay Unit
Class B Concrete for Encasing Utility Lines	Cubic Yard

SECTION 1510
WATER LINES

1510-1 DESCRIPTION

Provide water lines suitable for use in transporting potable water.

1510-2 MATERIALS

Refer to Division 10.

Item	Section
Water Pipe and Fittings	1036

The Contractor may use any of the water pipe specified under Section 1036 except where a particular type pipe is specified in the plans or required by environmental regulations or Departmental policy. The Contractor shall verify that the pipe is appropriate for the test pressure of the system and the external loading.

Use ductile iron fittings on water lines 4 inches or larger.

Use #12 AWG solid-copper wire with blue insulation for the utility locator wires.

Use 2 inch plastic marking tape colored blue with “Caution Water Line” or similar wording, permanently printed at 36 inch centers.

Protect steel rods and other metal clamps and lugs by galvanizing or painting with approved bituminous paint as found on the NCDOT APL.

1510-3 CONSTRUCTION METHODS

(A) General

Meet the installation standards of AWWA or ASTM for water line construction.

Apply Section 1505 for excavation, trenching, pipe laying and backfill to water line installation.

Install small diameter pipe (4 inches or less) under existing pavement by a trenchless method at no additional cost to the Department.

Connect the ends of the water service piping using AWWA C800 type couplings or fittings. Make NPT screw joints with a double wrap of a polytetrafluoroethylene (PTFE) tape and torque as required by the manufacturer.

Store plastic pipe out of direct sunlight until burying. All plastic pipe showing discoloration or deterioration will be rejected for use and replaced with suitable pipe as specified under Article 106-9.

Install water lines with 36 inches to 42 inches of cover to finished grade unless otherwise directed or approved by the Engineer. Install water lines with greater cover for short distances to accommodate utility controls, to make tie-ins to existing facilities, to eliminate high points in the pipeline or to provide clearance between existing and proposed utilities, drainage, other obstacles or actual field conditions.

(B) Testing and Sterilization

Perform pressure and leakage tests and sterilization on newly installed water mains and altered water mains prior to placing such pipelines into service. Provide all equipment, piping, controls, pumps, water and safety devices necessary for performing the tests and sterilization.

Obtain clean water for cleaning, testing and sterilization from approved sources. Provide connections to potable water sources with approved backflow preventors until acceptance of all test results.

Perform tests using clean water and provide certified results demonstrating leakage less than the following amount when pressurized at 200 ± 5 psi for 2 hours.

$$\mathbf{W} = LD\sqrt{P} \div 148{,}000$$

Where:

W = allowable leakage in gallons per hour
L = length of pipeline tested, in feet
D = nominal diameter of the pipe, in inches
P = average test pressure during the leakage test, in lb/sq.in.

Repair using approved methods or replace pipe, controls or appurtenances as necessary to reduce leakage below acceptable levels. Additionally, repair any leaks that are visible after 2 hours duration.

Clean water lines by flushing with water at least 2.5 feet per second velocity. Remove all debris and dirt from water mains larger than 4 inches by passing a medium density foam pig with abrasive strips through the lines.

Sterilize water lines in accordance with Section 1003 of the Rules Governing Public Water supply and AWWA C651 Section 4.4, the Continuous Feed Method. Provide a

chlorine solution with between 50 parts per million and 100 parts per million in the initial feed. If the chlorine level drops below 10 parts per million during a 24 hour period, then flush, refill with fresh chlorine solution, and repeat for 24 hours. Provide certified bacteriological and contaminant test results from a state-approved or state-certified laboratory. Operate all valves and controls to assure thorough sterilization. Testing, cleaning and sterilization shall be performed consecutively.

Dispose of waste water in accordance with all environmental regulations.

For short sections (less than 100 feet) and tie-in sections of water lines perform visual tests for leakage after installation instead of separate pressure and leakage tests. Sterilize according to AWWA C651 Sections 4.6 and 4.7.

Provide an electronic copy of the test results to the Engineer and to the water line owner. Provide a hard copy to the water line owner as requested.

Flush with clean water until the residual chlorine is reduced to the same level as in the existing water mains.

Place new water lines into service after approval of all testing and flushing and authorization by the Engineer.

1510-4 MEASUREMENT AND PAYMENT

__" *Water Line* will be measured and paid in actual number of linear feet of water line that has been incorporated into the completed and accepted work. Measurement of water line will be made by counting the number of joints used and multiplying by the length of the joint to obtain the number of linear feet of water line installed and accepted. Measurements of partial joints will be made along the length of the partial joint to the nearest 0.1 foot.

The quantity of *Ductile Iron Water Pipe Fittings* will be measured and paid per pound based on the published weights for ductile iron fittings, exclusive of the weights of any accessories, as listed in the "DI Fittings Weight Chart" located on the Utilities Unit website. If the Contractor elects to use compact ductile iron water pipe fittings, measurement will be based on the weight of standard size ductile iron water pipe fittings. Any fitting not listed will be measured based on the published weights for ductile iron fittings listed in AWWA C110/A21.10. Any fitting not listed in AWWA C110/A21.10 will be measured based on the published weights for ductile iron compact fittings listed in AWWA C153. This is limited to pressure pipe 4 inches or larger.

If the contract does not include such pay items, measurement will not be made and the work will be incidental to other contract pay items.

Payment will be made under:

Pay Item	**Pay Unit**
__" Water Line	Linear Foot
Ductile Iron Water Pipe Fittings	Pound

SECTION 1515
UTILITY CONTROLS

1515-1 DESCRIPTION

Provide appropriate control devices, valves, meters, backflow prevention assembly and hydrants on water lines and force main sewers.

1515-2 MATERIALS

Refer to Division 10.

Item	Section
Sanitary Sewer	1034
Water	1036

Deliver only approved materials to the project.

Air release valves and combination air valves shall meet AWWA C512. In addition, air release valves for sanitary sewer force mains shall have long bodies, shall be equipped with back flushing connections and shall have a hood over the outlet.

Double check valves (DCV) and Reduced Pressure Zone principal (RPZ) backflow prevention assemblies shall be listed on the University of Southern California Foundation for Cross-Connection Control and Hydraulic Research list of approved backflow devices. Line stops consist of a sleeve, temporary valve and closure cap. The sleeve and cap shall meet applicable AWWA standards, shall be made of cast iron or stainless steel, shall be pressure rated at 200 psi and shall be sized for the type pipe to be tapped. The temporary valve shall be suitable for contact with potable water with NSF certification and designed to match the actual field conditions.

Line stop bypass pipe shall be pressure rated at 200 psi, shall be NSF certified and shall be adequately restrained.

Use screw or slip type valve boxes with a base to fit the valve yoke and a removable plug cap with the word “Water” or “Sewer” cast therein.

Install precast manholes in accordance with Section 1525.

1515-3 CONSTRUCTION METHODS

Apply Section 1505 for excavation, trenching, pipe laying and backfill.

Place two 4 inch x 8 inch x 16 inch concrete blocks beneath valves and fire hydrants for support.

When necessary, due to project staging, install valves, meters and fire hydrants as appropriate for the current grade and make adjustments to finished grade as work progresses.

Provide enclosures with positive drainage for utility controls.

(A) Valves

Install all valves with an approved valve box set flush with the ground or pavement. Place a 24 inch diameter precast concrete ring flush with the ground around all valve boxes not in pavement.

Test and sterilize tapping valves before making the tap. Do not allow cuttings to enter the tapped main.

(B) Meters

Install water meters adjacent to the right of way or as shown in the plans.

Place meter boxes with the top of the meter box flush with finished grade of the project.

(C) Backflow Prevention Assembly

Install backflow prevention assembly off the highway right of way or as shown in the plans.

Licensed installers shall test and certify RPZ backflow preventer installations. Enclose RPZ backflow prevention assembly above grade in a hot box.

Enclose DCV backflow prevention assembly below grade in a precast concrete vault with positive drainage or above grade in a hot box.

Install the hot box on a 4 inch thick concrete slab that is 6 inches larger than the box and 2 inches to 4 inches above finished grade.

(D) Fire Hydrants

Install fire hydrants outside of the vehicle recovery area of the roadway, adjacent to the right-of-way line or in protected areas.

Connect fire hydrants to the main with a 6 inch valve and branch line having at least as much cover as the distribution main. Set hydrants plumb with the pumper nozzle facing the roadway and with the breakaway safety flange between 1 inch and 4 inches above the finished surrounding grade. Except where otherwise approved, place hydrants into service as soon as practicable. Place at least 7 cf of clean crushed stone around the base of the hydrant to insure drainage of the hydrant barrel.

Where necessary, remove the hydrant shoe and replace with the appropriate type to connect a relocated hydrant to the new pipe. Furnish and install or remove hydrant extension pieces to provide the proper bury of the pipe and hydrant.

(E) Line Stops

Provide line stop valves to temporarily shut down the flow in pressurized pipes. Provide line stops to temporarily dead end a pipeline when there are no available working valves on the existing piping. Provide line stops with bypass to isolate a section of the existing pipeline while maintaining the flow.

After line stop valves are removed, permanently cap the tapping sleeve and backfill the entire excavation with compacted select material.

(F) Air Release Valves and Combination Air Valves

Install air release valves and combination air valves at the high point of pressurized pipelines. Place a precast manhole around air release valves and combination air valves.

(G) Miscellaneous Controls

Install corporation stops with tapping saddles for connecting 2 inches or smaller water lines to larger water lines. Install corporation stops at 45 ± 10 degrees from vertical on the larger line.

To aid in testing and flushing, install corporation stops at all elevated points along the pipeline to bleed off all entrapped air.

1515-4 MEASUREMENT AND PAYMENT

__" *Valves,* __" *Water Meters, Fire Hydrants,* __" *Line Stops* and other items listed in the pay items will be measured and paid per each for the appropriate size and type. *Fire Hydrant Leg* will be paid per linear foot. Valves for the fire hydrant leg will be paid separately as __" *Valves*.

The term *Relocate* in a pay item means to physically move the existing item, either vertically or horizontally, using the appropriate materials to place the item into working order. Measurement and payment will be made per each for the appropriate size and type. When relocating a fire hydrant, valves will only be paid for if there is no properly functioning existing valve.

No additional compensation will be made for adjustments due to project staging on new or relocated items.

Reconnect Water Meter means to transfer or replace the piping from a new water line to an existing water meter that is not relocated. Measurement and payment for meters will be made per each.

__" *Water Service Line* will be paid per linear foot for pipes 2 inches or greater.

Water Service Line will be paid per linear foot for pipes less than 2 inches.

Valve boxes, meter boxes, hot boxes, vaults and manholes for protecting and servicing utility controls are incidental to the appropriate pay item.

A __" *Line Stop with Bypass* consists of installing line stops on opposite ends of the piping to be isolated, tapping the piping beyond the line stops and providing temporary bypass piping between the taps. The entire assembly of valves and piping will be measured as one unit and paid per each.

Corporation stops or other items to aid in testing and flushing of the piping are incidental items.

If the contract does not include such pay items, measurement will not be done and the items will be incidental to other contract pay items. All piping, controls, certifications, appurtenances and other miscellaneous items necessary to place the new or relocated item in proper working condition are incidental.

Payment will be made under:

Pay Item	**Pay Unit**
__" Valve	Each
__" Insertion Valve	Each
__" Plug Valve	Each
__" Tapping Sleeve and Valve	Each
__" Air Release Valve	Each
__" Combination Air Valve	Each
__" Blow Off	Each
__" Water Meter	Each
Relocate Water Meter	Each
Reconnect Water Meter	Each
__" DCV Backflow Prevention Assembly	Each
Relocate __" DCV Backflow Prevention Assembly	Each
__" RPZ Backflow Prevention Assembly	Each
Relocate __" RPZ Backflow Prevention Assembly	Each
Fire Hydrant	Each
Relocate Fire Hydrant	Each
__" Line Stop	Each
__" Line Stop with Bypass	Each
Fire Hydrant Leg	Linear Foot
__" Water Service Line	Linear Foot
Water Service Line	Linear Foot

SECTION 1520
SANITARY SEWER

1520-1 DESCRIPTION

Provide sanitary sewers suitable for transporting sewage.

1520-2 MATERIALS

Refer to Division 10.

Item	**Section**
Sanitary Sewer Pipe and Fittings	1034

Use any pipe specified under Section 1034 except where a particular type pipe is specified in the plans or required by environmental regulations or Departmental policy. Verify the pipe is appropriate for the test pressure of the system and the external loading.

For sewer services and laterals use pipe conforming to the current requirements of the *North Carolina State Building Code: Plumbing Code* for building sewer pipe.

Use ductile iron fittings on pressurized (force main) pipelines 4 inches or larger.

Use screw type plastic or brass clean-out covers.

Use #12 AWG solid-copper wire with green insulation for the utility locator wires.

Use 2 inch plastic marking tape colored green with "Caution Sewer Line," or similar wording, permanently printed at 36 inch centers.

1520-3 CONSTRUCTION METHODS

Apply Section 1505 for excavation, trenching, pipe laying and backfill to sanitary sewer installation.

Assemble pipe in accordance with the recommendations of the manufacturer.

Install PVC pipe in accordance with approved bedding methods.

Install vitrified clay sewer pipe in accordance with ASTM C12.

Install 4 inch minimum diameter sanitary sewer clean-outs flush with finished grade on 4 inch and 6 inch service lines. Provide clean-outs at the right-of-way line and at changes in direction. Do not locate clean-outs within the roadway pavement or shoulders. Provide clean-outs no more than 50 feet apart when beyond the roadway shoulders.

Use ductile iron pipe for sewers with 10% or greater slope.

Install sewer lines entering manholes with the crown at or higher than the sewer line leaving the manhole.

Install small diameter pipe (4 inches or less) under existing pavement by a trenchless method at no additional compensation.

(A) Gravity Sanitary Sewer

Construct gravity sanitary sewers in conformance with *NCDEQ Gravity Sewer Minimum Design Criteria*.

(1) Pipe Installation

Use fittings or saddles to connect service lines to the sewer main.

Maintain sewer flow at all times. Use temporary diversions or pumping to maintain flow when connecting proposed sewers to existing sewers. Use engineered temporary pumping systems capable of handling full pipe flow. Use pumping systems with automatic reliable operation or constantly tended manual operation.

(2) Testing

Perform tests on newly installed sewers and altered sewers before placing into service. Provide all equipment, piping, controls, pumps, water and safety devices necessary for performing the tests.

Test all 24 inches and smaller gravity sewer lines for leakage using infiltration, exfiltration, or air test. Perform visual inspection on gravity sewer lines larger than 24 inches. Perform line and grade testing and deflection testing on all gravity sewer lines.

(a) Infiltration

For sewer lines greater than 3 feet below groundwater, measure the amount of water infiltrating into the pipeline between manholes in at least 24 hours. Repair leaks or replace piping when the rate of infiltration exceeds the following equation:

$$W = 0.000789LD$$

Where:

W = maximum allowable leakage in gallons per hour
L = length of pipeline tested, in feet
D = nominal diameter of the pipe, in inches

(b) Exfiltration

For sewer lines above groundwater, perform an exfiltration test on the pipeline between manholes. Repair leaks or replace piping when the rate of exfiltration exceeds maximum allowable leakage calculated in Subarticle 1520-3(A)(2)(a).

The exfiltration test shall consist of securely plugging the pipe at the lower manhole and filling the pipeline with water. Allow the water to sit for 24 hours in clay or concrete pipes. Raise the water level in the upstream manhole to 3 feet above the top of pipe. After 4 hours, measure the amount of water required to bring the water level back to the level at the start of the test and record the time.

Perform exfiltration tests through a series of manhole to manhole segments to limit the length of pipe tested to between 300 feet and 1,500 feet. Shorter sections may be tested with longer test times. No additional leakage allowance for manholes permitted.

(c) Air Test

Instead of hydrostatic testing, sewer lines 24 inches in diameter or smaller may be air tested in accordance with ASTM C828 and the following. Securely plug the sewer pipe at the manholes. Fill the pipe with air to 4.0 psi and hold this pressure for 5 minutes. Reduce the pressure to 3.5 psi. Measure the time for the pressure to drop 1.0 psi to the new pressure of 2.5 psi. Exceed the minimum test time shown in Table 1520-1 for the appropriate nominal pipe diameter.

TABLE 1520-1
AIR TEST TIME

Pipe Size (Inches)	Test Time (Minutes/100 ft)	Pipe Size (Inches)	Test Time (Minutes/100 ft)
8	1.2	18	2.4
10	1.5	21	3.0
12	1.8	24	3.6

(d) Visual Inspection

Visually inspect sewer lines larger than 24 inches from the inside using approved cameras. Correct any leakage, rolled gaskets or defects.

(e) Line and Grade

Test all sewers for straight alignment by lamping or using a laser.

(f) Deflection Testing

Perform deflection tests on all flexible pipes. Conduct the test after the final backfill has been in place at least 30 days to permit stabilization of the soil-pipe system. As an alternative to waiting 30 days to permit stabilization of the

soil-pipe system, provide certified soil testing verifying the backfill of the trench has been compacted to at least 95% maximum density.

No pipe shall exceed a deflection of 5%. If deflection exceeds 5%, relay the pipe.

The rigid ball or nine-point mandrel used for the deflection test shall have a diameter not less than 95% of the base inside diameter or average inside diameter of the pipe depending on which is specified in the ASTM, to which the pipe is manufactured. The pipe shall be measured in compliance with ASTM D2122. The test shall be performed without mechanical pulling devices.

(B) Force Main Sanitary Sewer

Construct force main sewers in conformance with *NCDEQ Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains*.

(1) Installation

Install lines with 36 inches to 42 inches of cover to finished grade unless otherwise directed or approved by the Engineer. Install lines with greater cover for short distances to accommodate utility controls, to make tie-ins to existing facilities, to eliminate high points in the pipeline or to provide clearance from existing or proposed utilities, drainage, other obstacles or actual field conditions.

Provide automatic air release valves at all high points.

(2) Testing

Perform pressure and leakage tests on newly installed force mains and altered sewers before placing such pipelines into service. Provide all equipment, piping, controls, pumps, water and safety devices necessary for performing the tests and sterilization.

Test all new sewer force mains with clean water at 200 ± 5 psi for a 2 hour duration. Vent all high points and expel all air. Provide certified results demonstrating leakage less than:

$$\mathbf{W} = 0.000106LD$$

Where:

W = allowable leakage in gallons per hour
L = length of pipeline tested, in feet
D = nominal diameter of the pipe, in inches

Repair leaks using approved methods or replace pipe, controls or appurtenances as necessary to reduce leakage. Additionally, repair any leaks that are visible after 2 hours duration.

1520-4 MEASUREMENT AND PAYMENT

__" *Sanitary Gravity Sewer* and __" *Force Main Sewer* will be measured and paid in actual number of linear feet of sewer line that has been incorporated into the completed and accepted work. Measurement of sewer line will be made by counting the number of joints used and multiplying by the length of the joint to obtain the number of linear feet of sewer line installed and accepted. Measurements of partial joints will be made along the length of the partial joint to the nearest 0.1 foot. All fittings will be incidental on *Sanitary Gravity Sewer*.

Sanitary Sewer Clean-Out will be measured and paid per each.

Sewer Service Line will be paid per linear foot.

The quantity of *Ductile Iron Sewer Pipe Fittings* will be measured and paid per pound based on the published weights for ductile iron fittings, exclusive of the weights of any accessories, as listed in the "DI Fittings Weight Chart" located on the Utilities Unit website. If the Contractor elects to use compact ductile iron sewer pipe fittings, measurement will be based

on the weight of standard size ductile iron sewer pipe fittings. Any fitting not listed will be measured based on the published weights for ductile iron fittings listed in AWWA C-110/A21.10. This is limited to pressure pipe 4 inches or larger.

Payment will be made under:

Pay Item	Pay Unit
__" Sanitary Gravity Sewer	Linear Foot
__" Force Main Sewer	Linear Foot
Sanitary Sewer Clean-Out	Each
Sewer Service Line	Linear Foot
Ductile Iron Sewer Pipe Fittings	Pound

SECTION 1525
UTILITY MANHOLES

1525-1 DESCRIPTION

Provide utility manholes on water and sanitary sewer lines.

1525-2 MATERIALS

Refer to Division 10.

Item	Section
Brick	1040-1
Concrete Block	1040-2
Curing Materials	1026
Gray Iron Castings	1074-7(B)
Grout, Type 2	1003
Mortar	1040-9
Portland Cement Concrete	1000
Precast Concrete Units	1077
Reinforcing Steel	1070
Select Materials	1016
Steps	1074-8
Structural Steel	1072

Use precast concrete manholes with monolithic bottoms which conform to ASTM C478, AASHTO M 199 and are as shown in the plans or in *Roadway Standard Drawings*. Use ASTM C443 gaskets or ASTM C990 flexible sealants for joints between precast manhole sections. Use resilient connectors for piping conforming to ASTM C923. Use ASTM A48, Class 35 cast iron or Grade 60 steel reinforcement steps with polypropylene plastic coating.

Use manhole frames and covers made of cast iron conforming to ASTM A48 Class 35, which are traffic bearing, have machined contact surfaces and are sized as shown. Use covers with two 1 inch diameter air vents for vented manholes and use solid, non-vented covers with gaskets for watertight installation. Use covers with “Sanitary Sewer” or “Water” cast in large letters as appropriate for the type of utility.

Use Type 2 grout with properties that meet Table 1003-2 except provide grout with a plastic consistency in accordance with ASTM C1107.

1525-3 CONSTRUCTION METHODS

Apply Section 1505 for excavation, trenching, pipe laying and backfill.

Make connections of pipe to manholes in cored or precast holes using a resilient connector. Use horseshoe type holes only when approved by the Engineer. For horseshoe type holes wrap the pipe with a butyl rubber gasket and fill the space between the pipe and manhole with a non-shrinking grout.

Provide an outside drop assembly on manholes for sewer pipes entering with 2.5 feet or more vertical drop. Inside drop assemblies may be used for connections to existing manholes when the drop exceeds 5 feet and the manhole diameter is greater than 4 feet.

In sewer manholes over 3 feet in depth, provide steps spaced 16 inches on center. Install steps in line with the effluent opening unless otherwise specified.

Construct invert channels to confine and direct the flow through sanitary sewer manholes. Use smooth finished invert channels that provide easy transition from inlet to outlet. Finish the benches or shelves to a non-slip texture and slope toward the invert channel. Precast invert channels are recommended but not required.

On deep manholes, a transition type manhole may be used provided there is at least 6 feet from the manhole bench to the transition cone.

Construct manholes with the top of the cover as shown in Table 1525-1.

TABLE 1525-1
MANHOLE CONSTRUCTION

Location	Top height above finished grade
Roadway pavement, Driveways, Sidewalks, Parking lots	Flush ± 1/4"
Vehicle Recovery Area	Flush ± 3"
Manicured Areas, such as lawns	Flush to + 2" with concrete pad
Flood Zones less than 3 ft above finished grade	1 ft above 100 year flood elevation
Flood Zones greater than 3 ft above finished grade	2 ft above finished grade with watertight frame and cover and vent pipe to 1 ft above 100 year flood
Other areas	2 ft above finished grade

For manholes installed before finished grading or paving, construct the top flush with the current grade to provide access during all phases of construction and adjust as grading and paving work progresses in accordance with Section 858.

(A) Cast-In-Place Concrete, Brick and Block Masonry

Construct concrete manholes in accordance with Section 825 with an ordinary surface finish. Construct brick masonry in accordance with Section 830. Furnish and place reinforcing steel in accordance with Section 425. Construct block masonry in accordance with Section 834 except that reinforcing will not be required.

Where necessary to fit field conditions, vary the dimensions of the manhole and footings as directed.

(B) Installation of Precast Units

Assemble precast manhole units in accordance with the manufacturer's instructions and grout together to form a sound structural unit. Fill all lifting holes with grout. Where it is necessary to use cast-in-place, brick masonry or block masonry construction as part of the structure, apply Subarticle 1525-3(A) to such construction.

(C) Fittings and Connections

Where fittings enter the manhole, place them as the work is built up, thoroughly bonded and accurately spaced and aligned.

Make pipe connections so that the pipe does not project beyond the inside wall of the manhole and grout smooth and uniform surfaces on the inside of the manhole.

Set metal frames for covers in full mortar beds and mechanically secure by an approved method.

(D) Testing

Vacuum test all manholes before grouting and backfilling. Test according to ASTM C1244.

1525-4 MEASUREMENT AND PAYMENT

The height of the manhole will be measured and paid to the nearest tenth of a foot from the inside bottom (invert) of the manhole to the final finished top of the manhole ring.

__' Dia Utility Manhole and *Utility Manhole Wall __' Dia* will be measured and paid by appropriate diameter per each for manholes of 0 to 6 feet height and per linear foot of height over 6 feet. Adjustment or reconstruction of existing manholes will be measured and paid in accordance with Article 858-4. Drop assemblies will be incidental to the work being performed.

Payment will be made under:

Pay Item	Pay Unit
__' Dia Utility Manhole	Each
Utility Manhole Wall __' Dia	Linear Foot

SECTION 1530
ABANDON OR REMOVE UTILITIES

1530-1 DESCRIPTION

Abandon or remove utility facilities.

1530-2 MATERIALS

Refer to Division 10.

Item	Section
Flowable Fill	1000-7
Portland Cement Concrete	1000
Select Materials	1016

1530-3 CONSTRUCTION METHODS

Apply Section 1505 for excavation, trenching, pipe laying and backfill.

(A) Abandoning Pipe

Abandon utility pipes shown in the plans or designated by the Engineer by emptying the pipeline contents and plugging the ends with grout or flowable fill. Prepare grout or flowable fill to a consistency that will flow and be vibrated in order for the mix to flow uniformly into the pipe to be filled. Use the construction methods in Article 340-3.

Fill or remove the following abandoned utility pipes:

(1) Pipe larger than 24 inches.

(2) Pipe located within the roadway typical section or the project slope stake line and one of the following:

(a) Pipe 12 inches to 24 inches diameter located less than 20 feet below finished grade.

(b) Pipe 6 inches to 12 inches diameter located less than 12 feet below finished grade and not made of cast iron, ductile iron, HDPE or PVC.

(c) Located below groundwater table that could become a conduit for water movement.

Excavate, remove and dispose of properly any abandoned pipe to be removed. Backfill the resulting trench and properly compact using local excavated material or select backfill as required.

Fill abandoned pipe with grout or flowable fill to at least 90% full or completely when on railroad right of way.

Remove any abandoned utility pipe exposed by grading operations to a minimum depth of 12 inches below subgrade elevation of the proposed roadbed or completed grading template.

Plug all abandoned utility pipes. Use grout to plug all abandoned utility pipes at the entrance to all manholes whether the manhole is to be abandoned or not. Use grout or flowable fill to plug all abandoned water mains after new mains are placed in service. Abandon valves by removing valve box and backfilling with approved material.

(B) Abandoning Manholes

Abandon utility manholes in the construction limits by removing the top of the manhole to the manhole spring line or to an elevation of 2 feet below the roadway subgrade, whichever is greater and filling the manhole barrel with approved material.

Plug connecting utility pipes before filling or removing the manhole.

Remove the manhole taper, wall and base on all manholes to be removed.

Removed frames and covers become the property of the Contractor for proper disposal.

(C) Remove Water Meter

Remove water meters by disconnecting and plugging the water service piping at the source main and plugging the piping at the right-of-way line. Return the meter to the utility owner. Dispose of all other parts, piping and boxes.

(D) Remove Fire Hydrant

Remove fire hydrants by disconnecting and plugging the hydrant leg piping as close to the water main as possible. If the hydrant valve is within 4 feet of the main, close the valve, plug the outlet side of the valve and remove the valve box.

Removed hydrants become the property of the Contractor for proper disposal.

1530-4 MEASUREMENT AND PAYMENT

Utility pipe that is abandoned by filling or removal will be measured and paid by the linear foot for the size of pipe. Utility pipe that is abandoned by plugging the ends only and leaving in place will not be measured or paid. Abandoned valves will not be measured and paid. Grout or flowable fill used for plugging of abandoned utility pipe is incidental to the work being performed. Utility pipe that is removed by other work of the contract will be incidental to the other work. Material used to fill the abandon utility pipes is incidental to the work being performed.

Abandon Utility Manhole will be measured and paid per each.

Remove Utility Manhole will be measured and paid per each.

Remove Water Meter and *Remove Fire Hydrant* will be measured and paid per each.

Payment will be made under:

Pay Item	Pay Unit
Abandon __" Utility Pipe	Linear Foot
Abandon Utility Manhole	Each
Remove Utility Manhole	Each
Remove Water Meter	Each
Remove Fire Hydrant	Each

SECTION 1540
ENCASEMENT

1540-1 DESCRIPTION

Furnish and install encasement or casing pipes. For the purposes of this specification the words encasement, casing, encasement pipe and casing pipe are interchangeable.

1540-2 MATERIAL

Refer to Division 10.

Item	Section
Concrete Pipe	1034-3
Flowable Fill	1000-7
Grout	1003
PVC Pipe	1034-2
Select Materials	1016
Steel Encasement Pipe	1036-4(B)
Treated Timber	1082-3
Clay Pipe	1034-1

Other pipe as designed by an engineer licensed by the State of North Carolina.

Submit material certifications and obtain approval from the Engineer before installation.

1540-3 CONSTRUCTION METHODS

(A) Open Cut

Apply Section 1505 for excavation, trenching, pipe laying and backfill.

(B) Welding

Weld in accordance with Article 1032-5.

(C) Encasements for Future Use

Mark encasements for future use with a treated wooden marker post. Place wooden marker post at the right of way or at the ends of encasements if encasements extend beyond the right of way.

(D) Carrier Pipe Installation

Install carrier pipe through casing using spacers or insulators to support the carrier pipe. Place spacers at intervals sufficient to support the carrier pipe without sagging. Install spacers sized to raise the carrier pipe bells above the encasement pipe invert.

Seal ends of casing with concrete, brick or other approved materials. Ensure drainage of encasement by leaving a 1 inch diameter weep hole in the seal of the lower end of the encasement.

(E) Casing Pipe Fill

Pump or place flowable fill; grout; or Class III, Class IV or Class V select materials into the annular void between the carrier pipe and casing pipes if required in the plans.

1540-4 MEASUREMENT AND PAYMENT

__" *Encasement Pipe* will be measured from end to end and paid at the contract unit price per linear foot for each size. Material used to fill the annular void is incidental to the work being performed.

Payment will be made under:

Pay Item	Pay Unit
__" Encasement Pipe	Linear Foot

SECTION 1550
TRENCHLESS INSTALLATION OF UTILITIES

1550-1 DESCRIPTION

Install pipe using a trenchless method. Pipe refers to the specified pipe, which may be the primary carrier pipe or an encasement pipe. Shoring means the earth support system used for installing the pipe. The terms for encasement, casing, encasement pipe and casing pipe are interchangeable.

An engineer licensed by the State of North Carolina shall design the method for installation of the pipe in the native soil and certify the work will not damage the roadway above or endanger the roadway user.

1550-2 MATERIAL

Refer to Division 10.

Item	Section
Portland Cement Concrete	1000
Encasement Pipe	1540
Flowable Fill	1000-7
Structural Timber	1082
Structural Steel	1072
Treated Timber	1082-3

Use pipe joints that are modified to suit the installation method. Provide engineering calculations for piping and shoring. Submit material certifications and obtain approval from the Engineer before installation.

Use steel or concrete liner plates. Steel tunnel liner plates shall meet Sections 16 and 25 in *AASHTO LRFD Bridge Construction Specifications*. Concrete liner plates shall meet AASHTO specifications.

Drilling fluids consist of water, bentonite and polymer additives.

Other materials will be considered with adequate design and quality control.

1550-3 CONSTRUCTION METHODS

(A) General

Apply Section 1505 for excavation, trenching, pipe laying and backfill.

Install the pipe to the lines and grades shown in the plans. Use workers that are skilled in the method of construction. Construct with good workmanship by skilled workers along with proper safety precautions.

Locate ends of trenchless construction and pits beyond the vehicle recovery area of the roadway. The vehicle recovery area may be reduced using acceptable traffic control methods.

(B) Design

Contract plans will show a trenchless method including but not limited to length, profile and bore pit locations based on available information. The Contractor's design shall confirm this method is appropriate for the field conditions, for the specified pipe and for the Contractor's equipment. Subsurface information in the vicinity of the trenchless installation may be available in accordance with Section 102-7.

Assess soil conditions expected during trenchless operations.

Design the method to minimize the vertical movement of the pipe or the completed roadway section. Use methods of construction and installation that will not disturb the soils outside of the immediate vicinity of the pipeline or pits.

Before construction, provide detailed plans for the method of installation certified by an engineer licensed by the State of North Carolina. Provide certified calculations demonstrating the method of installation as safe and of minimal risk. Provide certified calculations of the structural adequacy of all materials. The design shall meet *AASHTO LRFD Bridge Design Specifications*. An engineer licensed by the State of North Carolina shall certify changes or modifications to the designed method as needed for actual field conditions.

(C) Water Control

Provide groundwater control and removal as appropriate for the method of excavation and installation. Remove the groundwater using an engineered dewatering system provided in the design submittal. Keep surface waters out of the excavation and pits.

(D) Shoring

Provide temporary or permanent shoring, as needed. Provide temporary shoring to maintain the hole or pit excavation for the duration of the work.

Fill all voids around the excavation and shoring with structural fill material as work progresses.

Either work continuously (24 hours/day and 7 days/week) on the operations from the time the excavation begins through the filling of voids or use an engineered system for shoring the excavation during work stoppage.

(E) Pre-Construction Meeting

The Contractor shall conduct a pre-construction meeting with the Engineer to review the proposed method for installation of the pipe. Conduct the meeting at least 48 hours before beginning installation. The meeting shall consist of, but is not limited to:

(1) Presentation of the construction methods for understanding by all involved,

(2) Presentation of methods for filling any potential voids around the pipe,

(3) Demonstrating that appropriate equipment and materials are on site,

(4) Providing a progress schedule, and

(5) Demonstrating ability to react to failures or roadway settlement or heave.

1550-4 TRENCHLESS METHODS

(A) Bore and Jack

For bore holes up to 6 inches in diameter in stable ground, the hole may be augured and the pipe pushed or jacked through the cleaned out hole. For bore holes greater than 6

inches, provide continuous support of the hole by simultaneously jacking the pipe or casing into the hole.

Use equipment suitably sized and designed to simultaneously bore or drill the soil or rock while pushing or jacking pipe on a controlled grade. Position the cutter head within one diameter of the leading edge of the pipe. In cohesive, dense and dry soils and rock, position the cutter head in front of the leading edge. In non-cohesive or loose soils, position the cutter head inside the pipe.

Dry bore only, do not use jetting or wet boring methods. Use drilling fluids only on the outside of pipe for lubrication or hole stabilization.

Minimize over bore, match cutter diameter to the outside diameter of the encasement pipe. Limit overbore to the O.D. + 2 inches.

Provide steering controls as necessary to maintain line and grade.

If conditions allow and with the approval of the Engineer, the Contractor may elect to use the pipe ramming method in lieu of bore and jack. Payment for the pipe ramming method will be paid as bore and jack.

(B) Directional Drilling

For drilled holes up to 6 inches in diameter in stable ground, the hole may be drilled and reamed followed by pulling the pipe into the hole within 8 hours. For drilled holes greater than 6 inches, simultaneously pull the pipe or casing into the hole as reaming occurs.

When under pavement or within a one horizontal to one vertical distance from pavement, maintain the depth of cover shown in Table 1550-1.

TABLE 1550-1
DEPTH OF COVER FOR DIRECTIONAL DRILLING

Drilled Hole Diameter	Minimum Depth of Cover
2" to 6"	6 ft
> 6" to 15"	12 times the hole diameter
> 15" to 36"	15 ft

Begin bores at locations that allow transitioning the bore to meet the above depths.

Use drilling fluids as appropriate for the type soils. Pump drilling fluids only while drilling or reaming. Monitor flow rates to match the amount leaving the bore hole. Do not increase pressure or flow to free stuck drillheads, reamers or piping.

Limit drilled or reamed holes to 1.5 x O.D. for pipe 12 inches or less and O.D. + 6 inches for pipes larger than 12 inches.

(C) Tunneling

Tunnel using hand mining, mechanical excavation, tunnel boring machine (TBM), microtunneling , or other accepted tunneling method. Use tunnel shields or fore poling along with benched excavation and breast boarding as appropriate for the field conditions. Alternatively, the Contractor’s engineer may certify that the soils are self-supporting of the dead and live loads and design tunneling methods as appropriate.

Provide active support to the tunnel walls. Shore tunnel walls using liner plates, steel ribs with lagging or other engineered method or by jacking piping into place.

Limit over excavation to 2 inches larger than the liner or shield. Grout the external voids as work progresses and as specified by the Contractor’s engineer.

(D) Pipe Ramming

Use pipe ramming only where soils are homogeneous and free of rock, boulders, stumps and debris. Do not use in the vicinity of quick or liquefiable soils.

Steel bands 1/2 inch thick are allowed on the outside of the leading edge of the pipe or casing to oversize the hole to reduce friction. Steel bands 1/2 inch thick may be used on the inside to compact the spoil and to prevent plugging.

Install at the following minimum depth of cover shown in Table 1550-2.

TABLE 1550-2
DEPTH OF COVER FOR PIPE RAMMING

Pipe or Casing Diameter	Minimum Depth of Cover
2" to 6"	4 ft
> 6" to 14"	6 pipe diameters
>14" to 72"	8 ft

Contain spoil within the casing during ramming. After completion, use compressed air or augers to remove the spoil. Clean the interior using a pig. Provide appropriate safety devises. Limit air pressure to less than the rating of the pipe or casing.

Use lubricants and surfactants as needed and ensure vibration induced consolidation of soils does not result in settlement greater than 0.02 feet.

(E) Other Methods

Other methods will be considered on a case by case basis when thoroughly engineered.

(F) Lubrication and Drilling Fluids

Use drilling fluids for lubrication. Do not use water alone.

1550-5 QUALITY CONTROL

The Contractor, at no cost to the Department, shall replace or repair damaged or defective installations. The method to be used shall be designed by the Contractor's engineer and approved by the Engineer.

(A) Ground Movement

Before excavation, establish control points for measuring vertical movement of the road at 10 feet intervals along the centerline and 10 feet each side of the pipeline. A land surveyor licensed in the State of North Carolina shall monitor these points daily until construction is complete.

Cease trenchless operations when measured movement exceeds 0.02 feet. Determine cause of settlement and repair as necessary. Modify trenchless methods as needed.

(B) Leakage

Limit leakage through tunnel walls to minor seepage. All leaks in pipes, casing or other permanent shoring shall be sealed.

(C) Roundness

Provide permanent shoring maintaining at least 95% of nominal diameter in all directions.

(D) External Voids

Fill all external voids greater than 2 inches high or 2 feet wide. Fill with flowable fill, grout or Class II or III select material.

1550-6 MEASUREMENT AND PAYMENT

Bore and Jack of ___" will be measured and paid in linear feet. Measurement will be made along the bore to the nearest linear foot.

Directional Drilling of ___" will be measured and paid in linear feet. Measurement will be made along the directional drill to the nearest linear foot.

Tunneling of ___" will be measured and paid in linear feet. Measurement will be made along the tunnel to the nearest linear foot.

Measurement will be made along utility pipes with required trenchless installation. Payment for trenchless installation will be made as additional compensation for utility piping with contract pay items of the various sizes. No additional payment will be made for access pits or shoring required for the installation. No additional payment will be made for changes or modifications to the designed method. Shoring required for the maintenance of traffic or the protection of building or other structures, on or off the right of way, will be paid under *Temporary Shoring*. Material used to fill external voids is incidental to the work being performed. No payment will be made for abandoning defective installations.

Payment will be made under:

Pay Item	**Pay Unit**
Bore and Jack of ___"	Linear Foot
Directional Drilling of ___"	Linear Foot
Tunneling of ___"	Linear Foot

DIVISION 16
EROSION CONTROL AND ROADSIDE DEVELOPMENT

SECTION 1605
TEMPORARY SILT FENCE

1605-1 DESCRIPTION

Furnish material, construct, maintain and remove temporary silt fence in locations shown in the plans or in locations that require surface drainage to be filtered.

1605-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextile, Type 3	1056

(A) Posts

Provide steel posts with at least 5 feet long, 1 3/8 inch wide measured parallel to the fence and 1.25 lbs. per foot in weight per length. Equip with an anchor plate with an area of at least 14.0 square inches. Ensure a means of retaining fencing material in the desired position without displacement.

(B) Woven Wire Fence

Provide woven wire fence at least 32 inches high with 5 horizontal wires, vertical wires spaced 12 inches apart, 10 gauge top and bottom wires and 12 1/2 gauge for all other wires.

(C) Attachment Device

Provide plastic ties, wire fasteners or other approved attachment device.

1605-3 CONSTRUCTION METHODS

Install in locations as shown in the plans or as directed by the Engineer.

Install wire and geotextile as shown in *Roadway Standard Drawings*.

Geotextile may be used without the woven wire fence backing with a post spacing of not more than 6 feet.

Install post inclined toward runoff source, at an angle of not more than 20° from vertical.

Attach geotextile to the post with acceptable methods.

Overlap geotextile at least 18 inches at splice joints.

1605-4 MAINTENANCE AND REMOVAL

Maintain the silt fence until the project is accepted by the Engineer or until the fence is removed. Remove and replace deteriorated or ineffective geotextile. Remove and dispose of silt accumulations in accordance with Section 1630 when necessary or as directed by the Engineer.

Leave silt fence in place until site stabilization and remove at project completion. Removed silt fence becomes the property of the Contractor. Dress and seed and mulch all areas where silt fence is removed in accordance with Section 1660.

1605-5 MEASUREMENT AND PAYMENT

Temporary Silt Fence will be measured and paid in linear feet, accepted in place, along the ground line of the fence. Temporary Silt Fence that requires removal and replacement due to general deterioration or ineffective geotextile will be paid at contract unit prices. Repairs to the fence due to carelessness or neglect on the part of the Contractor will be at no cost to the Department.

Silt Excavation will be measured and paid in accordance with Article 1630-3.

Seeding and Mulching will be measured and paid in accordance with Article 1660-8.

Article 104-5, pertaining to revised contract prices, will not apply to *Temporary Silt Fence*. No revision in the contract unit price will be allowed because of any overrun or underrun.

Payment will be made under:

Pay Item	Pay Unit
Temporary Silt Fence	Linear Foot

SECTION 1606
SPECIAL SEDIMENT CONTROL FENCE

1606-1 DESCRIPTION

Furnish materials, construct, maintain and remove special sediment control fence. Place special sediment control fence as shown in the plans or as directed by the Engineer.

1606-2 MATERIALS

Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005

(A) Posts

Provide steel posts in accordance with Subarticle 1605-2(A).

(B) 1/4" Hardware Cloth

Provide hardware cloth with 1/4 inch openings constructed from 24 gauge wire.

(C) Attachment Device

Provide plastic ties, wire fasteners or other approved attachment device.

1606-3 CONSTRUCTION METHODS

Install hardware cloth and sediment control stone in accordance with *Roadway Standard Drawings*. Attach hardware cloth to post with acceptable methods.

Maintain the special sediment control fence until the project is accepted by the Engineer or until the fence is removed. Remove and dispose of silt accumulations at the fence in accordance with Section 1630 and as directed by the Engineer.

1606-4 MEASUREMENT AND PAYMENT

Silt Excavation will be measured and paid in accordance with Article 1630-3.

1/4" Hardware Cloth will be measured and paid in accordance with Article 1632-5.

Sediment Control Stone will be measured and paid in accordance with Article 1610-4.

SECTION 1607
GRAVEL CONSTRUCTION ENTRANCE

1607-1 DESCRIPTION

Furnish, install, maintain and remove all material required for the construction of a gravel construction entrance.

1607-2 MATERIALS

Refer to Division 10.

Item	Section
Stone for Erosion Control, Class A	1042
Geotextile for Drainage, Type 2	1056

1607-3 CONSTRUCTION METHODS

Install a gravel construction entrance in accordance with *Roadway Standard Drawings* and at locations as directed by the Engineer. Install gravel construction entrances in a way to prevent vehicles from bypassing the construction entrance when leaving the project site.

1607-4 MEASUREMENT AND PAYMENT

Geotextile for Drainage will be measured and paid in accordance with Article 876-4.

Stone for Erosion Control, Class ____ will be measured and paid in accordance with Article 1610-4.

Such price and payment shall be full compensation for all work covered by this section including all materials, construction, maintenance and removal of a gravel construction entrance.

SECTION 1609
CLEAN WATER DIVERSION

1609-1 DESCRIPTION

Install, maintain, and remove any and all material required for the construction of clean water diversions. The clean water diversions shall be used to direct water flowing from offsite around/away from specific area(s) of construction.

1609-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextile for Soil Stabilization, Type 4	1056

1609-3 CONSTRUCTION METHODS

Install in location(s) shown on the plans or as directed by the Engineer. Construct in accordance with the details.

Stabilize excavated material immediately in accordance with Section 1620 or using other stabilization methods utilized with prior approval from the Engineer.

Line clean water diversion with geotextile unrolled in the direction of flow and lay smoothly but loosely on soil surface without creases. Bury top of slope geotextile edge in a trench at least 5 inches deep and tamp securely. Make vertical overlaps a minimum of 18 inch with upstream geotextile overlapping the downstream geotextile.

Secure geotextile with eleven gauge wire staples shaped into a *u* shape with a length of at least 6 inches and a throat of at least 1 inch in width. Place staples along outer edges and throughout the geotextile a maximum of 3 feet horizontally and vertically.

1609-4 MEASUREMENT AND PAYMENT

Silt Excavation will be measured and paid for in accordance with Article 1630-3.

Geotextile for Soil Stabilization will be measured and paid for in accordance with Article 270-4.

Stabilization of the excavated material will be paid for as *Temporary Seeding* as provided in Section 1620.

Such price and payment shall be considered full compensation for all work covered by this section including all materials, construction, maintenance and removal of the clean water diversions.

SECTION 1610
STONE FOR EROSION CONTROL

1610-1 DESCRIPTION

Furnish, stockpile if directed by the Engineer, place and maintain an approved stone for construction of erosion control devices at ditches, diversions, swales, pipe inlets, pipe outlets, drainage turnouts and at other locations designated in the plans or as directed by the Engineer. The work includes, but is not limited to, furnishing, weighing, stockpiling, re-handling, placing and maintaining stone; and disposal of any stone not incorporated into the project when necessary.

1610-2 MATERIALS

Refer to Division 10.

Item	Section
Sediment Control Stone	1005
Stone for Erosion Control	1042

Use the class or standard size of stone specified in the contract.

1610-3 CONSTRUCTION METHODS

Place stone, in locations and to the thickness, widths and lengths as shown in the plans or as directed by the Engineer. Construct erosion control devices in accordance with the plans neatly and uniformly with an even surface and meeting the plans.

1610-4 MEASUREMENT AND PAYMENT

Stone For Erosion Control, Class __ will be measured and paid in tons of each class of stone incorporated into the work, or has been delivered to and stockpiled on the project as directed by the Engineer. Stone placed in the stockpile will not be measured a second time. Measure stone by weighing in trucks on certified platform scales or other certified weighing devices.

Sediment Control Stone will be measured and paid in tons of stone incorporated into the work, or has been delivered to and stockpiled on the project as directed by the Engineer. Stone placed in the stockpile will not be measured a second time. Measure stone by weighing in trucks on certified platform scales or other certified weighing devices.

Payment will be made under:

Pay Item	Pay Unit
Stone For Erosion Control, Class __	Ton
Sediment Control Stone	Ton

SECTION 1615
TEMPORARY MULCHING

1615-1 DESCRIPTION

Furnish, place and secure mulch material to prevent excessive soil erosion during construction operations where it is impossible or impractical to perform permanent seeding and mulching.

The actual conditions which occur during the construction of the project will determine the quantity of mulching. The quantity of mulching may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of work.

1615-2 MATERIALS

Refer to Division 10.

Item	Section
Mulch for Erosion Control	1060-5
Tacking Material	1060-5

1615-3 CONSTRUCTION METHODS

Place temporary mulch promptly at locations on temporarily seeded or non-seeded areas when so directed by the Engineer.

Spread mulch uniformly over the area by hand or by means of appropriate mechanical spreaders or blowers to obtain a satisfactory uniform cover. A satisfactory application of temporary mulch on non-seeded areas consists of a sufficient amount to completely and uniformly cover the ground. Apply tack within 24 hours after temporary mulch application.

When temporary mulching is performed in conjunction with temporary seeding, apply mulch in accordance with Article 1660-6. Complete mulching and tacking within 24 hours of temporary seeding work. Exercise care to prevent displacement of soil and seed or other damage to areas where temporary seeding is done.

Apply tack meeting the requirements of Article 1060-5 when using grain straw to assure that the temporary mulch is properly held in place. Take adequate precautions to prevent damage to traffic, structures, guardrails, traffic control devices or any other appurtenances during the application of tacking material. Provide adequate covering or change methods of application as required to prevent such damage. Repair any damage that occurs, including any necessary cleaning.

Apply emulsified asphalt tackifier at a rate of 0.10 gallons per square yard (approximately 484 gallons per acre). Apply cellulose hydromulches at a rate of 1000 pounds (dry weight) per acre. Apply other approved tackifiers at manufacturer's recommended application rate.

Take sufficient precautions to prevent mulch from entering drainage structures through displacement by wind, water or other causes and promptly remove any blockage to drainage facilities.

1615-4 MEASUREMENT AND PAYMENT

Temporary Mulching will be measured and paid in acres, measured along the surface of the ground over which temporary mulch has been placed as directed and accepted by the Engineer.

Tacking material is incidental to the application of *Temporary Mulching* and no additional payment will be made.

Payment will be made under:

Pay Item	Pay Unit
Temporary Mulching	Acre

SECTION 1620
TEMPORARY SEEDING

1620-1 DESCRIPTION

Seed and mulch selected areas in advance of the permanent seeding and mulching operations to minimize erosion of graded areas during construction operations. The work includes preparing seedbeds; furnishing, placing and covering fertilizer and seed; furnishing and placing mulch; and other operations necessary for seeding the required areas.

Perform temporary seeding promptly at the locations and under any of the following conditions when directed by the Engineer:

(A) When it is impossible or impractical to bring an area to the final line, grade and finish so that permanent seeding and mulching operations can be performed without subsequent serious disturbance by additional grading;

(B) When erosion occurs or is considered to be potentially substantial on areas of graded roadbed where construction operations are temporarily suspended or where the grading of the roadbed has been completed substantially in advance of the paving construction;

(C) During seasons of the year when permanent seeding and mulching is prohibited by the contract;

(D) When an immediate cover would be desirable to minimize erosion, siltation or pollution on any area.

The actual conditions that occur during the construction of the project will determine the quantity of seed or fertilizer to be used. The quantity of seed or fertilizer may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1620-2 MATERIALS

Refer to Division 10.

Item	Section
Fertilizer	1060-2
Mulch for erosion control	1060-5
Seed	1060-4

See the contract for analysis of fertilizer and the kinds of seed.

1620-3 CONSTRUCTION METHODS

(A) Seedbed Preparation

Scarify areas to be seeded to a depth of not less than 5 inches unless directed by the Engineer otherwise. The soil conditions and topography will determine the required depth of the seedbed.

Prepare the surface to be seeded with adequate furrows, ridges, terraces, trenches or other irregularities in which seeding materials can lodge with reasonable assurance that the materials will not be easily displaced by wind, rain or surface runoff.

(B) Applying and Covering Fertilizer and Seed

The analysis of fertilizer, the kinds of seed and the rates of application of fertilizer and seed shall be as stated in the contract.

Apply no fertilizer or seed when the Engineer determines that conditions are unfavorable

for such operations.

Distribute the fertilizer or seed uniformly over the seedbed at the required rates of applications.

Cover fertilizer and seed unless otherwise directed by the Engineer. If covering is required, provide it to the depth acceptable to the Engineer for the prevention of displacement by wind, rain or surface runoff.

Mulch all areas temporarily seeded, in accordance with Section 1615, unless otherwise indicated in the contract or as directed by the Engineer.

Article 1660-5 will be applicable to the approval of equipment and the protection of traffic, structures, guardrails, traffic control devices and other appurtenances.

(C) Mowing and Repair of Temporary Seeding

Maintain areas where temporary seeding is performed in a satisfactory condition, including mowing at the locations and times as directed by the Engineer.

Repair areas of temporary seeding which have been damaged or have failed. Repair includes reshaping or the placing of additional earth material and repeating the seeding process.

1620-4 MEASUREMENT AND PAYMENT

Seed for Temporary Seeding will be measured and paid in pounds. The weight of seed will be determined by bag count of standard weight bags or by weighing the seed.

Fertilizer for Temporary Seeding will be measured and paid in tons. The weight of dry fertilizer will be determined by bag count of standard weight bags or by weighing the fertilizer in trucks on certified platform scales or other certified weighing devices.

Temporary Mulching will be measured and paid in accordance with Article 1615-4.

Mowing will be measured and paid in accordance with Article 1660-8.

Where earthwork and temporary seeding have been adequately constructed, completely drained and properly maintained, and damage occurs due to natural causes, the Contractor will be paid at the contract unit price for the excavated material required for repairs to the damaged earthwork and the contract unit prices for *Seed For Temporary Seeding* and *Fertilizer for Temporary Seeding* for correcting the damaged temporary seeding.

Repair, at no cost to the Department, any damage to earthwork or temporary seeding which is due to carelessness or neglect on the part of the Contractor.

Payment will be made under:

Pay Item	Pay Unit
Seed For Temporary Seeding	Pound
Fertilizer For Temporary Seeding	Ton

SECTION 1622
TEMPORARY SLOPE DRAINS

1622-1 DESCRIPTION

Furnish, place, maintain and remove temporary slope drains at the locations shown in the plans and at locations as directed by the Engineer. Work includes, but is not limited to, furnishing all pipe, anchor stakes and compacted earth; installation and removal of the slope drain; constructing the sump, earth shoulder berm and earth berm ditch block; constructing the stone inlet protection; constructing the outlet protection; and dressing, seeding and mulching the disturbed area after the slope drain and berm have been removed. Standard T-sections and elbows at the inlet of the slope drain pipe may be required as directed by the

Engineer.

The actual conditions during the construction of the project will determine the quantity of temporary slope drains.

The quantity of temporary slope drains may be increased, decreased or eliminated entirely at the direction of the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1622-2 MATERIALS

Provide temporary slope drains, standard T-sections and elbows with pipe of sufficient size to carry the anticipated volume of water with a minimum diameter of 12 inches.

Refer to Division 10.

Item	Section
Corrugated Plastic Pipe and Fittings	1044-7
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class B	1042

1622-3 CONSTRUCTION METHODS

(A) Temporary Slope Drains

Install temporary slope drains in accordance with *Roadway Standard Drawings* during all phases of grading operations and adjust as needed to properly direct water flow.

Construct an earth berm at the top of cut and fill sections to direct water flow into temporary slope drains.

At locations of single direction water flow, locate temporary slope drain inlets in a sump along the earth berm. Construct an earth berm ditch block perpendicular to the direction of the water flow on the downstream side of the temporary slope drain. Construct ditch blocks of sufficient height to block the flow of water but at no higher elevation than the earth shoulder berm. Install an elbow at inlet of slope drain pipe as directed by the Engineer.

At locations of multi direction flow, install a sump on both sides of the slope drain inlet. Construct inlet protection with sediment control stone and Class B stone in accordance with *Roadway Standard Drawings*. Install a standard T-section at the slope drain inlet as directed by the Engineer.

Join multiple pipe sections using an approved pipe coupling. Anchor slope drains in accordance with the *Roadway Standard Drawings*. Extend slope drain to bottom of slope and erosion control measures.

(B) Outlet Protection at Temporary Slope Drain

Protect outlet locations subject to scour by placing Class B stone or a silt detention device. A special stilling basin may also be used as outlet protection in accordance with Section 1639 and as directed by the Engineer. Construct outlet protection devices as shown in the plans and at other locations as directed by the Engineer.

1622-4 MEASUREMENT AND PAYMENT

Temporary Slope Drains will be measured and paid in linear feet of pipe, including inlets, tees and elbows, measured along the invert of the temporary slope drain, completed and accepted.

Sediment Control Stone will be measured and paid in accordance with Article 1610-4.

Stone for Erosion Control, Class ____ will be measured and paid in accordance with Article 1610-4.

Silt Excavation will be measured and paid in accordance with Article 1630-3.

No payment will be made for temporary slope drains that were required due to the Contractor's negligence, carelessness or failure to install permanent controls as a part of the work scheduled.

Temporary Slope Drains will be considered minor items. Article 104-5, pertaining to revised contract unit prices for overrunning minor items, will not apply to these items.

Payment will be made under:

Pay Item	Pay Unit
Temporary Slope Drains	Linear Foot

SECTION 1629
COIR FIBER MAT

1629-1 DESCRIPTION

Furnish material, install and maintain coir fiber mat in locations shown on the plans or in locations as directed by the Engineer. Work includes providing all materials, excavating and backfilling, and placing and securing coir fiber mat with stakes, steel reinforcement bars or staples as directed by the Engineer.

1629-2 MATERIALS

Refer to Division 10.

Item	Section
Coir Fiber Mat	1060-14
Staples	1060-8(D)

Stakes, reinforcement bars or staples shall be used as anchors.

Provide hardwood stakes 12 inches to 24 inches long with a 2 inch x 2 inch nominal square cross section. One end of the stake shall be sharpened or beveled to facilitate driving through the coir fiber mat and down into the underlying soil. The other end of the stake shall have a 1 inches to 2 inches long head at the top with a 1 inch to 2 inches notch following to catch and secure the coir fiber mat.

Provide uncoated #10 steel reinforcement bars 24 inch nominal length. The bars shall have a 4 inch diameter bend at one end with a 4 inch straight section at the tip to catch and secure the coir fiber mat.

1629-3 CONSTRUCTION METHODS

Place the coir fiber mat immediately upon final grading. Provide a smooth soil surface free from stones, clods, or debris that will prevent the contact of the mat with the soil. Unroll the mat and apply without stretching such that it will lie smoothly but loosely on the soil surface.

For stream relocation applications, take care to preserve the required line, grade and cross section of the area covered. Bury the top slope end of each piece of mat in a narrow trench at least 6 inches deep and tamp firmly. Where one roll of matting ends and a second roll begins, overlap the end of the upper roll over the beginning of the second roll so there is a 6 inch overlap. Install staple checks at 30 feet intervals or as directed by the Engineer. Fold over and bury mat to the full depth of the trench, close and tamp firmly. Overlap mat at least 4 inches where 2 or more widths of mat are installed side by side.

Place anchors across the mat at the ends on 10 inch centers. Place anchors down the center of the mat 3 feet apart.

Adjustments in the trenching or anchoring requirements to fit individual site conditions may be required by the Engineer.

1629-4 MEASUREMENT AND PAYMENT

Coir Fiber Mat will be measured and paid for as the actual number of square yards measured along the surface of the ground over which coir fiber mat is installed and accepted.

No measurement will be made for anchor items.

Payment will be made under:

Pay Item	Pay Unit
Coir Fiber Mat	Square Yard

SECTION 1630
CONSTRUCTION AND MAINTENANCE OF SILT DETENTION DEVICES

1630-1 DESCRIPTION

Excavate and satisfactorily dispose of all materials excavated in the construction, cleaning out and maintenance of silt basins, silt ditches, diversions and other silt detention devices. Work includes, but is not limited to, excavation, shaping of the basins or ditches, cleaning out and maintaining the basins or ditches, disposal of all materials and backfilling.

1630-2 CONSTRUCTION METHODS

(A) General

Excavate silt basins, silt ditches, diversions or other silt detention devices to the dimensions and at the locations shown in the plans or as directed by the Engineer for the purpose of siltation control with non-vertical side slopes and not greater than 1.5:1 slope. Clean out silt detention devices when sediment volume reaches 50% of the storage volume or as directed by the Engineer, to maintain their effectiveness. Backfill and shape for seeding and mulching silt detention basins and silt ditches before completion of the project unless otherwise directed by the Engineer.

(B) Disposal of Materials

Use all excavated materials in the construction of roadway embankments except where otherwise directed by the Engineer. Dispose of materials not used in the construction of roadway embankments in waste areas in accordance with Section 802.

(C) Stockpile Areas

Install and maintain erosion control devices sufficient to contain sediment around any erodible material stockpile areas as directed by the Engineer.

(D) Access and Haul Roads

At the end of each working day, install or re-establish temporary diversions or earth berms across access/haul roads to direct runoff into sediment devices. Silt fence sections that are temporarily removed shall be reinstalled across access/haul roads at the end of each working day.

1630-3 MEASUREMENT AND PAYMENT

Silt Excavation will be measured and paid in cubic yards measured in the original position, of all materials excavated within the limits established by the plans or directed by the Engineer. If in the opinion of the Engineer it is not feasible to measure the excavated material in its original position, the volume will be determined by truck measurement in accordance with Article 230-5, except that no deduction for shrinkage will be made.

The filling of silt basins, diversions or silt ditches will be paid as provided in Article 225-7 for *Unclassified Excavation* or in Article 230-5 for *Borrow Excavation*, depending on the source of the material used to fill the basins or ditches.

Payment will be made under:

Pay Item	Pay Unit
Silt Excavation	Cubic Yard

SECTION 1631
ROLLED EROSION CONTROL PRODUCTS

1631-1 DESCRIPTION

Furnish, place and maintain a rolled erosion control product (matting) on previously shaped and seeded drainage ditches, slopes or other areas at locations shown in the contract or as directed by the Engineer. Work includes providing all materials, excavation and backfilling, placing and securing matting and maintaining the drainage ditch.

The conditions which occur during the construction of the project will determine the quantity of matting placed. The quantity of matting may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1631-2 MATERIALS

Refer to Division 10.

Item	Section
Matting for Erosion Control	1060-8
Staples	1060-8(D)

1631-3 CONSTRUCTION METHODS

Place matting immediately following seeding. Provide a smooth soil surface free from stones, clods or debris that will prevent the contact of the matting with the soil. Preserve the required line, grade and cross section of the area covered.

Unroll matting in the direction of the flow of water and apply without stretching so that it will lie smoothly but loosely on the soil surface. Bury the up-channel or top of slope end of each piece of matting in a narrow trench at least 6 inches deep and tamp firmly. Where one roll of matting ends and a second-roll begins, overlap the end of the upper roll over the buried end of the second roll so there is a 4 inch overlap. Construct staple checks 4 inches on center and every 30 feet longitudinally in the matting or as directed by the Engineer. Fold over and bury matting to the full depth of the trench, close and tamp firmly. Overlap matting at least 4 inches where 2 or more widths of matting are laid side by side.

Place staples across matting at ends, junctions and check trenches approximately 10 inches apart.

Place staples along the outer edges and down the center of each strip of matting 3 feet apart. Place staples along all lapped edges 10 inches apart.

Install product with netting on the top side when excelsior or straw matting is used.

The Engineer may require adjustments in the trenching or stapling requirements to fit individual cut or fill slope conditions.

1631-4 MEASUREMENT AND PAYMENT

Matting For Erosion Control will be measured and paid in square yards as measured along the surface of the ground, over which matting has been acceptably placed.

Payment will be made under:

Pay Item	Pay Unit
Matting For Erosion Control	Square Yard

SECTION 1632
ROCK INLET SEDIMENT TRAP

1632-1 DESCRIPTION

Construct, maintain and remove devices around catch basins and/or drop inlets to reduce water velocity and contain sediment. Work includes furnishing all fence posts, hardware cloth, hardware, stone and other materials, installing and maintaining the 1/4 inch hardware cloth.

The actual conditions which occur during the construction of the project will determine the quantity of rock inlet sediment traps constructed. The quantity of inlet sediment traps may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1632-2 MATERIALS

Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class A or Class B	1042

(A) Steel Posts

Provide steel posts in accordance with Subarticle 1605-2(A).

(B) Attachment Devices

Provide plastic ties, wire fasteners or other approved attachment device.

(C) 1/4" Hardware Cloth

Provide hardware cloth with 1/4 inch openings constructed from 24 gauge wire and with at least 48 inches width as specified in ASTM A740.

1632-3 CONSTRUCTION METHODS

(A) Type A

Place structural stone, Class B, around the outside perimeter of the inlet structure with approximately 2:1 side slopes and plate the upstream side with sediment control stone.

(B) Type B

Place structural stone, Class A, around the outside perimeter of the inlet structure with approximately 2:1 side slopes and plate the upstream side with sediment control stone.

(C) Type C

Construct rock inlet sediment trap Type C devices as shown in the plans and at other locations as directed by the Engineer. Attach hardware cloth to posts with wire staple or other acceptable methods.

1632-4 MAINTENANCE AND REMOVAL

Maintain the rock inlet sediment trap, remove and dispose of silt accumulations at the inlet sediment traps in accordance with Section 1630 or as directed by the Engineer.

Remove rock inlet sediment traps as the project nears completion, or as directed by the

Engineer. Dress the area to blend with existing contours, seed and mulch the area in accordance with Section 1660.

1632-5 MEASUREMENT AND PAYMENT

Payment for rock inlet sediment traps will be made as follows:

1/4" Hardware Cloth will be measured and paid in linear feet of hardware cloth, measured in place from end post to end post at each separate installation completed and accepted.

Stone for Erosion Control, Class ____ will be measured and paid in accordance with Article 1610-4.

Sediment Control Stone will be measured and paid in accordance with Article 1610-4.

Silt Excavation will be measured and paid in accordance with Article 1630-3.

Payment will be made under:

Pay Item	Pay Unit
1/4" Hardware Cloth	Linear Foot

SECTION 1633
TEMPORARY ROCK SILT CHECKS

1633-1 DESCRIPTION

Construct, maintain and remove devices placed in ditches, diversions or swales to reduce water velocity and contain sediment.

The actual conditions which occur during the construction of the project will determine the quantity of temporary rock silt checks constructed. The quantity of silt check dams may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1633-2 MATERIALS

Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class B	1042
Matting for Erosion Control	1060-8

Flocculant shall be applied in powder form and shall be anionic or neutrally charged. Soil samples shall be obtained from the project location and from offsite material used to construct the roadway and analyzed for the appropriate flocculant to be utilized with each wattle. The flocculant product used shall be listed on the North Carolina Department of Environmental Quality Division of Water Resources website as an approved flocculant product for use in North Carolina.

1633-3 CONSTRUCTION METHODS

(A) Type A

Place structural stone in the channel, ditch, diversion or swale with approximately 2:1 side slopes. Place sediment control stone, approximately 12 inches thick on the upstream side.

(B) Type A with Excelsior Matting and Flocculant

Place structural stone in the channel, ditch, diversion or swale with approximately 2:1 side slopes. Place sediment control stone, approximately 12 inches thick on the upstream

side. Install excelsior matting over sediment control stone as shown in the plans. Apply 4 oz of flocculant to the top of the excelsior matting section.

(C) Type B

Construct temporary rock silt check Type B devices as shown in the plans and at other locations as directed by the Engineer.

1633-4 MAINTENANCE AND REMOVAL

Maintain the temporary rock silt checks, remove and dispose of silt accumulations at the silt checks in accordance with Section 1630 and as directed by the Engineer.

Remove temporary rock silt checks as the project nears completion. The actual time of removal will be as directed by the Engineer. After removal of silt checks, dress the area to blend with existing contours and seed and mulch the area in accordance with Section 1660.

Reapply flocculant after every rainfall event that equals or exceeds 0.5 inches.

1633-5 MEASUREMENT AND PAYMENT

Payment for temporary rock silt checks will be as follows:

Stone for Erosion Control, Class ____ will be measured and paid in accordance with Article 1610-4.

Sediment Control Stone will be measured and paid in accordance with Article 1610-4.

Silt Excavation will be measured and paid in accordance with Article 1630-3.

Matting for Erosion Control will be measured and paid in accordance with Article 1631-4.

Flocculant will be measured and paid for by the actual weight in pounds of flocculant applied to the temporary rock silt checks. Such price and payment will be full compensation for all work covered by this section, including but not limited to, furnishing all materials, labor, equipment and incidentals necessary to apply the *Flocculant*.

Payment will be made under:

Pay Item	Pay Unit
Flocculant	Pounds

SECTION 1634
TEMPORARY ROCK SEDIMENT DAMS

1634-1 DESCRIPTION

Construct, maintain and remove devices placed in ditches, diversions, swales or drainage turnouts to reduce water velocity and contain sediment.

The actual conditions which occur during the construction of the project will determine the quantity of temporary rock sediment dams constructed. The quantity of rock sediment dams may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1634-2 MATERIALS

Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class 1 or Class B	1042
Coir Fiber Mat	1060-14

1634-3 CONSTRUCTION METHODS

Install coir fiber baffles on the upstream side of each type of dam in accordance with Section 1640 and as directed by the Engineer.

(A) Type A

Place structural stone in the channel, ditch diversion, swale or drainage turnouts with 2:1 side slope on the upstream side and 3:1 side slope on the downstream side. Plate the upstream side with sediment control stone approximately 12 inches thick. Use a minimum spacing of 15 feet and as directed by the Engineer for the coir fiber baffles.

Provide a weir section approximately 2/3 of the channel width and with an 8 foot maximum height from the bottom of the channel. In the center of the device, place the weir section approximately 12 inches lower than the sides of the device or the top of the channel, whichever is lower.

(B) Type B

Place structural stone in the channel, ditch diversion, swale or drainage turnouts with 2:1 side slopes and plate the upstream side with sediment control stone approximately 12 inches thick.

In the center of the device, provide a weir section with a 4 foot minimum width constructed 12 inches lower than the sides of the device or the top of the channel, whichever is lower. Construct the temporary rock sediment dam Type B with a 5 foot minimum thickness measured along the top of the dam structure.

Use earthen backfill material to extend dam width and create a larger sediment storage volume for the temporary rock sediment dam Type B where needed.

1634-4 MAINTENANCE AND REMOVAL

Maintain the temporary rock sediment dams, remove and dispose of silt accumulations at the sediment dams when so directed by the Engineer.

Remove temporary rock sediment dams as the project nears completion, or at such time as the Engineer deems the device to be no longer useful. The Engineer will direct the actual time of removal. Prepare seed bed, seed and mulch the area in accordance with Section 1660.

1634-5 MEASUREMENT AND PAYMENT

Payment for temporary rock sediment dams will be made as follows:

Coir Fiber Baffle with be measured and paid in accordance with Article 1640-4.

Stone for Erosion Control, Class ____ will be measured and paid in accordance with Article 1610-4.

Sediment Control Stone will be measured and paid in accordance with Article 1610-4.

Silt Excavation will be measured and paid in accordance with Article 1630-3.

SECTION 1635
ROCK PIPE INLET SEDIMENT TRAP

1635-1 DESCRIPTION

Construct, maintain and remove devices placed around outside perimeters of pipe structures, to reduce water velocity and trap sediment.

The conditions which occur during the construction of the project will determine the quantity of temporary rock pipe inlet sediment traps to be constructed. The quantity of inlet sediment traps may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a

change in the character of the work.

1635-2 MATERIALS

Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class A or Class B	1042

1635-3 CONSTRUCTION METHODS

(A) Type A

Construct rock pipe inlet sediment trap Type A devices at locations shown in the plans or as directed by the Engineer.

(B) Type B

Construct rock pipe inlet sediment trap Type B devices at locations shown in the plans or as directed by the Engineer.

1635-4 MAINTENANCE AND REMOVAL

Maintain the rock pipe inlet sediment traps, remove and dispose of silt accumulations at the pipe inlet sediment traps in accordance with Section 1630 or as directed by the Engineer.

Remove rock pipe inlet sediment traps as the project nears completion, or as directed by the Engineer. Prepare a seed bed to blend with existing contours and seed and mulch in accordance with Section 1660.

1635-5 MEASUREMENT AND PAYMENT

Payment for temporary rock pipe inlet sediment traps will be as follows:

Stone for Erosion Control, Class ____ will be measured and paid in accordance with Article 1610-4.

Sediment Control Stone will be measured and paid in accordance with Article 1610-4.

Silt Excavation will be measured and paid in accordance with Article 1630-3.

SECTION 1636
TEMPORARY STREAM CROSSING

1636-1 DESCRIPTION

Construct and maintain culverted temporary stream crossings. Temporary stream crossings are not shown in the plan sheets and shall be determined as directed by the Engineer.

The quantity of stream crossings to be installed will be affected by the actual conditions that occur during the construction of the project. The quantity of stream crossings may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1636-2 MATERIALS

Refer to Division 10.

Item	Section
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class B	1042
Geotextile for Drainage, Type 2	1056

1636-3 CONSTRUCTION METHODS

Construct stream crossings according to *Roadway Standard Drawings* or as directed by the Engineer.

The Contractor shall determine the diameter of pipe(s) that will pass the peak or bankfull flow, whichever is less, from a 2-year peak storm, without overtopping. Place the geotextile on natural ground, on streambanks and in streambed beneath the temporary pipe(s) and stone according to the detail. Install Class B stone around the pipe(s), in the stream channel and on the crossing road sideslopes. Place sediment control stone on top of Class B stone according to *Roadway Standard Drawings*.

1636-4 MEASUREMENT AND PAYMENT

Sediment Control Stone will be measured and paid in accordance with Article 1610-4.

Stone for Erosion Control, Class __ will be measured and paid in accordance with Article 1610-4.

Geotextile for Drainage will be measured and paid in accordance with Article 876-4.

Temporary Pipe for Stream Crossing will be measured and paid at the contract unit price per linear foot of temporary pipe approved by the Engineer and measured in place from end to end.

Article 104-5, pertaining to revised contract prices, will not apply to *Temporary Pipe for Stream Crossing*. No revision in the contract unit price will be allowed because of any overrun or underrun.

Such price and payment will be full compensation for all work covered by this section, including, but not limited to, furnishing all materials, labor, equipment and incidentals necessary to construct the stream crossings.

Payment will be made under:

Pay Item	Pay Unit
Temporary Pipe for Stream Crossing	Linear Foot

SECTION 1637
RISER BASIN

1637-1 DESCRIPTION

Construct, maintain and remove riser basin devices to reduce water velocity and contain sediment.

The actual conditions which occur during the construction of the project will determine the quantity of riser basin devices constructed. The quantity of riser basins may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1637-2 MATERIALS

Refer to Divisions 3 and 10.

Item	Section
C.S. Pipe Tee riser	1032-3
Stone for Erosion Control, Class B	1042
Coir Fiber Mat	1060-14

Provide appropriately sized and approved skimmer device.

1637-3 CONSTRUCTION METHODS

Work includes constructing earth embankments and overflow spillways, and installing outlet pipe, tee-riser sections, trash racks, anti-flotation devices, coir fiber baffles, skimmer and stone energy dissipater in silt basins in accordance with *Roadway Standard Drawings*. Use either anti-flotation method shown in the *Roadway Standard Drawings*.

Construct earth embankments with 2:1 side slopes with material meeting roadway embankment specifications in accordance with Section 1018. The maximum height of earth embankments is 12 feet. Compact embankment to at least 90% of AASHTO T 99 as modified by the Department or as directed by the Engineer. Excavate when required to provide minimum surface area and minimum storage volume area measured below the top of the principal spillway (top of the riser pipe).

Install a C.S. pipe tee riser as specified in the plans. Additional C.S. pipe may be required to obtain the required riser pipe height (crest elevation) as indicated in the plans. Construct a trash rack and an anti-flotation device on the riser pipe. Attach skimmer to riser pipe 1 foot above bottom elevation of basin.

Install coir fiber baffles in the basin in accordance with Section 1640 or as directed by the Engineer.

Construct an overflow spillway outlet, on natural ground, one foot above riser pipe. Plate overflow spillway with erosion control stone Class B as specified in the plans.

Stabilize the embankment and surrounding areas with vegetation after installation. Construct energy dissipater pad at the barrel pipe outlet with erosion control stone Class B in accordance with the *Roadway Standard Drawings*.

1637-4 MAINTENANCE AND REMOVAL

Place a marker in the basin indicating the 50% volume level. Clean out riser basin in accordance with Section 1630.

Remove riser basin devices as the project nears completion or as directed by the Engineer. Prepare a seed bed, seed and mulch the area in accordance with Section 1660 after removal of the riser basin.

1637-5 MEASUREMENT AND PAYMENT

C.S. Pipe Tee Riser, __" Thick will be measured and paid in units of each installed and accepted. Such price shall include furnishing and installing any additional pipe required for correct riser height, the trash rack and the anti-flotation device.

Stone for Erosion Control, Class __ will be measured and paid in accordance with Article 1610-4.

Pipe for the outlet will be measured and paid in accordance with Article 310-6.

Silt Excavation will be measured and paid in accordance with Article 1630-3.

Coir Fiber Baffle will be measured and paid in accordance with Article 1640-4.

__" Skimmer will be measured and paid in accordance with Article 1644-5.

Payment will not be made for any work performed under this section that is solely for the convenience of the Contractor or that is made necessary due to negligence of the Contractor.

Payment will be made under:

Pay Item	Pay Unit
__" x __" x __" C.S. Pipe Tee Riser, __" Thick	Each

SECTION 1638
STILLING BASIN

1638-1 DESCRIPTION

Construct, maintain and remove earth embankments used to trap sediment from dewatering construction sites during construction of drilled piers, footing excavation or culvert construction. Work includes providing permeable stone drain, cleaning out, maintaining, removing and disposing of the stilling basins and all components and reshaping the area.

The actual conditions that occur during the construction of the project will determine the quantity of stilling basins constructed. The quantity of stilling basins may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1638-2 MATERIALS

Use suitable excavated materials, as specified in Sections 225, 230 and 240, in the construction of earth embankments for stilling basins, except where otherwise specified by the Engineer.

Refer to Division 10.

Item	Section
Coir Fiber Mat	1060-14
Sediment Control Stone, Standard Size No. 5 or 57	1005
Stone for Erosion Control, Class B	1042

1638-3 CONSTRUCTION METHODS

Construct stilling basins at the locations shown in the plans and at other locations as directed by the Engineer.

Construct earth embankment with a permeable stone drain in a rectangular form adjacent to the stream and culvert following the applicable requirements of Section 235. The maximum height allowed for earth dikes is 5 feet. Excavate below the natural ground for greater depths of basins.

Install coir fiber baffles in accordance with Section 1640 or as directed by the Engineer.

1638-4 MAINTENANCE AND REMOVAL

Maintain the stilling basins, coir fiber baffles and remove and dispose of silt accumulations at the stilling basins in accordance with Section 1630.

Remove the stilling basins as the project nears completion, or at such time the Engineer deems the device to be no longer useful. Prepare a seed bed and seed and mulch the area after removal of the stilling basin in accordance with Section 1660.

1638-5 MEASUREMENT AND PAYMENT

Stilling Basin quantities will be measured and paid in cubic yards, in place and computed by the average-end-method for the actual number of cubic yards of basin capacity. The measurements will be the internal measurements of the basin measured up to the top of the permeable stone drain. Materials used to construct the basin that originates from another payment item (i.e., unclassified excavation, borrow excavation) will not be deducted from the volume of that original pay item.

Stone for Erosion Control, Class ____ will be measured and paid in accordance with Article 1610-4.

Sediment Control Stone will be measured and paid in accordance with Article 1610-4.

Coir Fiber Baffle will be measured and paid in accordance with Article 1640-4.

Payment will be made under:

Pay Item	Pay Unit
Stilling Basins	Cubic Yard

SECTION 1639
SPECIAL STILLING BASIN

1639-1 DESCRIPTION

Furnish, place and remove special stilling basins as directed by the Engineer. The special stilling basin can be used to filter pumped water during construction of drilled piers, footing excavation or culvert construction. The special stilling basin can be used for sediment storage at the outlet of temporary slope drain pipes.

1639-2 MATERIALS

Refer to Division 10.

Item	Section
Geotextile for Drainage, Type 2	1056
Sediment Control Stone, Standard Size No. 5 or 57	1005

Use geotextile and sediment control stone that is clean and without debris.

Use a special stilling basin that is a water permeable geotextile bag that traps sand, silt and fines as sediment-laden water is pumped into it, or as runoff flows into it through the temporary slope drain pipe(s).

Provide special stilling basin of a bag constructed to a minimum size of 10 feet x 15 feet made from a nonwoven geotextile. Provide a sewn-in 8 inches (maximum) spout for receiving pump discharge. Sew the bag seams with a double needle machine using a high strength thread. The seams shall have a minimum wide width strength of 60 lbs. per inch in accordance with ASTM D4884.

Construct the bag with a geotextile stabilized to provide resistance to UV degradation meeting Table 1639-1.

TABLE 1639-1
GEOTEXTILE PROPERTIES

Property	Minimum Requirement	Test Method
Weight	8.0 oz/yd	ASTM D3776
Grab tensile	200.0 lb	ASTM D4632
Puncture	520 lb	ASTM D6241
Flow rate	80.0 gal/min/sf	ASTM D4491
UV Resistance	70.0%	ASTM D4355

1639-3 CONSTRUCTION METHODS

Install the special stilling basin(s), geotextile and stone in accordance with the plans and as directed by the Engineer. Place the special stilling basin(s) on level ground.

Construct the special stilling basin(s) such that it is portable and can be used adjacent to each drilled pier, footing and/or culvert, as required by the project commitments. Temporary slope drain pipe(s) or pump discharge hoses will be attached to the special stilling basin(s) to divert runoff or pumped effluent directly into the special stilling basin(s). The special stilling basin may be cut to allow slope drain pipe to be inserted if needed and tied off tightly. The remaining sleeve or spout of the bag, if present, may be used to connect more than one special stilling basin in series as directed by the Engineer. If not used in this manner, the sleeve shall be tied off tightly to allow the bag to contain the effluent and force it to filter through the sides

of the special stilling basin. Place the special stilling basin(s) so the incoming runoff or pumped effluent flows into and through it without causing erosion to adjacent slopes or streambanks. In areas of turbidity and water quality concern, place the special stilling basin(s) up grade and direct its runoff into a sediment control measure before being allowed to discharge into jurisdictional waters.

Replace and dispose of the special stilling basin(s) when it is 3/4 full of sediment or when it is impractical for the bag to filter the sediment out at a reasonable flow rate. Prior approval from the Engineer shall be received before removal and replacement.

Provide a sufficient quantity of bags to contain silt from pumped effluent during construction of drilled piers, footing excavation and culvert construction. A sufficient quantity of special stilling basins shall be provided to contain sediment from temporary slope drain runoff.

1639-4 MEASUREMENT AND PAYMENT

Special Stilling Basin will be measured and paid as the actual number of bags used during temporary slope drain installation, drilled pier construction, footing excavation or culvert construction as specified and accepted.

Geotextile for Drainage will be measured and paid in accordance with Article 876-4.

Sediment Control Stone will be measured and paid in accordance with Article 1610-4.

Such price and payment will be full compensation for all work covered by this section, including but not limited to, furnishing all materials, placing and maintaining the special stilling basin(s) and removal and disposal of silt accumulations and bag.

Payment will be made under:

Pay Item	Pay Unit
Special Stilling Basins	Each

SECTION 1640
COIR FIBER BAFFLE

1640-1 DESCRIPTION

Furnish material, install and maintain coir fiber baffles according to the details in the plans or in locations as directed by the Engineer. Install coir fiber baffles in silt basins and sediment dams at drainage outlets. Work includes providing all materials, placing, securing, excavating and backfilling of coir fiber baffles.

1640-2 MATERIALS

(A) Coir Fiber Mat

Provide matting to meet Article 1060-14

(B) Staples

Provide staples made of 0.125 inch diameter new steel wire formed into a U-shape not less than 6 inches in length with a throat of 1 inch in width.

(C) Posts

Provide steel posts at least 5 feet in length, approximately 1 3/8 inches wide measured parallel to the baffle and have a minimum weight of 1.25 lbs. per foot of length. Equip the post with an anchor plate having a minimum area of 14.0 square inches and of the self-fastener angle steel type to have a means of retaining wire and coir fiber mat in the desired position without displacement.

(D) Wire

Provide 9-gauge high tension wire strand of variable lengths.

(E) Attachment Device

Provide plastic ties, wire fasteners or other approved attachment device.

1640-3 CONSTRUCTION METHODS

Place the coir fiber baffles immediately upon construction of sediment dams and basins. Install 3 baffles in basins with a spacing of 1/4 the basin length and according to the detail sheets. Install 2 coir fiber baffles in basins less than 20 feet in length with a spacing of 1/3 the basin length.

Place steel posts at a depth of 2 feet below the basin surface, with spacing of no more than 4 feet. The top height of the coir fiber baffles shall not be below the elevation of the emergency spillway base of dams and basins. Attach a 9-gauge high-tension wire strand to the steel posts at a height of 3 feet with plastic ties or wire fasteners. Install a steel post into side of the basin at a variable depth and a height of 3 feet from the bottom of the basin to anchor coir fiber mat. Secure anchor post to the upright steel post in basin with wire fasteners.

Drape the coir fiber mat over the wire strand with at least 3 feet of material on each side of the strand. Secure the coir fiber mat to the posts and wire strand with approved fastener. Place staples across the matting at ends and junctions approximately one foot apart at the bottom and side slopes of basin. Overlap matting at least 6 inches where 2 or more widths of matting are installed side by side. Refer to details in the plans. The Engineer may require adjustments in the stapling requirements to fit individual site conditions.

1640-4 MEASUREMENT AND PAYMENT

Coir Fiber Baffle will be measured and paid as the actual number of linear feet of coir fiber baffles which are installed and accepted. Such price and payment will be full compensation for all work covered by this section, including, but not limited to, furnishing all materials, labor, equipment and incidentals necessary to install the coir fiber baffles.

Payment will be made under:

Pay Item	Pay Unit
Coir Fiber Baffle	Linear Foot

SECTION 1642
WATTLE DEVICES

1642-1 DESCRIPTION

Work includes furnishing materials, installation of wattles, matting installation, maintenance and removing wattles. Install wattles as shown in the plans or as directed by the Engineer to intercept runoff, act as a velocity break and contain sediment.

The actual conditions which occur during the construction of the project will determine the quantity of wattles constructed. The quantity of wattles may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1642-2 MATERIALS

Refer to Division 10.

Item	Section
Matting for Erosion Control	1060-8
Staples	1060-8(D)

(A) Stakes

Place structural stone in the channel, ditch diversion, swale or drainage turnouts with 2:1 side slope on the upstream side and 3:1 side slope on the downstream side. Plate the upstream side with sediment control stone approximately 12 inches thick. Use a minimum spacing of 15 feet and as directed by the Engineer for the coir fiber baffles.

Provide a weir section approximately 2/3 of the channel width and with an 8 foot maximum height from the bottom of the channel. In the center of the device, place the weir section approximately 12 inches lower than the sides of the device or the top of the channel, whichever is lower.

(B) Wattle

Excelsior Wattles shall meet Table 1642-1.

TABLE 1642-1
100% CURLED WOOD (EXCELSIOR) FIBERS

Property	Property Value
Minimum Diameter	12 inches
Minimum Density	2.5 pcf +/- 10%
Net Material	Synthetic
Net Openings	1 inch x 1 inch
Net Configuration	Totally Encased
Minimum Weight	20 lb +/- 10% per 10 foot length

Coir Fiber Wattles shall meet Table 1642-2.

TABLE 1642-2
100% COIR (COCONUT) FIBERS

Property	Property Value
Minimum Diameter	12 inches
Minimum Density	3.5 pcf +/- 10%
Net Material	Coir Fiber
Net Openings	2 inch x 2 inch
Net Strength	90 lb
Minimum Weight	2.6 pcf +/- 10%

(C) Flocculant

Flocculant shall be applied in powder form and shall be anionic or neutrally charged. Soil samples shall be obtained in areas where the wattles will be placed, and from offsite material used to construct the roadway, and analyzed for the appropriate flocculant to be utilized with each wattle. The flocculant product used shall be listed on the North Carolina Department of Environmental Quality Division of Water Resources website as an approved flocculant product for use in North Carolina.

1642-3 CONSTRUCTION METHODS

(A) Wattle Check

Wattles shall be excelsior or coir fiber as shown in the plans. Wattles shall be secured to the soil by wire staples approximately every 1 linear foot and at the end of each section of wattle. A minimum of 4 stakes shall be installed on the downstream side of the wattle with a maximum spacing of 2 linear feet along the wattle. Install a minimum of 2 stakes on the upstream side of the wattle. Stakes shall be driven into the ground a minimum of 10 inches with no more than 2 inches projecting from the top of the wattle. Drive stakes at an angle to wedge wattles to the bottom of the ditch.

Only install wattle(s) to a height in ditch so flow will not wash around wattle and scour ditch slopes and as directed. Overlap adjoining sections of wattles a minimum of 12

inches.

Installation of matting shall be in accordance with the plans, and in accordance with Article 1631-3.

Only apply flocculant on wattles per plans and as directed by the Engineer. When required, flocculant shall be applied over the lower center portion of the wattle where the water is going to flow over at a rate of 2 oz per wattle, and 1 oz of flocculant on matting on each side of the wattle. Flocculant applications shall be done during construction activities after every rainfall event that is equal to or exceeds 0.50 inches. Do not apply flocculent to a wattle that serves as a stormwater discharge outfall.

(B) Silt Fence Wattle Break

Construct silt fence wattle breaks using excelsior or coir fiber wattles in conjunction with temporary silt fence as shown on the plans or as directed by the Engineer.

Excavate a trench the entire length of each wattle with a depth of 1 inch to 2 inches for the wattle to be placed. Secure silt fence wattle breaks to the soil by wire staples approximately every linear foot and at the end of each wattle. Install at least 4 stakes on the downslope side of the wattle with a maximum spacing of 2 linear feet. Install at least 2 stakes on the upslope side of the silt fence wattle break. Drive stakes into the ground at least 10 inches with no more than 2 inches projecting from the top of the wattle. Drive stakes at an angle to wedge wattles to the bottom of the trench.

Install temporary silt fence in accordance with Section 1605 and overlap each downslope side of silt fence wattle break by 12 inches.

(C) Wattle Barrier

Construct wattle barriers with minimum 18 inch diameter excelsior or coir fiber wattles as shown on the plans. Wattle barriers are to be placed at locations shown on the plans or as directed by the Engineer. When wattle barriers are used on slopes to reduce runoff velocity, 9 inch diameter wattles may be used.

Align wattle barriers in an overlapping and alternating pattern. Overlap adjoining sections of wattles a minimum of 12 inches. Excavate a trench the entire length of each wattle with a depth of 2 inches to 3 inches for the wattle to be placed. Secure wattle barriers to the soil by wire staples approximately every linear foot and at the end of each wattle. Install at least 4 stakes on the downslope side of the wattle with a maximum spacing of 2 linear feet. Install at least 2 stakes on the upslope side of the wattle barrier. Drive stakes into the ground at least 10 inches with no more than 2 inches projecting from the top of the wattle. Drive stakes at an angle to wedge wattles to the bottom of the trench.

For wattle barriers used to reduce runoff velocity for large slopes, use a maximum spacing of 25 feet for the barrier measured along the slope.

1642-4 MAINTENANCE AND REMOVAL

Maintain the wattles, remove and dispose of silt accumulations at the wattles as directed by the Engineer in accordance with Section 1630.

1642-5 MEASUREMENT AND PAYMENT

_____ *Wattle Check* will be measured and paid for by the actual number of linear feet of wattles which are installed and accepted. Such price and payment will be full compensation for all work covered by this section, including, but not limited to, furnishing all materials, labor, equipment and incidentals necessary to install the Wattle.

_____ *Wattle Barrier* will be measured and paid as the actual number of linear feet of wattles installed and accepted. Such price and payment will be full compensation for all work

covered by this provision, including, but not limited to, furnishing all materials, labor, equipment and incidentals necessary to install the wattle barrier.

Matting for Erosion Control will be measured and paid for in accordance with Article 1631-4.

Flocculant will be measured and paid for by the actual weight in pounds of flocculant applied to the wattles. Such price and payment will be full compensation for all work covered by this section, including, but not limited to, furnishing all materials, labor, equipment and incidentals necessary to apply the Flocculant.

Silt Excavation will be measured and paid for in accordance with Article 1630-3.

Payment will be made under:

Pay Item	Pay Unit
_____ Wattle Check	Linear Foot
_____ Wattle Barrier	Linear Foot
Flocculant	Pound

SECTION 1644
SKIMMER BASINS

1644-1 DESCRIPTION

Provide a skimmer basin to remove sediment from construction site runoff at locations shown in the erosion control plans. Work includes constructing sediment basin, installation of temporary slope drain pipe and coir fiber baffles, furnishing, installation and cleanout of skimmer, providing and placing stone pad on bottom of basin underneath skimmer device, providing and placing a geotextile spillway liner, providing coir fiber mat stabilization for the skimmer outlet, disposing of excess materials, removing temporary slope drain, coir fiber baffles, geotextile liner and skimmer device, backfilling basin area with suitable material and providing proper drainage when basin area is abandoned.

1644-2 MATERIALS

Refer to Division 10.

Item	Section
Anchors	1629-2
Coir Fiber Baffle	1640
Coir Fiber Mat	1060-14
Fertilizer for Temporary Seeding	1060-2
Geotextile for Soil Stabilization, Type 4	1056
Matting for Erosion Control	1060-8
Seeding and Mulching	1060-4
Seed for Temporary Seeding	1060-4
Staples	1060-8(D)
Temporary Slope Drain	1622-2

Provide appropriately sized and approved skimmer device.

Provide Schedule 40 PVC pipe with a length of 6 feet to attach to the skimmer and the coupling connection to serve as the arm pipe. For skimmer sizes of 2.5 inches and smaller, the arm pipe diameter shall be 1.5 inches. For skimmer sizes of 3 inches and larger, refer to manufacturer recommendation.

Provide 4 inch diameter Schedule 40 PVC pipe to attach to coupling connection of skimmer to serve as the barrel pipe through the earthen dam.

The geotextile for the spillway liner shall meet Table 1644-1 physical properties for low permeability, woven polypropylene geotextiles:

TABLE 1644-1 GEOTEXTILE PROPERTIES – SPILLWAY LINER		
Property	**Minimum Requirement**	**Test Method**
Tensile Strength	315 lbs.	ASTM D4632
Tensile Elongation	15.0% (Maximum Requirement)	ASTM D4632
Trapezoidal Tear	120 lbs.	ASTM D4533
CBR Puncture	900 lbs.	ASTM D6241
UV Resistance	70.0% (% retained at 500 hr)	ASTM D4355
Apparent Opening Size (AOS)	40 US Std. Sieve	ASTM D4751
Permittivity	0.05 sec-1	ASTM D4491
Water Flow Rate	4 gal/min/sf	ASTM D4491

1644-3 CONSTRUCTION METHODS

(A) Skimmer Basin with Baffles and Lower Basin of Tiered Skimmer Basin with Baffles

Construct basin according to the plans with basin surface free of obstructions, debris, and pockets of low-density material. Construct the coir fiber baffles in accordance with Section 1640 and as directed by the Engineer.

Install skimmer device according to manufacturer recommendations. Install 4 inch Schedule 40 PVC pipe into dam on the lower side of basin 1 feet from the bottom of the basin and extend the pipe so the basin will drain. Attach a 6 foot arm pipe to the coupling connection and skimmer according to manufacturer recommendations. The coupling shall be rigid and non-buoyant and not exceed 12 inches in length. Attach a retrieval rope to the skimmer in a manner that will not interfere with the skimmer's function, and the other end to a wooden stake or metal post on the berm of the basin. Construct a stone pad of Class B stone directly underneath the skimmer device at bottom of basin according to the plans.

Line primary spillway with low permeability polypropylene geotextile unrolled in the direction of flow and lay smoothly but loosely on soil surface without creases. Bury edges of geotextile in a trench at least 5 inches deep and tamp firmly. If geotextile for the primary spillway is not one continuous piece of material, make horizontal overlaps a minimum of 18 inches with upstream geotextile overlapping the downstream geotextile. Place staples along outer edges and throughout the geotextile a maximum of 3 feet. horizontally and vertically. Geotextile shall be placed to the bottom and across the entire width of the basin. Place sealant inside basin around barrel pipe on top of geotextile with a minimum width of 6 inches.

At the skimmer outlet, install coir fiber matting in accordance with the plans and Section 1629.

All bare side slope sections of the skimmer basin shall be seeded with a temporary or permanent seed mix as directed and in accordance with Articles 1620-3, 1620-4, 1620-5, 1660-4, 1660-5 and 1660-7. Straw or excelsior matting shall be installed on all bare side slope sections immediately upon the completion of seeding and in accordance with Article 1631-3.

(B) Upper Basin(s) of Tiered Skimmer Basin with Baffles

Construct upper basins according to the plans with basin surface free of obstructions, debris, and pockets of low-density material. Construct the coir fiber baffles in accordance with Section 1640 and as directed by the Engineer. Multiple upper basins may be required based on site conditions and as directed by the Engineer.

Install skimmer device according to manufacturer recommendations. Install 4 inch Schedule 40 PVC pipe into dam on the lower side of basin 1 feet from the bottom of the basin and extend the pipe to an energy dissipator pad on the bottom of the lower basin.

Attach a 6 feet arm pipe to the coupling connection and skimmer according to manufacturer recommendations. The coupling shall be rigid and non-buoyant and not exceed 12 inches in length. Attach a retrieval rope to the skimmer in a manner that will not interfere with the skimmer's function, and the other end to a wooden stake or metal post on the berm of the basin. Construct a stone pad of Class B stone directly underneath the skimmer device at bottom of basin according to the plans.

Line primary spillway with low permeability polypropylene geotextile unrolled in the direction of flow and lay smoothly but loosely on soil surface without creases. Bury edges of geotextile in a trench at least 5 inches deep and tamp firmly. If geotextile for the primary spillway is not one continuous piece of material, make horizontal overlaps a minimum of 18 inches with upstream geotextile overlapping the downstream geotextile. Place staples along outer edges and throughout the geotextile a maximum of 3 feet horizontally and vertically. Geotextile shall be placed to the bottom and across the entire width of the basin. Place sealant inside basin around barrel pipe on top of geotextile with a minimum width of 6 inches.

All bare side slope sections of the skimmer basin shall be seeded with a temporary or permanent seed mix as directed and in accordance with Articles 1620-3, 1620-4, 1620-5, 1660-4, 1660-5 and 1660-7. Straw or excelsior matting shall be installed on all bare side slope sections immediately upon the completion of seeding and in accordance with Article 1631-3.

1644-4 MAINTENANCE AND REMOVAL

Place a marker in the basin indicating the 50% volume level. Clean out skimmer basin in accordance with Section 1630.

Clean out skimmer device when it becomes clogged with sediment and/or debris and is unable to float at the top of water in skimmer basin. Take appropriate measures to avoid ice accumulation in the skimmer device.

Remove skimmer basins as the project nears completion or as directed by the Engineer. Prepare a seed bed and seed and mulch the area in accordance with Section 1660 after removal of the skimmer basin.

1644-5 MEASUREMENT AND PAYMENT

Silt Excavation will be measured and paid for in accordance with Article 1630-4, as calculated from the typical section throughout the length of the basin as shown on the plans.

Geotextile for Soil Stabilization will be measured and paid for in accordance with Article 270-4.

Low Permeability Geotextile will be measured and paid for as the actual number of square yards measured along the surface of the spillway over which the geotextile is installed and accepted.

Coir Fiber Baffles will be measured and paid for in accordance with Article 1640-4.

__" *Skimmer* will be measured in units of each. __" *Skimmer* will be measured and paid for as the maximum number of each size skimmer acceptably installed and in use at any one time during the life of the project. Barrel and arm pipe, cleanout, relocation and reinstallation of __" *Skimmer* is considered incidental to the measurement of the quantity of __" *Skimmer* and no separate payment will be made. No separate payment shall be made if __" *Skimmer*, barrel and/or arm pipe(s) are damaged by ice accumulation.

Coir Fiber Mat will be measured and paid for in accordance with Article 1629-4.

Temporary Slope Drain will be measured and paid for in accordance with Article 1622-4.

Stone for Erosion Control, Class __ will be measured and paid for in accordance with Article 1610-4.

Seeding and Mulching will be measured and paid for in accordance with Article 1660-8.

Seed for Temporary Seeding will be measured and paid for in accordance with Article 1620-6.

Fertilizer for Temporary Seeding will be measured and paid for in accordance with Article 1620-6.

Matting for Erosion Control will be measured and paid for in accordance with Article 1631-4.

No measurement will be made for other items or for over excavation or stockpiling.

Payment will be made under:

Pay Item	Pay Unit
__" Skimmer	Each
Coir Fiber Mat	Square Yard
Low Permeability Geotextile	Square Yard

SECTION 1650
WOODED AREA CLEANUP

1650-1 DESCRIPTION

Remove and satisfactorily dispose of debris and of dead, partially dead or broken vegetation from wooded areas of the right of way outside clearing limits and from other areas outside construction limits on which seeding and mulching is not to be performed. Work includes treating stumps with herbicide and repairing any damage to vegetation.

Cutover timberland, reforested areas or thickets of young native volunteer vegetation will be considered to be wooded areas.

1650-2 MATERIALS

Refer to Division 10.

Item	Section
Herbicide	1060-13

1650-3 CONSTRUCTION METHODS

Remove all logs, stumps, snags, loose roots, down timber, slabs, tree laps, lumber, dead or partially dead trees, broken trees or brush, dead brush, sawdust piles, discarded fences, leaf piles, brick, tile masonry and other debris from the cleanup areas. Cut, all dead trees, stumps, snags, broken or partially dead trees and brush, flush with the ground. Remove vegetation which dies between initial cleanup and completion of the project before final acceptance. Hand raking of areas or removal of a normal leaf layer is not required unless stated in the contract.

Treat partially dead stumps or broken vegetation with a herbicide immediately after cutting. Use the herbicide and the method and rate of application, specified in the contract. Follow all applicable instructions, warnings and safety precautions stated on the manufacturer's label, and comply with all laws and regulations governing herbicides that are in effect at the time of use.

Dispose of all material cleaned up under this item in accordance with the applicable requirements of Article 200-5 and Article 802-2.

1650-4 DAMAGE TO REMAINING VEGETATION

Conduct operations so as to prevent injury to trees, shrubs or other types of vegetation that are to remain growing and to prevent damage to adjacent property.

Remove broken branches and rough edges of scarred trees or shrubs. Prune and shape these areas in accordance with the International Society of Arboriculture pruning techniques. Cut and dispose of any plants that are damaged beyond their value for landscape purposes and seed and mulch vegetation that is damaged by the Contractor at no cost to the Department when so directed by the Engineer.

1650-5 MEASUREMENT AND PAYMENT

Wooded Area Cleanup will be measured and paid in acres, measured horizontally, completed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Wooded Area Cleanup	Acre

SECTION 1651
SELECTIVE VEGETATION REMOVAL

1651-1 DESCRIPTION

Remove selected living trees and undesirable living undergrowth from areas of the right of way outside clearing limits in accordance with the contract. Work includes treating stumps with herbicide and repairing any damage to vegetation.

1651-2 MATERIALS

Refer to Division 10.

Item	Section
Herbicide	1060-13

1651-3 CONSTRUCTION METHODS

(A) Trees

Remove trees shown in the plans or designated by the Engineer. Measure all tree diameter sizes at a height of 4.5 feet above the ground.

(B) Undergrowth

Remove all undergrowth from areas shown in the plans, described in the specifications or designated, except for those plants designated to be preserved. All plants less than 4 inches in diameter, measured at a height of 4.5 feet above the ground shall be classified as undergrowth.

(C) General

Treat stumps with a herbicide immediately after cutting to prevent sprouting. Use the herbicide and the method and rate of application specified in the specifications. Follow all applicable instructions, warnings and safety precautions stated on the manufacturer's label, and comply with all laws and regulations governing herbicides that are in effect at the time of use.

When work is performed properly in accordance with these specifications, no subsequent re-cutting of sprouts or seedling growth will be required.

Dispose of all trees and undergrowth cut in accordance with Article 200-5.

1651-4 DAMAGE TO REMAINING VEGETATION

Conduct operations so as to prevent injury to trees, shrubs or other types of vegetation that are to remain growing, and also to prevent damage to adjacent property.

Remove broken branches and rough edges of scarred trees or shrubs. Shape and make smooth

these areas in accordance with generally accepted horticultural practice. Cut and dispose of any plants that are damaged beyond their value for landscape purposes and seed and mulch vegetation that is damaged by the Contractor at no cost to the Department.

1651-5 MEASUREMENT AND PAYMENT

Selective Tree Removal __" will be measured and paid in units of each. Each tree removed will be paid at the contract unit price for the pay item size applicable to the actual tree diameter, measured at a height of 4.5 feet above the ground, as indicated in Table 1651-1.

TABLE 1651-1
SELECT TREE REMOVAL PAY ITEM SIZES

Pay Item Size	Actual Tree Diameter
6 inch	4 inches up to 8 inches
10 inch	8 inches up to 12 inches
15 inch	12 inches up to 18 inches
18 inches	18 inches and over

Selective Undergrowth Removal will be measured and paid in acres, measured horizontally, completed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Selective Tree Removal, 6"	Each
Selective Tree Removal, 10"	Each
Selective Tree Removal, 15"	Each
Selective Tree Removal, 18"	Each
Selective Undergrowth Removal	Acre

SECTION 1657
COMPOST BLANKET

1657-1 DESCRIPTION

Furnish, install, maintain and seed a water permeable compost blanket to reduce soil erosion and sediment by promoting the establishment of vegetation on sandy soils where vegetation is difficult to establish.

1657-2 MATERIALS

Refer to Division 10.

Item	Section
Compost	1060-15

1657-3 CONSTRUCTION METHODS

Install compost blanket(s) as shown on the plans or as directed. Unless otherwise specified, compost blankets should be installed at a minimum depth of 1 inch.

Seed compost blanket at the time of installation for establishment of permanent vegetation. The Engineer will specify seeding requirements. The type and rate of seed, fertilizer and lime shall be in accordance with the Seeding and Mulching provisions of this contract and as directed by the Engineer.

Compost blankets are not to be used in direct flow situations or in runoff channels.

1657-4 MAINTENANCE

Maintain the compost blanket in a functional condition and routinely repair the compost blanket where damaged. Where the compost blanket deteriorates or fails, repair or replace it with a more effective approved alternative.

The compost blanket will be seeded on site, at rates and seed types as determined by the Engineer. Once vegetation is established, final seeding is not required.

1657-5 MEASUREMENT AND PAYMENT

The Contractor shall provide the Engineer with proof that a minimum 1 inch thick *Compost Blanket* has been applied after settling. This rate equals approximately 270 cy of compost material per acre of application area. The Contractor shall supply satisfactory evidence that the specified amount of material has been effectively placed (i.e., truck load tickets).

Compost Blanket will be measured and paid for as the actual number of acres measured along the surface of the ground over which the Compost Blanket is installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Compost Blanket	Acre

SECTION 1660
SEEDING AND MULCHING

1660-1 DESCRIPTION

Prepare seedbed; furnish, place and incorporate limestone, fertilizer and seed; compact seedbed; furnish, place and secure mulch; mow; and perform other operations necessary for the permanent establishment of vegetation from seed on shoulders, slopes, ditches or other roadside areas.

Perform seeding and mulching on all earth areas disturbed by construction and on portions of areas seeded under previous contracts as directed by the Engineer where there is unsatisfactory vegetative cover.

Adapt operations to variations in weather or soil conditions as necessary for the successful establishment and growth of the grasses or legumes.

Preserve the required line, grade and cross section of the area treated.

The actual conditions which occur during the construction of the project will determine the quantity of mowing. The quantity of mowing may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1660-2 MATERIALS

Refer to Division 10.

Item	Section
Fertilizer	1060-2
Limestone	1060-3
Seed	1060-4
Mulch for Erosion Control	1060-5
Tacking Material	1060-5

The analysis of fertilizer and the kinds of seed will be as stated in the contract.

1660-3 COORDINATION WITH GRADING OPERATIONS

Perform seeding and mulching operations on a section by section basis immediately upon completion of earthwork sections in accordance with Article 225-2.

When grading operations have been suspended, and seeding and mulching has been performed on areas where work has been suspended, include in the work of seeding and mulching of the adjacent sections any necessary overlapping of operations on previously established vegetative cover.

When the Contractor fails or neglects to coordinate grading with seeding and mulching operations and to pursue diligently the control of erosion and siltation, the Engineer may suspend the Contractor's grading operations until such time as the work is coordinated in a manner acceptable to the Engineer. Such suspension will be in accordance with Article 108-7.

1660-4 SEEDBED PREPARATION

Cut and satisfactorily dispose of weeds or other unacceptable growth on the areas to be seeded. Shape and smooth uneven and rough areas outside of the graded section, such as crop rows, farm contours, ditches and ditch spoil banks, fence line and hedgerow soil accumulations and other minor irregularities which cannot be obliterated by normal seedbed preparation operations, to provide for more effective seeding and for ease of subsequent mowing operations.

Scarify or otherwise loosen the soil to a depth of not less than 5 inches except as otherwise provided below or otherwise directed by the Engineer. Break clods and work the top 2 inches to 3 inches of soil into an acceptable seedbed by the use of soil pulverizers, drags or harrows; or by other methods approved by the Engineer. Remove all rock and debris 3 inches or larger on median, shoulder and ditch cut or fill slopes which are 3:1 or flatter, before the application of seed and fertilizer. Remove rock 6 inches and larger displaced during seeding operations.

Scarify, groove, trench or puncture all slope surfaces. The depth of preparation and the degree of smoothness of the seedbed may be reduced on cut slopes that are 2:1 and steeper, as permitted by the Engineer.

On cut slopes that are either 2:1 or steeper, the Engineer may permit the preparation of a partial or complete seedbed during the grading of the slope. If at the time of seeding and mulching operations such preparation is still in a condition acceptable to the Engineer, additional seedbed preparation may be reduced or eliminated.

Limit seedbed preparation to within 2 feet of the edge of any pavement to a depth of 2 inches to 3 inches.

Do not prepare seedbed when the soil is frozen, extremely wet or when the Engineer determines that it is an otherwise unfavorable working condition.

1660-5 APPLYING AND COVERING LIMESTONE, FERTILIZER AND SEED

(A) General

The contract will state the seasonal limitation for seeding operations; the kinds of grades of fertilizers; the kinds of seed; and the rates of application of limestone, fertilizer and seed.

Obtain approval from the Engineer before using equipment for the application, covering or compaction of limestone, fertilizer and seed. Approval may be revoked by the Engineer at any time if equipment is not maintained in satisfactory working condition, or if the equipment operation damages the seed.

Apply limestone, fertilizer and seed within 24 hours after completion of seedbed preparation unless otherwise permitted by the Engineer. When the Engineer determines that weather and soil conditions are unfavorable, do not distribute any limestone or fertilizer and do not sow any seed.

Take adequate precautions to prevent damage to traffic, structures, guardrails, traffic control devices or any other appurtenances during the application of fertilizer. Provide adequate covering or change methods of application as required to avoid such damage. Repair any damage that occurs, including any cleaning that may be necessary.

(B) Limestone and Fertilizer

Limestone may be applied as a part of the seedbed preparation, provided it is immediately worked into the soil. If not so applied, distribute limestone and fertilizer uniformly over the prepared seedbed at the specified rate of application and then harrow, rake or otherwise thoroughly work or mix into the seedbed.

(C) Seed

Distribute seed uniformly over the seedbed at the required rate of application, and immediately harrow, drag, rake or otherwise work so as to cover the seed with a layer of soil. Cover to a depth as directed by the Engineer. If two kinds of seed are to be used which require different depths of covering, sow separately.

When a combination seed and fertilizer drill is used, drill fertilizer with seed after applying and incorporating limestone into the soil. If using two kinds of seed requiring different depth of cover, the seed requiring the lighter cover may be sown broadcast or with a special attachment to the drill, or drilled lightly following the initial drilling operation.

When using a hydraulic seeder for application of seed and fertilizer, do not allow the seed to remain in water containing fertilizer for more than 30 minutes before application unless otherwise permitted by the Engineer.

Compact the seedbed immediately after seed has been properly covered in the manner and degree approved by the Engineer.

(D) Modifications

When adverse seeding conditions are encountered due to steepness of slope, height of slope or soil conditions, the Engineer may direct or permit that modifications be made in the above requirements which pertain to incorporating limestone into the seedbed; covering limestone, seed and fertilizer; and compaction of the seedbed.

Such modifications with approval by the Engineer may include but not be limited to the following:

(1) The incorporation of limestone into the seedbed may be omitted as follows:

(a) On cut slopes steeper than 2:1;

(b) On 2:1 cut slopes when a seedbed has been prepared during the excavation of the cut and is still in an acceptable condition; or

(c) On areas of slopes where the surface of the area is too rocky to permit the incorporation of the limestone.

(2) The rates of application of limestone, fertilizer and seed on slopes 2:1 or steeper or on rocky surfaces may be reduced or eliminated.

(3) Compaction after seeding may be reduced or eliminated on slopes 2:1 or steeper, on rocky surfaces or on other areas where soil conditions would make compaction undesirable.

1660-6 MULCHING

(A) General

Mulch all seeded areas unless otherwise indicated in the contract or directed by the Engineer.

Use grain straw as mulch at any time of the year. If permission to use material other than grain straw is requested and the use of such material is approved by the Engineer, the seasonal limitations, the methods and rates of application, the type of binding material or

other conditions governing the use of such material will be established by the Engineer at the time of approval.

(B) Applying Mulch

Apply mulch within 24 hours after completion of seeding unless otherwise permitted by the Engineer. Exercise care to prevent displacement of soil or seed or other damage to the seeded area during the mulching operations.

Spread mulch uniformly by hand or by approved mechanical spreaders or blowers which will provide an acceptable application. An acceptable application will be that which will allow some sunlight to penetrate and air to circulate but also partially shade the ground, reduce erosion and conserve soil moisture.

(C) Holding Mulch

Provide and apply tacking material to hold mulch in place in accordance with Article 1060-5. Apply emulsified asphalt tackifier at a rate of 0.10 gallons per square yard (approximately 484 gallons per acre). Apply cellulose hydromulches at a rate of 1000 pounds (dry weight) per acre. Apply other approved tackifiers at manufacturer's recommended application rate.

Take adequate precautions to prevent damage to traffic, structures, guardrails, traffic control devices or any other appurtenances during the application of asphalt binding material. Provide adequate covering or change methods of application as required to avoid such damage. Repair any damage that occurs, including any cleaning that may be necessary.

Take sufficient precautions to prevent mulch from entering drainage structures through displacement by wind, water or other causes and promptly remove any blockage to drainage facilities which may occur.

1660-7 MAINTENANCE OF SEEDING AND MULCHING

Maintain areas where seeding and mulching have been performed in a satisfactory condition until final acceptance of the project.

Mow at the location and times as directed by the Engineer.

Correct areas of damage or failure due to any cause by repairing or completely reworking as directed by the Engineer.

Repair in accordance with Section 1661 where extensive seedbed preparation is unnecessary.

Rework seeding and mulching in accordance with this section where correction requires extensive seedbed preparation, or where earthwork repairs or complete reshaping are necessary.

As an exception to the above, repair areas of damage or failure resulting either from negligence on the part of the Contractor in performing subsequent construction operations or from not taking adequate precautions to control erosion and siltation as required throughout the various sections of the specifications, at no cost to the Department.

1660-8 MEASUREMENT AND PAYMENT

Seeding and Mulching will be measured and paid in acres, measured along the surface of the ground completed and accepted. No direct payment will be made for furnishing and applying the limestone and fertilizer as such work and materials will be incidental to the work covered by *Seeding and Mulching*.

Mowing will be measured and paid in acres measured along the surface of the ground mowed as directed by the Engineer. Where an area has been mowed more than once at the direction of the Engineer, separate measurement will be made each time the area is mowed.

Corrective work will be compensated where seeding and mulching has been damaged or has failed to establish a satisfactory stand of vegetation.

Where correction can be made without extensive seedbed preparation, the work will be paid in accordance with Article 1661-5 for *Seed for Repair Seeding* and *Fertilizer for Repair Seeding.*

Where earthwork and seeding and mulching has been damaged to the extent that earthwork repairs or complete reshaping are necessary, the Contractor will be paid at the contract unit price for the excavated material required for repairs to the damaged earthwork, and at the contract unit price for *Seeding and Mulching* for correcting the damaged seeding and mulching.

As an exception to the above, repair, at no cost to the Department, any damage to earthwork or seeded and mulched areas which is due to carelessness or neglect on the part of the Contractor.

Tacking Material is incidental to *Seeding and Mulching* and no additional payment will be made.

Payment will be made under:

Pay Item	**Pay Unit**
Seeding and Mulching	Acre
Mowing	Acre

SECTION 1661
REPAIR SEEDING

1661-1 DESCRIPTION

Repair areas previously seeded and mulched in accordance with Section 1660 but damaged or failed to successfully establish a stand of vegetation. This work does not include repair seeding made necessary by negligence on the part of the Contractor as described in Article 1660-7, nor does it include repairs to temporary seeding constructed in accordance with Section 1620.

Repair damage or failure in accordance with this section where correction can be made without extensive seedbed preparation.

Where correction will require extensive seedbed preparation, or where earthwork repairs or complete reshaping are necessary, repair in accordance with Section 1660.

Repair seeding includes minor seedbed preparation; the furnishing, placing and covering of fertilizer and seed; and mulch as required, all in accordance with these specifications.

Perform repair seeding promptly at the locations and times as directed by the Engineer.

The actual conditions which occur during the construction of the project will determine the quantity of seed or fertilizer used. The quantity of seed or fertilizer may be increased, decreased or eliminated entirely at the discretion of the Engineer. Such variation in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1661-2 MATERIALS

Refer to Division 10.

Item	**Section**
Fertilizer	1060-2
Seed	1060-4
Mulch for Erosion Control	1060-5

The analysis of fertilizer and the kinds of seed shall be as stated in the contract.

1661-3 SEEDBED PREPARATION

Seedbed preparation will be required unless otherwise permitted.

A seedbed preparation as extensive as that performed for the original seeding and mulching will not be required. The degree of preparation shall be sufficient to retain the seed against displacement by wind, rain or surface runoff, and be acceptable to the Engineer. The acceptable degree of seedbed preparation will depend on the location, soil conditions and drainage conditions at the site.

1661-4 APPLICATION OF FERTILIZER, SEED AND MULCH

The analysis of fertilizer, the kinds of seed and the rates of application of seed and fertilizer is the same as specified in the project special provision for seeding and mulching, unless otherwise directed by the Engineer, but in no case will the total rate of seed and fertilizer vary more or less than 25% of that specified for seeding and mulching.

Do not distribute fertilizer or sow seed when the Engineer determines that conditions are unfavorable for such operations.

Cover fertilizer and seed and secure mulch in place to prevent displacement by wind, rain or surface runoff.

Article 1660-5 will be applicable to the approval of equipment and the protection of traffic, structures, guardrails, traffic control devices and other appurtenances.

1661-5 MEASUREMENT AND PAYMENT

Seed for Repair Seeding will be measured and paid in pounds. The weight of seed will be determined by bag count of standard weight bags or by weighing the seed. No direct payment will be made for furnishing and applying mulch and all materials used to hold mulch in place, as such work and materials will be incidental to the work covered by *Seed for Repair Seeding*.

Fertilizer for Repair Seeding will be measured and paid in tons. The weight of dry fertilizer will be determined by bag count of standard weight bags, or by weighing the fertilizer in trucks on certified platform scales or other certified weighing devices.

Payment will be made under:

Pay Item	Pay Unit
Seed for Repair Seeding	Pound
Fertilizer for Repair Seeding	Ton

SECTION 1662
SUPPLEMENTAL SEEDING

1662-1 DESCRIPTION

Apply additional seed to areas which have been previously seeded with permanent seed but on which there is an unsatisfactory cover of vegetation.

This work is only to provide an additional amount of seed to areas that have an insufficient stand of vegetation but which are too well established to require repair seeding. Work covered by this provision does not include seedbed preparation, fertilizer or mulch.

Perform supplemental seeding promptly at the locations and times as directed by the Engineer.

The actual conditions which occur during the construction of the project will determine the quantity of seed used. The quantity of seed may be increased, decreased or eliminated entirely as directed by the Engineer. Such variation in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1662-2 MATERIALS

Refer to Division 10.

Item	Section
Seed	1060-4

Use seeds as stated in the contract.

1662-3 APPLICATION

Seedbed preparation will not be required.

The contract will state the kinds and rates of application of seed. Sow no seed when the Engineer determines that conditions are unfavorable.

Article 1660-5 will be applicable to the approval of equipment; and the protection of traffic, traffic control devices and other appurtenances.

1662-4 MEASUREMENT AND PAYMENT

Seed for Supplemental Seeding will be measured and paid in pounds. The weight of seed will be determined by bag count of standard weight bags or by weighing the seed.

Payment will be made under:

Pay Item	Pay Unit
Seed for Supplemental Seeding	Pound

SECTION 1664
SODDING

1664-1 DESCRIPTION

Prepare soil, furnish and place limestone, fertilizer, sod and water; and other operations necessary for the permanent establishment of vegetation from sod on shoulders, slopes, ditches or other roadside areas.

Adapt operations to variations in weather and soil conditions so as to assure the successful establishment and growth of grasses.

Preserve the required line, grade and cross section of the area treated.

The actual conditions which occur during the construction of the project will determine the quantity of water used and mowing required. The quantity of water or mowing may be increased, decreased or eliminated entirely at the direction of the Engineer. Such variations in quantity will not be considered alterations in the details of construction or a change in the character of the work.

1664-2 MATERIALS

Refer to Division 10.

Item	Section
Fertilizer	1060-2
Limestone	1060-3
Sod	1060-7
Water	1060-9

The contract will state the analysis of fertilizer and the kinds of sod.

1664-3 SODDING

(A) Handling and Storing Sod

Exercise extreme care during all operations of loading, transporting, unloading, storing,

placing, tamping and staking sod, to prevent breaking the sod sections and to prevent the sod from drying out. Any sod that is torn, broken or too dry will be rejected by the Engineer. Torn or broken sod, if kept moist, may be used for filling unavoidable small gaps in sod cover as permitted.

Place sod on the designated areas within 48 hours after being cut unless otherwise directed by the Engineer.

(B) Soil Preparation

Remove litter and other debris. Mow and satisfactorily dispose of weeds or other unacceptable growth on the areas to be sodded.

Bring the area to be sodded to a firm uniform surface at such elevation that the surface of the complete sodding conforms to the finished grade and cross section as shown in the plans.

Scarify or otherwise loosen soil to a depth of not less than 5 inches. Break clods and work the top 2 inches to 3 inches of soil into an acceptable soil bed by using soil pulverizers, drags or harrows.

Place limestone and fertilizer before placing the sod. The contract will state the kind and grade of fertilizer, and the rates of application of limestone and fertilizer. Distribute the limestone and fertilizer uniformly over the area and thoroughly mix in the top 5 inches of the soil by discing, harrowing or other methods approved by the Engineer.

Prepare the area by harrowing, dragging, raking or other methods approved by the Engineer to give a lawn type finish. Remove all trash, debris and stones larger than 1 ½ inches in diameter or other obstructions that could interfere with the placing of the sod. Moisten the finished surface with water before placing the sod.

(C) Placing Sod

The contract will state the seasonal limitations for sodding and the kind of sod to use.

Sod handling and placement will be a continuous process of cutting, transporting and installing without appreciable delays. Install sod within 48 hours after being cut and water immediately after installation.

Place sod firmly and carefully by hand within 24 hours after soil preparation is completed and accepted by the Engineer. Pack each piece of sod tightly against the edge of adjacent pieces so that the fewest possible gaps will be left between the pieces. Close unavoidable gaps with small pieces of sod.

When placing sod on a slope, begin at either the top or the toe of the slope. Place sod with the long edge horizontal and with staggered vertical joints. Turn the edge of the sod slightly into the ground at the top of a slope and place a layer of earth over it and compact so as to divert the surface water over and onto the top of the sod.

Stake sod in place by driving stakes flush with the sod, on all slopes 2:1 or steeper, in drainage channels, on other areas shown in the plans, and on any areas that are in such condition that there is danger of sod slipping. Perform staking concurrently with sod placement and before tamping with sound wooden stakes which are approximately one inch square or one inch in diameter and not less than 12 inches in length. Place enough stakes to prevent slipping or displacement of the sod. Drive stakes perpendicular to the slope. Where backfill is necessary on cut slopes to obtain a uniform sodding area, provide stakes of sufficient length to reach at least 3 inches into the solid earth underneath the backfill.

On all other areas, use metal staples in place of wooden stakes. The metal staples should be 12 inches long, made of 11 gauge new steel wire so as not to bend when pinned or driven through the sod. Shorter staples may be used with the approval of the Engineer.

Place, stake and staple the sod where necessary, then tamp or roll carefully and firmly by acceptable means. If rolled, roller shall weigh 150 lbs. per foot of roller width. Take extreme care to prevent the installed sod from being torn or displaced.

Do not place sod when the atmospheric temperature is below 32°F. Do not use frozen sod or place on frozen soil.

(D) Watering Sod

Water carefully and thoroughly after sod has been placed and tamped. Perform watering as directed by the Engineer until final acceptance. Application of water may be made by the use of hydraulic seeding equipment, farm type irrigation equipment or by other methods approved by the Engineer.

1664-4 MAINTENANCE

Maintain sod in a satisfactory and live condition until final acceptance of the project. Maintenance includes watering and mowing at the locations and times as directed by the Engineer.

1664-5 MEASUREMENT AND PAYMENT

Sodding will be measured and paid in square yards, measured along the surface of the ground completed and accepted. No direct payment will be made for mowing the sodding areas before soil preparation as such work will be incidental to sodding. No direct payment will be made for furnishing and applying limestone and fertilizer, as such will be incidental to the work covered by sodding.

Water will be measured and paid in 1,000 gallon units. Measurement of water will be made by means of an approved metering device at the source of supply, or by determining the volumetric capacity of tank trucks used to deliver water to the project and recording the number of loads delivered by each truck.

Mowing will be measured and paid in accordance with Article 1660-8.

The above prices and payment will be full compensation for all work covered by this section.

Payment will be made under:

Pay Item	Pay Unit
Sodding	Square Yard
Water	1,000 Gallons

SECTION 1665
FERTILIZER TOPDRESSING

1665-1 DESCRIPTION

Furnish and uniformly distribute fertilizer as a topdressing to areas on which seeding and mulching, sprigging or sodding are completed and a vegetative cover is established. Top dress previously seeded, sprigged or sodded areas under other contracts when so stated in the contract or where so directed by the Engineer.

The actual conditions that occur during the construction of the project will determine the quantity of fertilizer topdressing used. In the event that a vegetative cover has not had sufficient time to develop to a size suitable for topdressing before completion of the project, the work of fertilizer topdressing will be decreased or eliminated entirely. Where the use of additional fertilizer topdressing would be beneficial to the establishment of grasses or legumes, the work of fertilizer topdressing will be increased. The quantity of fertilizer topdressing may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of work.

1665-2 MATERIALS

Use fertilizer containing no urea for topdressing.

Refer to Division 10.

Item	Section
Fertilizer	1060-2

The analysis of fertilizer shall be as stated in the contract.

1665-3 APPLICATION

Apply fertilizer topdressing at the locations and times as directed by the Engineer, regardless of whether or not other seeding, sprigging or sodding operations are underway at the time.

The contract will state the rate of application and analysis of fertilizer. Distribute fertilizer uniformly without any type of soil disturbance.

Refer to the contract for the approval of equipment and the protection of traffic, structures, guardrails, traffic control devices and other appurtenances.

1665-4 MEASUREMENT AND PAYMENT

Fertilizer Topdressing will be measured and be paid in tons. The weight of dry fertilizer will be determined by bag count of standard weight bags or by weighing the fertilizer in trucks on certified platform scales or other certified weighing devices.

In the event that an alternative analysis of fertilizer topdressing is approved by the Engineer and used, it will be in an equivalent number of tons of fertilizer, of the specified analysis, based on nutrient value.

Payment will be made under:

Pay Item	Pay Unit
Fertilizer Topdressing	Ton

SECTION 1667
SPECIALIZED HAND MOWING

1667-1 DESCRIPTION

This work consists of specialized hand mowing around or under fixed objects, including but not limited to guardrails, signs, barriers and slopes in a method acceptable to the Engineer.

Specialized hand mowing shall be completed with mechanically powered trimmers, string trimmers, hand operated rotary mowers or self-propelled mowers of sufficient size and quality to perform the work timely and efficiently.

The quantity of mowing to be performed will be affected by the actual conditions that occur during the construction of the project. The quantity of mowing may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1667-2 MEASUREMENT AND PAYMENT

Specialized Hand Mowing will be measured and paid as the actual number of man hours each worker spends hand mowing, as directed. When directed by the Engineer to mow an area more than once, separate measurement will be made each time the area is mowed.

Payment will be made under:

Pay Item	Pay Unit
Specialized Hand Mowing	Man Hour

SECTION 1670
PLANTING

1670-1 DESCRIPTION

Furnish, deliver and plant trees, shrubs, vines, ground covers, bedding plants and seedlings at locations shown in the plans or as directed by the Engineer, in accordance with these specifications.

The work of planting includes plant bed preparation, initial planting, plant establishment and replacement planting.

Perform the operations carefully to promote the continued life and healthy growth of all plants in their final location.

The actual conditions that occur during the construction of the project will determine the quantity of plant bed fumigation or post-emergent and pre-emergent herbicidal treatment for plant beds. The quantities of post-emergent and pre-emergent herbicidal treatment for plant beds may be increased, decreased or eliminated entirely as directed by the Engineer. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

1670-2 MATERIALS

Refer to Division 10.

Item	Section
Fertilizer	1060-2
Herbicide	1060-13
Materials for Staking or Guying	1060-12
Mulch for Planting	1060-11
Nursery Grown Plant Materials	1060-10
Water	1060-9

Furnish nursery grown plant materials.

The contract will state the kind of herbicides to be used.

1670-3 WEATHER AND SEASONAL LIMITATIONS

Perform planting operations only between the dates shown in the contract except where otherwise permitted by the Engineer.

Do not plant when the temperature is below 32°F, when the plant hole is frozen or when soil to excavate and fill the plant hole is frozen or too wet.

Apply post-emergent herbicide when the weeds are near maturity but not when the weeds are under stress from drought, disease, insect damage or any other cause.

Do not apply post-emergent herbicide when rain is likely within the next 6 hours or as restricted on the product label.

1670-4 CARE AND HANDLING PLANTS

(A) General

Exercise utmost care in digging, loading, transporting, unloading, planting or otherwise handling plants and use adequate precautions to prevent injury to or drying out of the trunk, branches or roots; and to prevent freezing of the plant roots. Heel-in plants within 48 hours of delivery from the nursery, if they cannot be planted within that time.

Properly maintain all heeled-in plants until planted. Do not have plants remain heeled-in for more than 30 days. Open plants immediately when delivered in boxes or wrapped in

bundles or other forms of closed packages and inspect and dampen if necessary.

(B) Balled and Burlapped Plants

Protect the roots of balled and burlapped plants, if not immediately planted after delivery, by adequately covering with a soil, mulch or sawdust that is kept moist constantly in an acceptable manner appropriate to weather or seasonal conditions. Preserve the solidity of the plant ball carefully.

(C) Bare Rooted Plants

Refrigerate or immediately heel-in all plants, if not promptly planted, in moist soil, mulch or sawdust in an acceptable manner corresponding to generally accepted horticultural practice.

Protect the plants from drying out by means of wet canvas, burlap or straw or by other means acceptable while being transported or planted.

(D) Geophytes

Geophytes; bulbs, corms and tuberous plants; that are being shipped shall be packaged in containers that meet industry standards and have been pre-approved by the engineer. All individual packages shall be clearly labeled with quantity and cultivar name.

While bulbs, corms and tuberous plants are being transported or are being distributed in planting beds, or are awaiting planting after distribution, protect them from drying out by means of wet canvas, burlap, or straw, or by other means acceptable to the Engineer and appropriate to weather conditions and the length of time they will be out of the ground. Care shall be taken to avoid unnecessary injury to the bulbs before planting.

Pre-plant cool treatment is required for plants planted in a USDA Climatic Zones 9 and 10. Storage of bulbs, corms and tuberous plants which do not require pre-plant cool treatment shall be stored in open trays and placed in a 55°F - 65°F, dry place away from frost and heat and never allowed to dry out to the point of shriveling. Packing in slightly moist peat is preferred. The storage area shall be well-ventilated and ethylene-free. Do not store bulbs with fruit such as apples or pears which produces ethylene gas which can cause problems with flowering. Do not store bulbs in paper or plastic bags unless otherwise specified or approved by the Engineer. If a refrigerator is used it shall be frequently ventilated.

1670-5 PLANT LOCATION

Locate and mark on the ground locations for plants and outlines for areas to be planted or reforested and obtain approval from the Engineer before digging plant holes for beds.

Where so directed by the Engineer, furnish and install standard identification wires with plastic flags to designate individual plants in major planting areas.

Flags will not necessarily be needed for all plants required by the contract, but use these flags on portions of the project until plant locations in these portions are approved by the Engineer.

Unforeseen conditions may make it necessary to make minor adjustments in plant locations due to utility lines, traffic signs, rock, drainage, etc., and such adjustments will be permitted subject to approval by the Engineer.

1670-6 PRUNING

Prune shrubs and trees after planting as shown in the plans or as directed by the Engineer. Pruning done at any time in no way alters the Department's right to reject plant material. Prune in accordance with the International Society of Arboriculture pruning techniques, and according to shape, size and condition of the individual plant.

1670-7 PLANT BED TREATMENT

(A) General

Treat plant beds by application of herbicides where called for by the plans or directed by the Engineer.

(B) License

Make pesticide applications by or under the direct supervision of an applicator licensed by the North Carolina Department of Agriculture and Consumer Services.

(C) Post-Emergent Herbicidal Treatment

Post-emergent herbicidal treatment includes applications of a systemic post-emergent total vegetation control herbicide.

The contract will state the rates of application of the post-emergent herbicides.

Apply all herbicides in accordance with the manufacturer's instructions on the product label.

Apply post-emergent herbicide when the weeds are near maturity but not when the weeds are under stress from drought, disease, insect damage or any other cause. If cloudy weather or other poor growing conditions are present, extend this 7 day period until there are visible signs of herbicidal activity. Reapply if necessary to achieve a thorough control.

(1) Post-Emergent Application for Plant Bed Preparation

Apply a systemic post-emergent total vegetation control herbicide to the bed area before any tilling or mowing is performed. Perform no tilling or mowing for at least 7 days after the application. Thoroughly till the bed after the waiting period, or when injury to the vegetation appears. Prepare the soil in good tilth with no clods over one inch present and before planting.

(2) Post-Emergent Application for Plant Bed Maintenance

Apply a systemic post-emergent herbicidal treatment in accordance with product label in a manner to ensure no damage to planted material. Perform no mowing or vegetation removal by other means for at least 7 days after the application.

(D) Pre-Emergent Herbicidal Treatment

Pre-emergent herbicidal treatment includes the application of a pre-emergent herbicide.

Apply a pre-emergent herbicide to the plant bed after the existing vegetation has been completely controlled by a post-emergent herbicide application as specified in herein and after installation of planting and mulching as described in Articles 1670-9 and 1670-10. Apply pre-emergent herbicide following planting and mulching of plant bed before germination of weed seeds. An additional application of post-emergent herbicidal treatment may be necessary to control emerged weeds, as directed by the Engineer, if sufficient time has lapsed between tillage and installation of plant material and mulch. No direct payment will be made for additional post-emergent herbicidal work if such work is due to carelessness or neglect on the part of the Contractor.

Apply herbicide evenly over the soil surface with properly calibrated equipment at the specified rate.

If at least 0.5 inches of rainfall does not occur within 15 days of application of pre-emergent herbicidal treatment, apply at least 0.5 inches of water (2.8 gal/sy) uniformly over the planting area to activate the herbicide.

1670-8 EXCAVATION OF PLANT HOLES

Provide cylindrical shaped plant hole excavations for plants other than reforestation plants, with the plant location stake marking the center of the circle and with the sides of the hole being approximately vertical. When mechanical means are used which make digging of cylindrical holes impractical, the complete hole shall have the minimum dimensions as shown in the plans.

When plants are to be grouped together in a plant bed as contrasted to widely separated individual plants, and when so indicated in the plans, loosen and pulverize clods to a depth of not less than 5 inches for the entire area of the plant bed by means of a scarifier, disc, spade or other appropriate means before plant holes are dug.

Plant reforestation plants in holes made by a planting spade, planting bar or other means which meet the approval of the Engineer. Make the hole of sufficient size to accommodate the entire extended root system of the plant without cramping.

When geophytes; bulbs, corms and tuberous plants; are to be grouped together in a plant bed as contrasted to widely separated individual plants, and when so indicated in the plans, loosen and pulverize clods to a depth of not less than 8 inches, or as indicated in the plans, for the entire area of the plant bed by means of a scarifier, disc, spade or other appropriate means before plant holes are dug.

Place plants in holes made by a planting spade, planting bar or other means which meet the approval of the Engineer. Make the hole of sufficient size to accommodate the entire plant structure without cramping. Take care to plant all plants at a uniform depth as indicated in the plans or directed by the Engineer.

When geophytes are to be planted separately as individual plants or in small separated groups, loosen and pulverize clods with a spade, auger or other means which meet the approval of the Engineer. Individual planting holes shall be to a depth of not less than 8 inches, or sufficient size to accommodate the entire plant structure without cramping or to a depth as indicated in the plans or directed by the Engineer.

1670-9 PLANTING, BACKFILLING AND WATERING

(A) General

The plans will state the kind and rate of application of fertilizer. Apply fertilizer during backfilling operations in a manner that will ensure proper placement of the fertilizer and avoid injury to the roots.

Scarify the walls and floor of the plant hole after the plant hole is dug. Place the plant in the prepared plant hole at the proper position as regards to depth, alignment, final grade of the surrounding ground level and vertical placement of the trunk. Maintain this position during all subsequent backfilling and watering operations. Set plants with the root collar at the same depth as grown in the nursery or raise above grade as indicated in the plans.

Moisten the soil with water after one-half to two-thirds of the backfilling and tamping has been completed, if the soil in the plant holes is not sufficiently moist. Apply water to moisten all soil but not a quantity that will saturate the soil to the extent of excluding all air from around the roots. Place the remainder of the backfill after complete absorption of water.

Construct water rings around all plants, except reforestation plants, in accordance with details shown in the plans. A water ring consists of a ridge of firmed soil in a ring around the plant and of a minimum inside diameter equal to the diameter of the plant hole. This ridge is approximately 6 inches high and is compacted firmly enough to hold water.

(B) Balled and Burlapped Plants

Handle balled and burlapped plants by the ball and place in the plant hole so that the soil of the ball will not be loosened from the roots. After the hole has been almost completely backfilled and the soil thoroughly firmed under and around the ball, cut the burlap away and remove from around the stem of the plant. Complete backfilling so as to avoid loosening of the soil of the root ball.

(C) Container Grown Plants

Planting requirements for container grown plants are the same as applicable to balled and burlapped plants. Remove container immediately before planting. During the removal of the container, take sufficient precautions to ensure that the soil and roots inside the container are undisturbed. Scarify roots when directed by the Engineer.

(D) Bare Rooted Plants

Before the plant is placed in the plant hole, cut off smoothly any bruised or broken parts of roots. Place the plant in its proper position in the hole and backfill. Carefully place the backfill material, worked around and under the roots and compacted in a manner that avoids bruising or breaking the roots.

(E) Reforestation Plants

Reforestation includes tree reforestation and shrub reforestation. Type, mixture, size, furnish description and spacing will be as shown on the reforestation detail sheet in the plans.

Before beginning reforestation, each area to be reforested will be measured by the Engineer to determine the exact number of acres for tree reforestation or shrub reforestation therein and the quantity of each species of seedling to be planted within the area.

Where structures or plantings do not adequately delineate the outline of the area to be reforested, stake the outline of the area as directed by the Engineer. Furnish cypress, cedar, oak, locust or other wood stakes approved by the Engineer. Provide stakes with a minimum industry standard of 2 inches x 2 inches (nominal) size and approximately 30 inches in length with a 15 inch white top. Drive stakes in the ground with approximately 18 inches remaining above the ground line and place as necessary to define and delineate the reforestation outline.

Ensure sample stock of reforestation seedlings are inspected by the Engineer, for general health and moisture content, within 24 hours before planting.

After the plant hole has been prepared, place the plant upright in the hole at the correct depth without crowding or bunching the roots. Firm the soil around the root system from the bottom of the plant hole to natural ground elevation.

Upon completion of planting the required number of seedlings within all areas to be reforested, the Contractor will be relieved of further responsibility in connection with reforestation except for damage caused directly by the Contractor.

(F) Geophytes

When planting geophytes; bulbs, corms and tuberous plants; take care to place all plants at a uniform depth as indicated in the plans or directed by the Engineer. All plants shall be set upright as originally grown and at the proper spacing and depth from the natural ground elevation. Soil that is backfilled into the hole to obtain the proper depth shall be firmed before plant placement. Soil backfilled over the plant shall be firmed.

Planting shall be accomplished when the soil temperature is 40°F to 45°F or as directed by the Engineer. No phase of this work shall be performed when the temperature is below 32°F, when the plant holes are frozen or when soil to excavate and fill the plant hole is frozen or too wet.

Geophytes shall be watered as stated in the contract or as directed by the Engineer. Watering will be required for geophytes if the soil in the plant hole is not sufficiently moist. Apply water to moisten all soil, but not in a quantity that will create standing water or saturate the soil to the extent of excluding all air from around the plant.

1670-10 MULCH FOR PLANTING

Place mulch within 7 days of initial planting as a top layer on the backfilled plant hole and water ring. Place mulch approximately 4 inches deep as shown in the plans or as directed by the Engineer. Place additional mulch as directed by the Engineer during establishment.

No mulching will be required for reforestation plants.

1670-11 WATER FOR PLANTING

Water at the time of planting as specified in Article 1670-9 and at the Contractor's election and the Engineer's approval. Water with gravity flow or low pressure applicators which have been approved by the Engineer, and which will not erode soil around the plant root system or damage to plants. Saturate the soil around each plant thoroughly at each watering.

1670-12 STAKING OR GUYING

Stake or guy plants as shown in the plans or as directed by the Engineer to prevent damage.

Ensure that the plant is attached and held rigid to the support in a manner that will prevent chafing or other injury to the bark, and that will permit normal development of the trunk or branch.

1670-13 INITIAL PLANTING

Initial planting will be complete when the plants have been placed in the plant hole, backfilled, fertilized, watered, mulched, staked and guyed, and the plants are in an acceptable condition.

1670-14 ESTABLISHMENT

Begin establishment for all initial or replacement plants immediately after they are planted. Maintain trees, shrubs, vines and groundcovers, and the area of planting until final acceptance of the project. Mow and maintain the area around trees and shrubs for a distance of 6 feet beyond the outside limits of water rings or 6 feet beyond the limits of the guy stakes, whichever is greater; within shrub beds; and for a distance of 6 feet outside the perimeter of the shrub beds. Establishment includes cutting of grass and control of weeds; watering; fertilization; replacement of mulch; repair or replacement of guy stakes, guy wires and water rings; and other work as directed by the Engineer to ensure the survival and growth of plant material and the satisfactory appearance of the project. Remove dead plant material from the project during the establishment period.

1670-15 REPLACEMENT PLANTING

Replace any trees, shrubs, wetland plantings or other plant materials that are dead, in an unhealthy condition, damaged during installation or stolen. Replacement plant materials shall conform to the guidelines of the *American Standard for Nursery Stock*. Replacement of reforestation plants will not be required.

Perform replacement planting within the planting season specified in the contract or as directed by the Engineer.

1670-16 FINAL INSPECTION

All planting shall be completed and all plants shall be in a living and healthy condition at the time of final inspection.

1670-17 MEASUREMENT AND PAYMENT

(Plant Species and Size Indicated in Contract) will be measured and paid in units of each, other than reforestation plants, planted and accepted.

Reforestation will be measured and paid in acres of land measured along the surface of the ground.

Wetland Reforestation will be measured and paid in acres of land, measured along the surface of the ground.

Post-emergent Herbicidal Treatment will be measured and paid in square yards of plant bed measured along the surface of the ground.

Pre-emergent Herbicidal Treatment will be measured and paid in square yards of plant bed measured along the surface of the ground.

Geophytes (plant species and size indicated in contract) will be measured and paid in units of each that have been planted and accepted.

Mulch for Planting will be measured and paid in cubic yards. Where mulch is furnished in bales or bags, the number of cubic yards in each bale or bag will be determined and then multiplied by the number of bales or bags of the same size which have been acceptably furnished and placed. Where mulch is furnished in trucks, each truck will be measured by the Engineer and shall bear a legible identification mark indicating its capacity. Load each truck to at least its measured capacity at the time it arrives at the site of the work.

Water for Planting will be measured and paid in units of 1,000 gallon units. Measurement of water will be made by means of an approved metering device at the source of supply, or by determining the volumetric capacity of tank trucks used to deliver water to the project and recording the number of loads delivered by each truck.

No payment will be made for plant bed preparation, tillage, staking or guying and fertilization, for this work will be incidental to other work in the contract.

Payment will be made under:

Pay Item	**Pay Unit**
(Plant species and size indicated in contract)	Each
Reforestation	Acre
Wetland Reforestation	Acre
Post-Emergent Herbicidal Treatment for Plant Beds	Square Yard
Pre-Emergent Herbicidal Treatment for Plant Beds	Square Yard
Geophytes	Each
Mulch for Planting	Cubic Yard
Water for Planting	1,000 Gallons

SECTION 1675
RESPONSE FOR EROSION CONTROL

1675-1 DESCRIPTION

Furnish the labor, materials, tools and equipment necessary to move personnel, equipment, and supplies to the project necessary for the pursuit of any or all of the following work shown in Table 1675-1, by a prequalified subcontractor.

TABLE 1675-1
RESPONSE FOR EROSION CONTROL WORK LIST

Section	Erosion Control Item	Unit
1605	Temporary Silt Fence	LINEAR FEET (LF)
1606	Special Sediment Control Fence	LF/TON
1615	Temporary Mulching	ACRE
1620	Seed - Temporary Seeding	LB
1620	Fertilizer - Temporary Seeding	TON
1631	Matting for Erosion Control	SY
1629	Coir Fiber Mat	SY
1640	Coir Fiber Baffles	LF
SP	Permanent Soil Reinforcement Mat	SY
1660	Seeding and Mulching	ACRE
1661	Seed - Repair Seeding	LB
1661	Fertilizer - Repair Seeding	TON
1662	Seed - Supplemental Seeding	LB
1665	Fertilizer Topdressing	TON
SP	Safety/Highly Visible Fencing	LF
1675	Response for Erosion Control	EA

1675-2 CONSTRUCTION METHODS

Provide an approved subcontractor who performs an erosion control action as described in the *NPDES Inspection Form SPPPForm30*. Each erosion control action may include one or more of the above work items.

1675-3 MEASUREMENT AND PAYMENT

Response for Erosion Control will be measured and paid for by counting the actual number of times the subcontractor moves onto the project, including borrow and waste sites, and satisfactorily completes an erosion control action described in *Form 1675*. The provisions of Article 104-5 of the *Standard Specifications* will not apply to this item of work.

Payment will be made under:

Pay Item	Pay Unit
Response for Erosion Control	Each

DIVISION 17
SIGNALS AND INTELLIGENT TRANSPORTATION SYSTEMS

SECTION 1700
GENERAL REQUIREMENTS

1700-1 DESCRIPTION

Furnish, install, modify and remove signals, flashing beacons, intelligent transportation systems, electrical systems and provisions for future systems.

1700-2 MATERIAL

Refer to Division 10.

Item	Section
Electrical Service Equipment	1098-1(H)
Electrical Materials	1091

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1700-3 CONSTRUCTION METHODS

(A) General

Before beginning signal work, verify all existing signal equipment is in satisfactory working order. Report all defective signal equipment to the Engineer so as not to be held responsible for defects.

Locate existing conduit, cable runs, inductive detection loops, lead-in cable, junction boxes and detection equipment before installing or using equipment that can damage or interfere with such facilities. The locations of existing inductive detection loops shown in the plans are approximate.

Locate all underground utilities before beginning drilling, digging or trenching operations.

Ensure that an IMSA certified, or equivalent, Level II traffic qualified signal technician is standing by to provide supervision and emergency maintenance services whenever work is being performed on traffic signal controller cabinets and traffic signal controller cabinet foundations. Stand by status is defined as being able to arrive, fully equipped, at the work site within 30 minutes ready to provide services.

Immediately cease work and notify the Engineer and affected owners if damage to existing utilities, cables or equipment occurs. Make all required repairs and replacements.

(B) Regulations and Codes

Comply with NCGS § 87, Article 4, Electrical Contractors. Comply with all regulations and codes imposed by the owner of affected utility poles.

Notify the Engineer, local traffic law enforcement agency, local utility company and affected railroad companies 7 business days before operational shutdowns to coordinate connection or disconnection to an existing utility or system.

Install standoffs, meter bases and service disconnects as required by the NESC, NEC, local utility companies and local ordinances.

(C) Utility Services

Coordinate all work to ensure electrical power of proper voltage, phase, frequency and ampacity is available to complete the work. Use electrical services cables with THWN insulation.

When electrical, telephone and telecommunication service is not furnished by the Department and is required, contact the utility company and make application to ensure all work can be completed. Obtain authorization for service in the Department's name and make application for service in the Department's name along with the associated NCDOT Asset Inventory Number shown in the contract. Notify the Engineer immediately if this number is not shown in the contract.

The Department will be responsible for direct payment of monthly utility company usage charges. The Contractor will be responsible for all expenses associated with utility installation costs, hookups, etc.

(D) Maintenance and Repair of Material

Furnish the Engineer with the name and telephone numbers of the supervisory employee who will be responsible for maintenance and repair of equipment during all hours.

Maintain and repair all signal and communications related equipment within the project construction limits until completion of the observation period in accordance with Subarticle 1098-1(C) and receipt of written notification of final acceptance of the project.

For all failures, malfunctions or damages to equipment, begin necessary repairs within 4 hours of notification. Complete repairs within 8 hours of notification. Comply with Section 150 for maintenance of traffic flow. The inability to contact the supervisory employee or prearranged alternate will not extend repair time requirements.

Remove and replace all signal and communications related equipment that fails. The Department will furnish the Contractor replacement equipment for Department-furnished equipment that fails.

Except for damages and malfunctions caused by the Contractor's work activities, the Contractor will not be held responsible for pre-existing conditions reported to the Engineer before starting traffic signal work at the specific intersection. The Contractor will assume responsibility for all maintenance and emergency services necessary once traffic signal work has begun at the specific intersection and for all damages and malfunctions caused either directly or indirectly by the Contractor's work activities.

Perform maintenance (testing) on all Traffic Signal Conflict Monitors every 12 months for the life of the project beginning with the initial test and every 12 months thereafter. Provide the initial test date via the manufacturer's certification or via testing prior to installation of the conflict monitor at an intersection. Use the ATSI Incorporated Model PCMT-2600 or newer Conflict Monitor Tester or an Engineer approved equivalent. Ensure that the Conflict Monitor Tester is maintained and calibrated per the manufacturer's recommendation. Provide to the Engineer a copy of the manufacturer's certification that the Conflict Monitor Tester is in proper working order before testing the Traffic Signal Conflict Monitors. Perform the test on the Traffic Signal Conflict Monitors per the manufacturer's recommendation. For each Traffic Signal Conflict Monitor tested, provide 2 dated copies of the test results: one copy for the Engineer and one copy for the traffic signal cabinet.

In the event the Contractor fails to perform in accordance with the plans and specifications within the time frame specified, the Department reserves the right to perform maintenance and emergency service necessary to ensure continuous traffic signal operation. Further, all expenses incurred by the Department in implementing this option will be deducted from payment due the Contractor, plus $2,500 liquidated damage per occasion, per day, or any portion thereof, until corrected.

(E) Inspections

The Department may access the Contractor's equipment to perform railroad, signal and preventative maintenance inspections or conflict monitor certification as necessary. The Contractor shall be present for these inspections.

(F) Removal of Existing Equipment and Material

Remove all Department-owned signals and communications related equipment and material that will not be used. Assume ownership of removed poles, messenger cable, interconnect cable, communications cable and supporting hardware, unless otherwise specified. Return all other equipment and material between 8:00 a.m. and 12:00 p.m., Monday through Thursday, to the Traffic Services Office within the Division responsible for administration of the project.

(G) Railroad Preemption

Where railroad preemption is required, coordinate all work with the railroad company. Do not place signals into operation until signal equipment has been interconnected with required railroad-highway crossing devices and railroad preemption is working properly. Ensure preemption sequences begin immediately after activation of train detection.

Contact and coordinate with the railroad company to schedule interconnection of the signal to the railroad controller cabinet. Install lead-in cable from the signal controller cabinet to a railroad company furnished and installed lockable junction box. Interconnection will be made by the railroad company.

Provide fail-safe operation such that removal of voltage from the railroad side of the isolation relay will initiate the railroad preemption sequence.

(H) Vehicle Preemption Systems

Where required, implement and install vehicle preemption systems. Coordinate vehicle preemption work with the proper operating authority. Contact the proper operating authority and schedule installation of preemption equipment.

(I) Timing of Signals

Implement timing values for signal controllers. Modify proposed phasing and timing of existing controllers.

Reinstall all existing time-based coordination. Make modifications to existing coordination to account for changes in signal phasing as directed by the Engineer.

The Department reserves the right to make or have the Contractor make, field timing changes necessary for pattern optimization and to eliminate identifiable, potential hazards to the motoring public. The Engineer will notify the Contractor of timing changes made.

(J) Wire and Cable

For installation in a conduit system, lubricate cable and wires before installing in conduit. Use lubricant that will not physically or chemically harm cable jacket, wire insulation or conduit.

Terminate all electrical wire and cable at recessed-screw or barrier type terminal blocks. Unless specifically allowed, connect no more than 2 conductors to the same terminal screw.

Splice electrical wire and cable in junction boxes or condulets as shown in the *Roadway Standard Drawings*. Maintain color coding of wires throughout each splice.

Protect ends of wire and cable from water and moisture.

(K) Electrical Service and Grounding

Where electrical services do not include an external electrical service disconnect, modify

service to include electrical service disconnect and a new grounding electrode system.

Provide a grounding electrode system at all new electrical services. All grounding and bonding equipment shall conform to UL Standard 467. Permanently bond grounding conductor to ground rod using an irreversible ground connector. Unless the irreversible ground connectors are designed for use with more than one conductor, only one conductor shall be used with each irreversible ground connector. Ensure all irreversible ground connectors are installed per manufacturer's installation instructions. Irreversible compression ground connectors requiring the use of a die for installation shall be made using a hydraulic, power, or ratcheting type crimper with appropriate dies. The use of handheld pliers for crimping irreversible compression ground connectors is prohibited.

Modify existing electrical services, as necessary, to meet the grounding requirements of the NEC, specifications, plans and test requirements. Remove any ground rods in the cabinet foundation and install a new grounding electrode system. Cut off abandoned ground rods in the cabinet foundation flush with the foundation surface.

In addition to NEC requirements, test grounding electrode resistance for a maximum of 20 ohms. Furnish and install additional ground rods to grounding electrode system as necessary to meet the specifications, plans and test requirements. Grounding electrode resistance test shall be verified or witnessed by the Engineer or the Engineer's designated representative.

Follow test equipment's procedures for measuring grounding electrode resistance. When using clamp-type ground resistance meters, readings of less than one ohm typically indicate a ground loop. Rework bonding and grounding circuits as necessary to remove ground loop circuits and retest. If a ground loop cannot be identified and removed to allow the proper use of a clamp-type ground resistance meter, use the three-point test method.

Complete *Inductive Loop & Grounding Test Form* available on the Department's website and place one copy in the traffic signal cabinet.

For ease of inspection, the top of ground rods shall be 12 inches (± 1 inch) below finished grade and shall remain exposed until electrical inspection is complete. Provide a length of marker tape 6 inches below finished grade directly over grounding electrodes and conductors.

For ground rods installed in areas where the slope is greater than 4:1, the top of the ground rods shall be a minimum of 24 inches below finished grade. Provide a length of marker tape 6 inches to 12 inches below finished grade directly over grounding electrodes and conductors.

(L) Electrical Bonding

Using an approved termination means, connect a #14 AWG minimum, 19-strand copper conductor (Type THWN) with green insulation to serve as an equipment grounding conductor to metal poles, vehicular and pedestrian signal pedestals and other metallic components. Use messenger cables on wood poles and metal strain poles to provide effective ground fault current path to cabinet ground.

(M) Traffic Signal Activation

Prior to placing signal in the steady (stop-and-go) mode, the signal should be placed in the flashing mode for up to 7 days or as directed by the Engineer. The signal should not be placed in the steady (stop-and-go) mode on a Saturday or Sunday without prior approval from the Engineer. Do not place the signal in steady (stop-and-go) mode until inspected and without prior approval of the Engineer.

(N) Temporary Traffic Signal Installations

When a traffic signal is installed for control of traffic during construction of the project and scheduled for removal during or upon completion of the project, install and remove the temporary traffic signal as required. Upon removal of the temporary traffic signal, restore surface to like-new condition. Rake smooth unpaved areas, repave paved areas and seed grassed areas that were damaged by Contractor activities.

Prepare intersection for sign control before removing the temporary traffic signal. Install required regulatory signs in accordance with Sections 900, 901 and 903. Cover signs with burlap bags until traffic signal is placed into flashing operation.

Place traffic signal into flashing operation and uncover signs simultaneously. Operate the flashing operation for a period of time as directed by the Engineer.

Signal cabinets, controllers, detector units, signal heads and accessories and microwave detectors are property of the Department. Return Department owned equipment between 8:00 a.m. and 12:00 p.m., Monday through Thursday, to the Traffic Services Office within the Division responsible for administration of the project. Assume ownership of removed poles, messenger cable, interconnect cable, communications cable, supporting hardware and loop emulator detection equipment, unless otherwise specified.

1700-4 MEASUREMENT AND PAYMENT

There will be no direct payment for work covered in this section. Payment at the contract unit prices for the various items in the contract will be full compensation for all work covered by this section.

Repair, removal and replacement of damaged or unacceptable equipment or work under this section will be at no additional cost to the Department. The Department will deduct the cost of Department-owned equipment damaged by the Contractor from money due to the Contractor.

If the Department performs maintenance and emergency service necessary to ensure continuous traffic signal operation, all expenses incurred by the Department in implementing this option will be deducted from payment due the Contractor, plus $2,500 liquidated damage per occasion, per day or any portion thereof, until corrected.

SECTION 1705
SIGNAL HEADS

1705-1 DESCRIPTION

Furnish and install vehicle and pedestrian LED signal heads, visors, interconnecting brackets, wire entrance fittings, mounting assemblies, signal cable, lashing wire, pedestrian pushbuttons (and associated lead-in cable), pedestrian signal signs, grounding systems and all necessary hardware.

1705-2 MATERIAL

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1705-3 CONSTRUCTION METHODS

(A) General

Bag new pedestrian and vehicle signal heads with burlap bags or bags made of non-ripping material specifically designed for covering signal heads until signal heads are placed in operation. Do not use trash bags of any type.

When new signal heads are placed into operation, immediately bag and remove signals heads that are not to be reused.

Adjust each signal head vertically and horizontally so that light output will be of maximum

effectiveness for traffic and pedestrians. Do not tilt signal heads forward.

Reposition signal heads as required for various construction phases.

(B) Vehicle Signal Heads

Install vehicle signal heads such that the top of the signal housing located over any portion of a highway that can be used by motor vehicles is no more than 25.6 feet above the pavement.

Install vehicle signal heads such that the maximum mounting height to the top of the signal housing is as shown in Figure 1705-1 if the location is between 40 feet and 53 feet from the stop line.

Maximum Mounting Height of Signal Heads
Located Between 40 Feet and 53 Feet from Stop Line

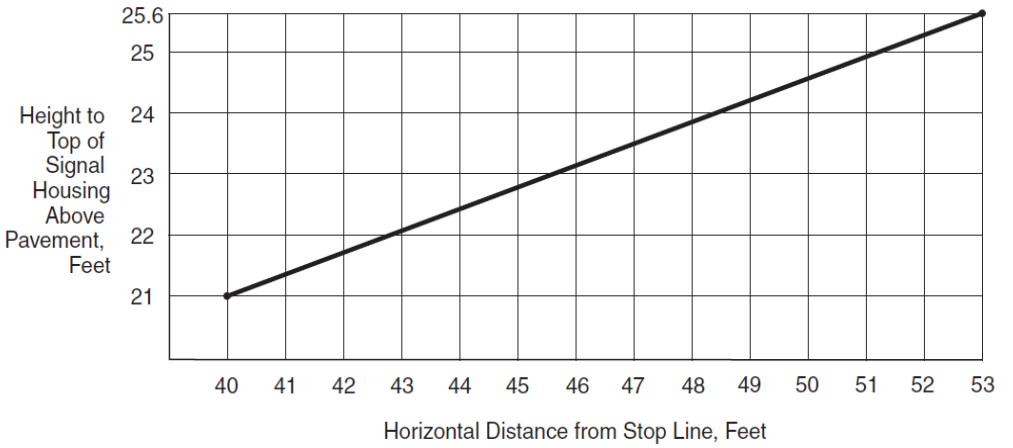


Figure 1705-1. Graph of maximum mounting height of signal heads.

Install vehicle signal heads such that the bottom of the signal housing and any related attachments to the signal head located over any portion of a highway that can be used by motor vehicles is at least 16.5 feet above the pavement directly below the signal head.

(1) Install vehicle signal heads such that the bottom of the signal housing (including brackets) of a signal head that is vertically arranged and not located over a roadway is as follows:

(a) A minimum of 8 feet and a maximum of 19 feet above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.

(b) A minimum of 8 feet and a maximum of 19 feet above the median island grade of a center median island if located on the near side of the intersection.

(2) Install vehicle signal heads such that the bottom of the signal housing (including brackets) of a signal head that is horizontally arranged and not located over a roadway is as follows:

(a) A minimum of 8 feet and a maximum of 22 feet above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.

(b) A minimum of 8 feet and a maximum of 22 feet above the median island grade of a center median island if located on the near side of the intersection.

Where vehicle signal heads are installed on messenger cable, install mounting hardware consisting of messenger cable hanger, balance adjuster, bottom cap, wire entrance fitting

bracket and insulating bushings.

Where vehicle signal heads are installed on mast arms, install mounting hardware consisting of rigid vehicle signal head mounting brackets.

Install signal cable in continuous lengths between signal controller cabinets and signal heads. Route signal cable to minimize the length of cable installed and the number of cables and conductors in each run. Pull 36 inches of additional signal cable into controller cabinets.

Wrap signal cable to messenger cable with at least 4 turns of wrapping tape spaced at intervals less than 15 inches or lash signal cable to messenger cable with one 360° spiral of lashing wire per 12 inches.

Make electrical connections inside each signal head, signal controller cabinet and termination compartment in metal poles. Do not splice cable at any other point between signal heads and controller cabinet.

Coil sufficient signal cable beside each vehicle signal head to accommodate head shifts during various construction phases. For final signal head locations, coil 36 inches on each side of signal head if signal cable comes from both directions. If signal cable terminates at the signal head, coil 36 inches of signal cable on the same side as the cable run.

(C) Pedestrian Signal Heads

Install signs with mounting hardware immediately above pedestrian pushbuttons.

Mount the pushbutton or accessible pedestrian signal (APS) at a minimum height of 3.5 feet but no higher than 4.0 feet above the adjacent pedestrian travelway.

Connect each pushbutton with a separate run of lead-in cable between the pushbutton and the termination panel in the controller cabinet. Bond pushbutton housing and all metal components to cabinet ground using lead-in cable ground.

Mount pedestrian signal heads so the bottom of the signal housing, including brackets, is not less than 7 feet or more than 10 feet above sidewalk level. Position and adjust the heads to provide maximum visibility at the beginning of the controlled crosswalk. Ensure pedestrian signal heads and vehicular signal heads mounted on the same support are physically separated from each other.

(D) Optically-Programmed Vehicle Signal Sections

Install vehicle signal heads with optically-programmed vehicle signal sections so that movement of the vehicle signals head is restricted. Tightly tether vehicle signal heads at the top and bottom when installed on messenger cable. Attach vehicle signal heads using a mounting-bracket assembly that locks the vehicle signal head into position from the back and restricts movement when installed on mast arms.

(E) Louvers

Attach the louvers to the visors using stainless steel hardware. Position the signal head to give the viewing angle as shown in the plans.

1705-4 MEASUREMENT AND PAYMENT

Vehicle Signal Head (____) and *Pedestrian Signal Head* (____) will be measured and paid as the actual number of signal heads of each type of material (aluminum or polycarbonate), size and number of sections furnished, installed and accepted.

Vehicle Signal Head with Single Optically-Programmed Sections will be measured and paid as the actual number of signal heads containing a single optically-programmed section furnished, installed and accepted.

Vehicle Signal Head with Multiple Optically-Programmed Sections will be measured and paid

as the actual number of signal heads containing multiple optically-programmed sections furnished, installed and accepted.

Louver will be measured and paid as the actual number of signal sections for which louvers have been furnished, installed and accepted.

Signal Cable will be measured and paid as actual linear feet of signal cable furnished, installed and accepted. Measurement will be point to point with no allowance for sag. Twenty-five feet will be allowed for vertical segments up or down poles.

Lead-in Cable will be measured and paid in accordance with Article 1726-4.

No measurement will be made of visors, wire entrance fittings, interconnecting brackets, mounting assemblies, pedestrian pushbuttons, pedestrian signal signs and signal head shifts as these are incidental to furnishing and installing signal heads. No measurement will be made for drip loops, coiled sections or lashing wire as these are incidental to furnishing and installing signal cable.

Payment will be made under:

Pay Item	Pay Unit
Vehicle Signal Head (____)	Each
Pedestrian Signal Head (____)	Each
Vehicle Signal Head With Single Optically-Programmed Sections	Each
Vehicle Signal Head With Multiple Optically-Programmed Sections	Each
Louver	Each
Signal Cable	Linear Foot

SECTION 1706
BACKPLATES

1706-1 DESCRIPTION

Furnish and install backplates for vehicle signal heads with all necessary hardware.

1706-2 MATERIAL

Refer to Division 10.

Item	Section
Backplates	1098-3

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1706-3 CONSTRUCTION METHODS

Install backplates for vehicle signal heads so as not to interfere with the function of all door hinges, signal section latches and mounting hardware. Do not bend or deform backplates during installation. Gooseneck fittings may be installed in reverse to accommodate backplates. Use stainless steel fasteners for attaching backplates to signal sections. Slot or tether backplates as required by the Engineer.

1706-4 MEASUREMENT AND PAYMENT

Backplates will be measured and paid in units of each, furnished, installed and accepted. No measurement will be made for different sizes, type or reflective taping of backplates.

Payment will be made under:

Pay Item	Pay Unit
Backplate	Each

SECTION 1710
MESSENGER CABLE

1710-1 DESCRIPTION

Furnish and install messenger cable (spanwire) with cable clamps, strandvise, machine bolts, eye bolts, 3-bolt clamps, eye nuts, split-bolt connectors and all necessary hardware.

1710-2 MATERIAL

Refer to Division 10.

Item	Section
Grounding Electrodes	1091-6
Messenger Cable	1098-4
Pole Line Hardware	1098-7
Wire	1091-2

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website..

1710-3 CONSTRUCTION METHODS

Install guy assemblies before installing messenger cable.

Use 3/8 inch messenger cable for spans supporting vehicle signal heads and/or signs.

Use 1/4 inch messenger cable for spans supporting only cables unless otherwise specified.

For messenger cable crossing over railroad tracks, provide a minimum of 27 feet of vertical clearance, unless otherwise specified.

For permanent installations, install messenger cable in continuous lengths with no splices except where an insulator is required. With prior approval, existing messenger for temporary installations may be extended instead of installing new messenger cable.

Tension messenger cable to eliminate appreciable sag and to match sag of surrounding utilities. Otherwise, allow 3% to 4% sag of the span length between poles.

For mid-run spans using wood poles, attach messenger cable to the pole with a 3-bolt cable clamp with J-hook consisting of 5/8 inch diameter machine bolts, J-hooks, washers and square nuts to attach messenger cable to wood poles. Provide machine bolts that are 3 inches longer than the pole diameter. For mid-run spans using metal or other Department-approved poles, attach messenger cable to the pole with a 3-bolt clamp with J-hook secured to the metal pole via a pole band clamp. Refer to *Metal Pole Standard Drawing* Sheets in effect on the date of advertisement.

When terminating spans at wood poles, connect messenger cable to a deadend strandvise attached to the pole via a 5/8 inch diameter shoulder eye bolt or 5/8 inch diameter shoulder angle bolt with 5/8 inch eye nut as shown in *Roadway Standard Drawings*. When terminating spans at metal or other Department-approved poles, connect messenger cable to a deadend strandvise attached to the pole via a pole attachment clamp. Refer to *Metal Pole Standard Drawing* Sheets as shown in the previous paragraph. Do not install more than one messenger cable and strandvise assembly to a single metal or other Department-approved pole attachment clamp. During installation, ensure that messenger cable is centered and directly aligned at the pole clamp's attachment point such that the cable does not exert forces on the sides of the clamp's attachment point.

Maintain electrical continuity at all splices.

(A) Messenger Cable for Signal Heads or Lead-In Cable

For messenger cable attached to joint use poles, install a new grounding system that complies with Article 1720-3 for bonding messenger cable. If a pole ground exists on the

joint use pole, bond new pole grounding system to existing pole ground using #6 AWG minimum solid bare copper grounding wire terminated with split bolt connectors or parallel groove clamp at each end. If existing poles do not have a grounding system, install new grounding system that complies with Article 1720-3.

(B) Messenger Cable for Communications Cable

For messenger cable attached to joint use poles, bond messenger cable to existing pole ground at each end and at 1,300-foot intervals. Install bond using #6 AWG minimum solid bare copper grounding wire terminated with split bolt connectors or parallel groove clamp at each end. If existing poles do not have a grounding system, install new grounding system that complies with Article 1720-3.

(C) Messenger Cable for Multiple Cables

On multiple messenger cable arrangements, connect all messenger cable ends with #6 AWG minimum solid bare copper wire and bond with split bolt connectors or parallel groove clamp and terminate to pole ground.

1710-4 MEASUREMENT AND PAYMENT

Messenger Cable (____) will be measured and paid as actual horizontal linear feet of messenger cable furnished, installed and accepted. Measurement will be point to point with no allowance for sag.

No measurement will be made of cable clamps, strandvise, machine bolts, eye bolts, 3-bolt assemblies, eye nuts, split bolt connectors and pole grounding systems as these will be incidental to furnishing and installing messenger cable.

Payment will be made under:

Pay Item	Pay Unit
Messenger Cable (____)	Linear Foot

SECTION 1715
UNDERGROUND CABLE INSTALLATION

1715-1 DESCRIPTION

Furnish and install temporary lead-in cable or conduit for underground cable installation with tracer wire, miscellaneous fittings, all necessary hardware, marker tape, backfill, graded stone, paving materials and seeding and mulching.

1715-2 MATERIAL

Refer to Divisions 5 and 10.

Item	Section
Conduit	1091-3
Conduit Plugs, Pull Line and Tracer Wire	1091-3(G)
Duct and Conduit Sealer	1091-4
Backfill	1018-2
Graded Stone	545-2 and 545-3

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1715-3 CONSTRUCTION METHODS

(A) General

Ensure conduit is free of moisture and debris before pulling cables.

Following installation of conduit where cable is not immediately installed or conduit is for

future use (spare), seal the ends of the conduit with a conduit plug. Secure a pull line to the conduit plug in such a manner that it will not interfere with installation of the conduit plug and provides a watertight seal.

Extend ends of conduit 2 inches to 4 inches above concrete surfaces and 4 inches above crushed stone bases. For metallic conduit, install metallic bushings and bond conduits.

(1) Conduit

(a) Conduit Entering Junction Boxes

Terminate conduits installed for communications cables (fiber-optic, ethernet and coaxial) in oversized junction boxes. Do not install other conduits in the oversized junction box unless otherwise specified.

Terminate conduits installed for signal wiring, including lead-in cable, in standard size junction boxes unless otherwise specified.

For all conduits entering junction boxes, seal spare conduits with approved conduit plugs. Seal conduits containing fiber-optic communications cable, signal cable and lead-in cable with duct and conduit sealer.

(b) Conduit Entering Cabinet Foundations

For all conduits entering the cabinet through the cabinet foundation, seal spare conduits with approved conduit plugs. Seal conduits containing fiber-optic communications cable, signal cable and lead-in cable with duct and conduit sealer.

(2) Tracer Wire

Install tracer wire in all conduits containing fiber-optic cable. Pull tracer wire simultaneously in a continuous length with the fiber-optic cable. Where multiple pulls of fiber-optic cable are required and conduit is placed in the same trench, only one tracer wire is required. Where multiple pulls of fiber-optic cable are required and conduits may separate into individual trenches, install a tracer wire in each conduit run. Provide waterproof butt splices where tracer wire is spliced. Splicing will be allowed only in cabinets and junction boxes. Label all tracer wires entering the equipment cabinet.

(3) Plan of Record Drawings

Upon completion of the conduit system for communications, furnish the Engineer with a plan of record drawing detailing the locations of the conduit system.

(B) Trenching

In certain cases, the Contractor may use an alternate material and method of installation between trenching and plowing based on existing field conduits and preferences. Obtain approval from the Engineer before proceeding.

(1) General

Install PVC, HDPE or rigid metallic conduit for all underground runs. Install rigid metallic conduit for all underground runs located inside railroad right-of-way. Clean existing underground conduit to be incorporated into a new system. Bond all metallic conduit.

If more than one conduit is required between the same points, install conduit in one common trench. Install non-detectable marker tape.

Install longitudinal runs of conduit a minimum of one foot from back of curb or 6 feet from edge of pavement in the absence of curb. If ditches are present, install conduit a minimum of 4 feet from the bottom of the ditch line.

Maintain a minimum trench depth of 30 inches (or 12 inches in areas blocked by rock or impenetrable obstructions) below finished grade or 6 inches below roadway subbase, whichever is deeper. Upon completion, restore surface to like-original condition within 7 calendar days of occurrence of damage. Remove all rock and debris from backfill material. Remove excess material from site and compact area according to Article 300-7. Backfill with excavated material and compact to 95% of original density.

Backfill trench at locations along the trench path where non-movable objects, such as rocks and boulders, cannot be avoided. The purpose of the backfill is to provide a gradual change in elevation of the trench, so that excessive bending and stress will not be transferred to conduits once underground conduit system is installed.

After installation of conduits and upon completion of tamping and backfilling, perform a mandrel test on each conduit to ensure no conduit has been damaged. Furnish a non-metallic mandrel having a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred, replace the entire length of conduit. Ensure pull line is re-installed.

(2) Unpaved Trenching

Install conduit in all unpaved areas for all cable including permanent traffic signal installations.

As shown in plans or as directed by the Engineer, direct bury lead-in cable for temporary traffic signal installations.

Rake smooth the top 1 1/2 inches and seed with same type of grass as surrounding area. Finish unpaved areas flush with surrounding natural ground.

(3) Paved Trenching

On concrete surfaces, replace the entire joint of concrete unless otherwise specified. On all other surfaces, neatly cut and replace the width of trench with like material.

Finish paved areas with materials matching damaged areas. For conduit installed under roadways, cut neatly and replace the width of paved area damaged by trenching. For conduit installed under sidewalks and walkways, remove entire section of slab from joint to joint and replace. Place graded stone material to temporarily maintain traffic where repairs cannot be performed immediately. Comply with Article 545-4.

(C) Plowing (HDPE Conduit Only)

Direct plow HDPE ducts simultaneously using chute plow method. Direct plow ducts at a minimum depth so the top of the highest duct is 30 inches deep unless otherwise approved by the Engineer.

Provide sufficient personnel to feed chute, operate prime mover and equipment carrying reels (if separate equipment is used), observe chute feeding, observe plowing and observe reel payout. Use chute with adequate dimensions to allow for passage of duct without damage. During plow operation, continuously check chute opening and path to be sure there are no obstructions and monitor payout reels to be sure reels are turning at a steady rate.

With prior approval, install a junction box at locations where splicing or coupling of the underground polyethylene conduits is necessary. Otherwise, splicing or joining of underground polyethylene conduit is prohibited.

(D) Directional Drilling

(1) Pre-Approvals and Minimum Depth Requirements

Obtain approval before beginning drilling operations.

At all points where HDPE conduit will traverse under roadways, driveways, sidewalks or Controlled Access Areas including entrance/exit ramps, maintain a minimum depth of 4 feet or 8 times the back reamer's diameter, whichever is deeper. For an installation that runs parallel to a controlled access area or entrance/exit ramps maintain a minimum depth of 30 inches below finished grade. Maintain a minimum clearance of 30 inches below finished grade when crossing ditch lines. For the following structures, the minimum clearance requirements are shown in Table 1715-1.

TABLE 1715-1
MINIMUM CLEARANCE REQUIREMENTS FOR STRUCTURES

Man-made Structure	Minimum Clearance Requirement
Bridge Foundation	5 ft horizontal and 4 ft vertical (clearances greater than minimum horizontal should continue to use the 4V:5H ratio, i.e., 10 ft horizontal should be no deeper than 8 ft)
Drainage Pipes 48" or Less	1 ft above or 2 ft below [while maintaining a minimum depth of 30" below grade]
Drainage Pipes Greater than 48"	1 ft above or 4 ft below [while maintaining a minimum depth of 30" below grade]
Box Culverts	1 ft above or 4 ft below [while maintaining a minimum depth of 30" below grade]
Slope Protection	2 ft below
Slope Protection Foundation Footing	5 ft below

Guarantee the drill rig operator and digital walkover locating system operator are factory-trained to operate the make and model of equipment provided and have at least one year experience operating the make and model of drill rig. Submit documentation of the operators' training and experience for review at least 2 weeks before start of directional drilling operations to the Engineer.

Provide a means of collecting and containing drilling fluid/slurry that returns to the surface such as a slurry pit. Provide measures to prevent drilling fluids from entering drainage ditches and storm sewer systems. Prevent drilling fluid/slurry from accumulating on or flowing onto pedestrian walkways, driveways and streets. Immediately remove all drilling fluids/slurry that are accidentally spilled.

(2) Directional Drill Operations

Provide grounding for the drill rig in accordance with the manufacturer's recommendations.

Place excavated material near the top of the working pit and dispose of properly. Backfill pits and trenches to facilitate drilling operations immediately after drilling is completed.

Use drill head suitable for type of material being drilled and sized no more than 2 inches larger than the outer diameter of the conduit. Direct drill to obtain proper depth and desired destination. Pressure grout with an approved bentonite/polymer slurry mixture to fill all voids. Do not jet alone or wet bore with water.

During drilling operation, locate drill head every 10 feet along drill path and before traversing underground utilities or structures. Use digital walkover locating system to track drill head during directional drilling operation. Ensure locating system is capable of determining pitch, roll, heading, depth and horizontal position of the drill head at any point.

Once drill head has reached final location, remove head and install back reamer of appropriate size (no more than 2 inches larger than outer diameter of conduits) to simultaneously facilitate back reaming of drill hole and installation of conduit. Back reamer is sized larger than actual conduits to ensure conduits are not adversely subjected to deviations caused by the original drill operation and are as straight as practical in their final position.

The intent of these *Standard Specifications* is to limit the diameter of the actual drill shaft/hole so that it is no more than 2 inches larger than the conduit outer diameter. The 2 inches larger diameter may be accomplished during the original bore or during the back reaming/conduit installation process.

Once installation of conduit has started, continue installation without interruption so as to prevent conduit from becoming firmly set. Apply bentonite/polymer slurry mixture during conduit installation.

Upon completion of conduit installation, perform a mandrel test on conduit system to ensure conduit has not been damaged. Furnish non-metallic mandrel with a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred, replace the entire length of conduit and ensure that pull line is re-installed.

(3) Drilling Fluids

Use lubrication for subsequent removal of material and immediate installation of the conduit. The use of water and other fluids in connection with directional drilling operations will be permitted only to the extent necessary to lubricate cuttings. Do not jet alone or wet bore with water. Use drilling fluid/slurry consisting of at least 10% high-grade bentonite/polymer slurry to consolidate excavated material and seal drill hole walls.

Transport waste drilling fluid/slurry from site and dispose of in a method that complies with Federal, State and local laws and regulations.

(4) Conduit Splicing

With prior approval, install a junction box at locations where splicing or coupling of conduit is necessary. Otherwise, splicing or joining of HDPE conduit is prohibited.

(E) Bore and Jack

For bore and jack areas, comply with Article 1550-4 except as follows:

For bore and jack areas, install metallic conduit at a minimum depth of 30 inches below finished grade or 6 inches below roadway subbase, whichever is greater. Provide a 3 feet clearance to conduit from back of curb or from edge of pavement. Terminate ends of conduit into junction boxes.

Comply with the *NCDOT Utilities Accommodations Manual* in effect on the date of advertisement.

1715-4 MEASUREMENT AND PAYMENT

Tracer Wire will be measured along the horizontal linear feet of tracer wire furnished, installed and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be made in linear feet. No payment will be made for excess tracer wire in junction boxes and/or cabinets.

Unpaved Trenching (qty)(size) & (qty)(size) will be measured horizontal linear feet of trenching for underground conduit installation of each type furnished, installed and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet.

Unpaved Trenching for Temporary Lead-in will be measured in horizontal linear feet of trenching for placement of temporary lead-in cable installed and accepted. Measurement will be along the approximate centerline of the trench. Payment will be in linear feet.

Paved Trenching (qty)(size) & (qty)(size) will be measured horizontal linear feet of trenching for underground conduit installation of each type furnished, installed and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet.

Plowing (qty)(size) & (qty)(size) will be measured horizontal linear feet of plowing for underground conduit installation furnished, installed and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet.

Directional Drill (qty)(size) & (qty)(size) will be measured horizontal linear feet of directional drill for underground conduit installation furnished, installed and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet.

Bore and Jack (qty)(size) & (qty)(size) will be measured in horizontal linear feet of bore and jack for underground conduit installation furnished, installed and accepted. Measurement will be along the approximate centerline of the bore from junction box to junction box. Payment will be in linear feet.

No measurement will be made of vertical segments, non-metallic conduit, metallic conduit, conduit sealing material, backfill, graded stone, paving materials, miscellaneous fittings, non-detectable marker tape, pull lines and seeding and mulching as these will be incidental to conduit installation.

Conduit will be paid per linear foot based on quantity and size of conduits. An example is an installation of a single 1.25 inch HDPE conduit would be paid as:

Directional Drill (1)(1.25") Linear Foot

Payment will be made under:

Pay Item	Pay Unit
Tracer Wire	Linear Foot
Unpaved Trenching (qty)(size) & (qty)(size)	Linear Foot
Unpaved Trenching for Temporary Lead-in	Linear Foot
Paved Trenching (qty)(size) & (qty)(size)	Linear Foot
Plowing (qty)(size) & (qty)(size)	Linear Foot
Directional Drill (qty)(size) & (qty)(size)	Linear Foot
Bore and Jack (qty)(size) & (qty)(size)	Linear Foot

SECTION 1716
JUNCTION BOXES

1716-1 DESCRIPTION

Furnish and install junction boxes (pull boxes) with covers, graded stone, grounding systems and all necessary hardware.

1716-2 MATERIAL

Refer to Division 10.

Item	Section
Junction Boxes	1098-6
#57 or #67 Washed Stone	1005

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1716-3 CONSTRUCTION METHODS

Install standard size junction boxes as shown in the plans and where underground splicing of electrical cables is necessary. Install standard size junction boxes within 3 feet of pole or pole foundation where transitioning from below ground to a riser assembly. Install standard size junction boxes within 5 feet of each end of each lateral run of conduit for electrical cables. When lateral runs for electrical cables are greater than 150 feet, install additional junction boxes to ensure distances between junction boxes does not exceed 150 feet.

Install oversized junction boxes for fiber-optic cables at locations shown in the plans.

Install all junction boxes a minimum of 4 feet from the centerline of any ditch.

Provide real world coordinates for all junction boxes and equipment cabinets installed or used under this project. Provide the coordinates in feet units using the North Carolina State Plane coordinate system (1983 North American Datum also known as NAD '83). Furnish coordinates that do not deviate more than 1.7 feet in the horizontal plane and 3.3 feet in the vertical plane. Global positioning system (GPS) equipment able to obtain the coordinate data within these tolerances may be used. Submit cut sheets on the GPS unit proposed to collect the data for approval by the Engineer.

Provide both a digital copy and hard copy of all information regarding the location (including, but not limited to, manufacturer, model number, and NCDOT inventory number) in the spreadsheet shown by example in Figure 1716-1. Place the hard copy in the signal cabinet and submit the digital copy to the Engineer.

Figure 1716-1. Spreadsheet. Submit coordinate information in a spreadsheet using the template below and in accordance with this article.

NCDOT Inv #	Name	Location	Latitude	Longitude	Manufacturer	Model #
05-0134	Equipment Cabinet	US 70 at Raynor Rd./ Auburn-Knightdale	35.6873	-78.5500	McCain	Type-332
05-0134	Junction Box # 1 (Phase 2 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	35.6879	-78.5516	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 2 (Phase 2 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	35.6876	-78.5506	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 3 (Near Cabinet)	US 70 at Raynor Rd./ Auburn-Knightdale	35.6873	-78.5501	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 4 (Phase 6 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	35.6873	-78.5486	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 5 (Phase 6 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	35.6876	-78.5493	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 6 (Phase 4 Side)	US 70 at Raynor Rd./ Auburn-Knightdale	35.6879	-78.5503	Quazite	PG1118BA12(Box) PG118HA00(Cover)

1716-4 MEASUREMENT AND PAYMENT

Junction Box (____) will be measured and paid in actual number of junction boxes of each size and type furnished, installed and accepted.

No measurement will be made of covers, washed stone and grounding systems as these will be incidental to furnishing and installing junction boxes.

Payment will be made under:

Pay Item	Pay Unit
Junction Box (____)	Each

SECTION 1720
WOOD POLES

1720-1 DESCRIPTION

Furnish and install poles, grounding systems and all necessary hardware.

1720-2 MATERIAL

Refer to Division 10.

Item	Section
Grounding Electrodes	1091-6
Inspection Requirements	1082
Wire	1091-2
Wood Poles	1082

Furnish material, equipment and hardware under this section that is pre-approved on the *ITS and Signals QPL* available on the Department's website.

1720-3 CONSTRUCTION METHODS

Mark final pole locations and receive approval before installing poles. Unless otherwise specified, locate poles a minimum of 6 feet behind face of curb or 10 feet from edge of travelway. Ensure poles are of sufficient length to maintain the minimum required clearances above the roadway, obstructions and affected railroad tracks.

Drill or auger a hole for placement of pole and to allow for compacting. Set pole at manufacturer's recommended depth, but at a minimum depth of 5 feet. Ensure the pole is within 2 degrees of vertical when fully loaded.

Backfill hole with pole installed and tamp backfill in 6 inch lifts with a mechanical tamp until compacted density is at least 95% of original density.

On new Department-owned poles, install a grounding system consisting of #6 AWG solid bare copper wire that is connected with an irreversible ground connector to a single ground rod installed at base of pole or to the electrical service grounding electrode system located within 10 feet of the pole. Install ground wire so as to minimize damage from vandalism and environmental exposures. Install ground wire up pole to a point adjacent to the uppermost span. Use hot-dipped galvanized wire staples to secure ground wire to pole.

1720-4 MEASUREMENT AND PAYMENT

Wood Pole will be measured and paid as the actual number of wood poles furnished, installed and accepted.

No measurement will be made for installing grounding systems as these will be incidental to furnishing and installing wood poles.

Payment will be made under:

Pay Item	Pay Unit
Wood Pole	Each

SECTION 1721
GUY ASSEMBLIES

1721-1 DESCRIPTION

Furnish and install guy assemblies with all necessary hardware.

1721-2 MATERIAL

Refer to Division 10.

Item	Section
Guy Assemblies	1098-8
Pole Line Hardware	1098-7

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1721-3 CONSTRUCTION METHODS

(A) Guy Assemblies for Signal Heads or Lead-in Cable

Install guy assemblies with guy cable, guy guards, anchors, 3-bolt clamps and associated fittings. Use 2-bolt attachment method where there is adequate room on the pole to comply with the NESC. Attach guy assembly and guy cable to 2 separate bolts with one bolt for span and one bolt for guy cable.

Where adequate spacing is not available and a violation of the NESC would occur with the 2-bolt attachment method, use approved one-bolt attachment method for attaching messenger cable and guy assembly.

Bond guy assembly to new pole grounding system as described in Article 1720-3.

Do not attach to existing guy assemblies unless specifically approved by owner.

(B) Guy Assemblies for Communications Cable

When installing messenger cable for supporting only communications cable, use approved one-bolt attachment method for attaching messenger cable and guy assembly.

Bond guy assembly to existing pole ground using parallel groove clamp or equivalent. If existing poles do not have a grounding system, install new grounding system for bonding guy assembly that complies with Article 1720-3.

Do not attach to existing guy assemblies unless specifically approved by owner.

1721-4 MEASUREMENT AND PAYMENT

Guy Assembly will be measured and paid as the actual number of guy assemblies furnished, installed and accepted.

No measurement will be made of guy cable, guy guards, anchors, clamps, grounding systems or fittings as these will be incidental to furnishing and installing guy assemblies.

Payment will be made under:

Pay Item	Pay Unit
Guy Assembly	Each

SECTION 1722
RISER ASSEMBLIES

1722-1 DESCRIPTION

Furnish and install riser assemblies with clamp-on, aluminum weatherheads or heat shrink tubing, galvanized pole attachment fittings and all necessary hardware.

1722-2 MATERIAL

Refer to Division 10.

Item	Section
Grounding Electrodes	1091-6
Pole Line Hardware	1098-7
Rigid Metallic Conduit	1091-3
Riser Sealing Devices	1098-5
Wire	1091-2

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1722-3 CONSTRUCTION METHODS

Install risers with required weatherheads or heat shrink tubing on poles using pole attachment fittings. Maintain a 10 inch minimum and 18 inch maximum offset from signal messenger to the top of riser for all risers. On utility-owned poles, maintain a 40 inch offset from electrical utility's power conductors to top of riser and riser attachment fittings.

Use approved heat shrink tubing retrofit kits when installing new fiber-optic or coaxial cable into exiting risers that contain existing fiber-optic or coaxial cables.

Install heat shrink tubing retrofit kits in existing risers as specified.

Use separate 1/2 inch riser with weatherhead for pedestrian pushbutton.

Use separate riser (1 inch minimum) with weatherhead for electrical service.

Use separate 2 inch riser with weatherhead for signal cables (bundled). Use separate 2 inch riser with weatherhead for lead-in cable. Install condulet on all risers for lead-in cable.

Install condulets on risers for lead-in cable, railroad preempt interconnection cables and signal pedestals.

Use separate 2 inch riser with heat shrink tubing for fiber-optic communications cables. Install risers with heat shrink tubing so that cable can be installed without violating its minimum bending radius. Install cable so it does not share a riser with any other cable.

Use separate 2 inch riser with weatherhead for coaxial cables for spread spectrum radio antennae.

Install heat shrink tubing in accordance with manufacturer's recommendations. Provide tubing a minimum of 5 inches in length with a minimum of 2.5 inches extended over cables and 2.5 inches extended over risers after heat has been applied. Use nylon filler rods with UV protection or equivalent and sealing spacer clips to separate cables where multiple cables enter a riser. Ensure sealing spacer clips have a heat activated sealing compound with the sealing compound fully encapsulating the space between cables. Ensure heat shrink tubing provides a watertight fit around individual cables and outer walls of risers. Do not use cut sections of cable or any other devices instead of filler rods. Use aluminum tape around cables to prevent damage from sealing chemicals. Use a heat source that will provide even heat distribution around tubing. Ensure no damage occurs to any cables.

Bond new risers, a minimum of 10 feet above grade, to the pole ground using a #6 AWG minimum solid bare copper wire and an approved pipe clamp, a split bolt connector or parallel groove clamp. On pole mounted cabinets where the riser are connected to the cabinet, bond risers in the cabinet using ground bushings with a #6 AWG minimum solid bare copper wire to the cabinet ground bus.

If a pole ground exists on the joint use pole, bond new riser to existing pole ground using #6 AWG minimum solid bare copper wire terminated with split bolt connectors or parallel groove clamp.

If existing poles do not have a grounding system, install new grounding system that complies with Article 1720-3 for bonding messenger cable.

Transition from rigid galvanized steel risers to underground PVC conduits using an approved rigid galvanized steel sweeping elbow with PVC female adaptor.

1722-4 MEASUREMENT AND PAYMENT

__" *Riser with* ____ will be measured and paid as the actual number of risers of each type and size furnished, installed and accepted. No measurement will be made of weatherheads, heat shrink tubing or pole attachment fittings as these will be incidental to furnishing and installing risers.

Heat Shrink Tubing Retrofit Kit will be measured and paid as the actual number of heat shrink tubing retrofit kits furnished, installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
__" Riser with ____	Each
Heat Shrink Tubing Retrofit Kit	Each

SECTION 1725
INDUCTIVE DETECTION LOOPS

1725-1 DESCRIPTION

Furnish and install inductive detection loops with loop slot sealant, loop wire, conduit with fittings and all necessary hardware.

1725-2 MATERIAL

Refer to Division 10.

Item	Section
Inductive Detection Loops	1098-9

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

Provide the Engineer a Type 3 material certification and SDS for the sealant in accordance with Article 106-3.

1725-3 CONSTRUCTION METHODS

All work performed in this section shall be done in the presence of the Engineer.

Notify Engineer one week before installing inductive detection loops.

Coordinate sawcutting and loop placement with pavement markings. For new construction or for resurfacing, install inductive detection loops before placing final layer of surface course. On unmarked pavement, pre-mark locations of stop lines and lane lines before locating inductive detection loops.

Before sawcutting, pre-mark inductive detection loop locations and receive approval. Sawcut pavement at approved pre-marked locations. Do not allow vehicles to travel over unsealed loop slots.

Install conduit with bushings from edge of pavement to junction box. Ensure conduit maintains a minimum 30 inches of cover from the edge of pavement structure to the junction box. Do not sawcut through curb.

Remove all loose material and wash saw slots with a high-pressure method using an air and water mixture. Dry saw slots with compressed air. Clear saw slots of jagged edges and

protrusions. Seat loop conductor at bottom of saw slot without damaging loop wire.

Before sealing loop conductors, test that impedance from the loop wire to ground is at least 100 megaohms. For each location with inductive loops, submit a completed *Inductive Detection Loop & Grounding Test Results form* and place copy in controller cabinet. Ensure all loops are included on form. The form is located on the Department's website.

Embed loop conductors in saw slot with loop sealant. Seal saw slot and dispose of excess sealant in an environmentally safe manner.

Between where loop conductor pairs leave saw cut in pavement and junction boxes, twist loop conductor pairs a minimum of 5 turns per foot. Permanently label each twisted pair in the junction box with nylon cable tie using indelible ink. Indicate loop number and loop polarity on the tie.

1725-4 MEASUREMENT AND PAYMENT

Inductive Loop Sawcut will be measured and paid as the actual linear feet of inductive loop sawcut furnished, installed and accepted.

No measurement will be made of trenching between edge of pavement and junction box, loop slot sealant, loop wire, conduit and conduit fittings as these will be incidental to furnishing and installing inductive detection loops.

Payment will be made under:

Pay Item	Pay Unit
Inductive Loop Sawcut	Linear Foot

SECTION 1726
LEAD-IN CABLE

1726-1 DESCRIPTION

Furnish and install lead-in cable with all necessary hardware to be used in conjunction with, but not limited to, inductive detection loops, pedestrian pushbutton assemblies, APS assemblies or railroad circuitry.

1726-2 MATERIAL

Refer to Division 10.

Item	Section
Lashing Wire and Hardware	1098-7
Lead-In Cable	1098-10
Wrapping Tape	1098-7

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1726-3 CONSTRUCTION METHODS

For underground runs, install lead-in cable in 2 inch non-metallic conduit. For aerial installation, wrap lead-in cable to messenger cable with at least 4 turns of wrapping tape spaced at intervals less than 15 inches or lash lead-in cable to messenger cable with one 360° spiral of lashing wire per 12 inches.

Where railroad preemption is required, install lead in cable from signal controller cabinet to railroad company furnished and installed lockable junction box.

Splicing of lead-in cable will be allowed only for runs in excess of 750 feet. Splice lead-in cable in junction boxes or condulets on poles.

Test each complete loop system from the controller cabinet by using a megger to verify that

impedance from the loop system to the ground is at least 50 megaohms. After successful completion of megger test, test loop system resistance using an electronic ohmmeter to verify loop system resistance is less than 0.00885 ohms per foot.

1726-4 MEASUREMENT AND PAYMENT

Lead-in Cable (____) will be measured and paid as the actual linear feet of lead-in cable furnished, installed and accepted. Measurement will be made by calculating the difference in length markings located on outer jacket from start of run to end of run for each run. Terminate all cables before determining length of cable run.

If markings are not visible, measurement will be point to point with no allowance for sag. Twenty-five feet will be allowed for vertical segments up or down poles.

Payment will be made under:

Pay Item	Pay Unit
Lead-in Cable (____)	Linear Foot

SECTION 1730
FIBER-OPTIC CABLE

1730-1 DESCRIPTION

Furnish and install single mode fiber-optic (SMFO) communications cable and drop cable assemblies, fiber-optic cable storage racks (snow shoes), communications cable identification markers, lashing wire and all necessary hardware.

1730-2 MATERIAL

Refer to Division 10.

Item	Section
Cable Identification Markers	1098-11(C)
Fiber-Optic Cable	1098-11
Lashing Wire and Hardware	1098-7
Storage Racks	1098-11(D)

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1730-3 CONSTRUCTION METHODS

(A) General

Prior to installation provide cable manufacturer's attenuation and Optical Time Domain Reflectometer (OTDR) testing data for each reel of cable upon request by the Engineer.

Install SMFO communications cable, snow shoes, communications cable identification markers, lashing wire and all necessary hardware.

Comply with manufacturer's recommendations. Install communications cable on signal poles, utility poles, messenger cable and in conduits as required to bring the fiber-optic cable into and, if necessary, out of each splice enclosure.

Take all precautions necessary to ensure cable is not damaged during storage, handling and installation. Do not violate minimum bending radius of 20 times the radius of cable diameter or manufacturer's recommendation, whichever is greater. Do not step on cable nor run over cable with vehicles or equipment. Do not pull cable over or around obstructions or along the ground.

Determine lengths of cable necessary to reach from termination-point to termination-point. Install cable in continuous lengths between approved splicing facilities. Additionally, provide a sufficient amount of slack cable to allow for an additional 20 feet of cable to be

present after removal of outer sheath for termination. Measure slack cable by extending cable straight out of cabinet door.

Keep cable ends sealed at all times during installation to effectively prevent the ingress of moisture. Use approved heat shrink cable end cap. Do not use tape to seal cable ends.

Before installing cable, provide 1 electronic copy of cable manufacturer's recommended and maximum pulling tension. Do not exceed manufacturer's recommended pulling tension. Use pulling grips containing a rotating swivel. Coil cable in a figure-8 configuration whenever cable is unreeled for subsequent pulling.

Install fiber-optic cable in separate 2 inch risers with heat shrink tubing or conduits. Do not share risers or conduits containing fiber-optic cable with other type cable.

(B) Aerial Installation

Double lash fiber-optic cable to messenger cable with one 360° spiral per foot.

Use pole attachment hardware and roller guides with safety clips to install aerial run cable.

Maintain tension during the pulling process for aerial run cable by using an approved mechanical clutch (dynamometer) device. Do not allow cable to contact the ground or other obstructions between poles during installation. Do not use a motorized vehicle to generate cable pulling forces.

Use a cable suspension clamp when attaching cable tangent to a pole. Select and place cable blocks and corner blocks so as not to exceed the cable's minimum bending radius. Do not pull cable across J-hooks.

Store 100 feet of each fiber-optic cable on all cable runs that are continuous without splices as shown on the plans. Obtain approval for spare cable storage locations. Store spare fiber-optic cable on fiber-optic cable storage racks (snow shoes). Locate spare cable storage in the middle of spans between termination points. Do not store spare fiber-optic cable over the roadway or driveways.

Install one communications cable identification marker within 36 inches of pole attachment points and at locations where more than one cable originates or terminates.

(C) Underground Installation

Install fiber-optic cable underground in conduit using cable pulling lubricants recommended by the fiber-optic cable manufacturer.

Obtain approval of cable pulling lubricant and method of pulling before installing underground fiber-optic cable.

Use a dynamometer (clutch device) so as not to exceed maximum allowable pulling tension if cable is pulled by mechanical means. Do not use a motorized vehicle to generate cable pulling forces.

Keep tension on cable reel and pulling line at start of each pull. Do not release tension if pulling operation is halted. Restart pulling operation by gradually increasing tension until cable is in motion.

For pulling cable through manholes, junction boxes and vaults, feed cable by manually rotating the reel. Do not pull cable through intermediate junction boxes, handholes or openings in conduit unless otherwise approved by the Engineer.

Install communications cable identification markers on each communications cable entering a junction box.

(D) Installation of Drop Cable Assembly

Determine length of drop cable needed, including slack, to reach from termination point to

termination point.

At aerial splice enclosures, store 100 feet of slack cable on cable storage racks. At below ground splice enclosures, coil 100 feet of slack cable in manhole or junction box where enclosure is located.

At equipment cabinet end of drop cable assembly, terminate all fibers with approved connectors to the connector panel. Label all connectors, pigtails and the connector panel. At the aerial splice enclosure location, cap off all unused fibers and label to correspond with the connector panel.

1730-4 MEASUREMENT AND PAYMENT

Communications Cable (____*-Fiber*) will be measured and paid as the actual linear feet of fiber-optic cable of each fiber count furnished, installed and accepted. Measurement will be made by calculating the difference in length markings located on outer jacket from start of run to end of run for each run. Terminate all fibers before determining length of cable run.

Drop Cable will be measured and paid as linear feet of fiber-optic drop cable furnished, installed and accepted. Measurement will be made by calculating the difference in length markings located on outer jacket from start of run to end of run for each run. Terminate all fibers before determining length of cable run.

No measurement will be made for terminating, splicing and testing fiber-optic cable, communications cable identification markers, fiber-optic cable storage racks or lashing wire and all necessary hardware as these will be incidental to the installation of fiber-optic cable.

Payment will be made under:

Pay Item	Pay Unit
Communications Cable (____-Fiber)	Linear Foot
Drop Cable	Linear Foot

SECTION 1731
FIBER-OPTIC SPLICE CENTERS

1731-1 DESCRIPTION

Furnish and install fiber-optic interconnect centers, fiber-optic splice enclosures and all necessary hardware.

Modify existing fiber-optic interconnect centers and/or splice enclosures as shown in the plans. Refer to manufacturer's recommendations for opening, modifying and re-sealing the existing fiber-optic interconnect center and/or fiber-optic splice enclosures.

1731-2 MATERIALS

Refer to Division 10.

Item	Section
Fiber-Optic Splice Centers	1098-12

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1731-3 CONSTRUCTION METHODS

(A) General

Include on the cover of each splice tray in a legible format the following information:

(1) Splice location reference number or identification information (i.e. 06-1011 tray 1 of 3, 06-1011 tray 2 of 3, etc.)

(2) Date the splice was made

(3) Company name of individual performing the splicing

(4) Name of individual performing the splicing

(B) Workmanship

Upon cutting the cable and removing the outer jacketing material down to the individual buffer tubes, secure the central strength member to the enclosure so that no tensile force is applied to the fibers. Secure the individual buffer tubes to the splice trays by a method recommend by the manufacturer. Determine the length of each buffer tube needed to ensure the buffer tube can be looped a minimum of two times around the inside of the splice tray. Upon determining the length of buffer tube needed remove the buffer tube to expose the individual fibers for fusion splicing. Adjust individual fiber lengths as necessary to ensure that once the fusion splicing process is completed that the finished splices will align with the "splice block organizer" supplied within the splice tray. Ensure the slice block organizer has individual fusion splice space holders for each fiber splice.

While prepping the individual fibers for splicing install the heat shrink protecting tube over the fiber and then perform the splicing operations, following the manufacturer's instructions. Verify the newly formed splice does not exceed 0.05 dB of attenuation. If the attenuation is more than 0.05 dB then remake the splice until it meets the 0.05 dB or less requirement. Finish the splicing operation by sliding the heat shrink tube over the splice and applying heat to activate the heat shrink tubing. Secure the finished splice in the splice block organizer. Ensure each splice is properly secured in a space holder in the splice block organizer. Multiple splices secured to the same space holder are unacceptable.

Ensure all buffer tubes are contained within splice trays so no bare fibers are outside tray and do not damage the fiber or violate the minimum bending radius of the fiber.

Prior to installing the cover over the splice tray and placing it in its final resting location, take a mandatory digital photograph of the splice tray that shows the final workmanship. Ensure the photograph shows the "Workmanship Identification Information" as well as the workmanship associated with installing and terminating the fiber. Include digital copies of each photograph via NCDOT's File Transfer System (FTS) as part of the OTDR Test Results submittal.

(C) Termination and Splicing within Interconnect Center

Install interconnect centers with connector panels, splice trays, storage for slack cable or fibers, mounting and strain relief hardware and all necessary hardware.

Terminate and splice all fibers including unused fibers.

Label all fiber-optic connectors, whether on jumpers, connector panels or other equipment, to prevent improper connection. Obtain approval of fiber-optic connector labeling method.

For all fibers designated for termination to connector panel within interconnect center, fusion splice fibers to pigtails.

For all cut fibers designated to pass through interconnect center, fusion splice fibers.

For all buffer tubes designated to pass through interconnect center, neatly coil excess tubing inside interconnect center.

(D) Termination and Splicing within Splice Enclosure

Install splice enclosures with splice trays, basket containment assemblies, racking for slack cable or fibers, mounting and strain relief hardware, and all other necessary hardware.

Fusion splice all fibers including fibers designated to be coupled with fibers from a drop cable assembly and cut fibers designated to pass through splice enclosure.

For all buffer tubes designated to pass through splice enclosure, neatly coil excess tubing inside basket provided with enclosure.

Label all fiber-optic splices. Obtain approval of fiber-optic connector labeling method from the Engineer.

Install heat shrink cable shields using methods recommended by the manufacturer of the enclosure. Perform a pressurization flash test on enclosure in accordance with manufacturer's recommended procedures at the conclusion of splicing procedure and before final placement of enclosure.

For aerial installations, secure enclosures to messenger cable using manufacturer supplied hardware. Secure SMFO cable and drop cable assemblies to snowshoes.

Install enclosures with enough slack cable to allow enclosure to be lowered to ground level and extended into a splicing vehicle.

For underground, manhole, and junction box facility installations, place the enclosure along with required spare cables in the facility in a neat and workmanship like manner.

(E) Modify Interconnect Centers and Splice Enclosures

Modify existing fiber-optic interconnect centers and splice enclosures as shown in the plans. Install additional patch panels, splice trays and pigtails where necessary and fusion splice fiber connections and perform OTDR testing as required by the plans. Install new fiber-optic jumpers and make connections to equipment and patch panels as necessary.

(F) Testing

Provide notification a minimum of 10 business days before beginning OTDR tests to the Engineer.

After splicing is completed, perform bi-directional OTDR tests on each fiber, including unused fibers. Install a 1,000 foot pre-tested launch cable between the OTDR and fiber-optic cable to be tested and a 1,000 foot pre-tested destination cable on the end of the fiber-optic cable to be tested. Ensure each launch cable has been tested and is compatible with the fiber being installed. Provide Engineer with test results of the launch cable before use. Re-test or replace launch cable at Engineer's request.

Ensure fusion splice losses do not exceed 0.05 dB and connectors have a loss of 0.5 dB or less. If any fiber exceeds maximum allowable attenuation or if fiber properties of the cable have been impaired, take appropriate actions up to and including replacement of the fiber cable.

Clearly label each OTDR trace identifying a starting and ending point for all fibers being tested. Record the attenuation level of each fiber and clearly indicate OTDR trace results in report format.

Test the fiber-optic cable at both 1310 and 1550 nm.

Furnish durable labeled plots and electronic copies via the Department's File Transfer System (FTS) of test results for each fiber including engineering calculations demonstrating that OTDR test results meet or exceed the attenuation requirements and that optical properties of the cable have not been impaired. Clearly label each OTDR trace identifying a starting and ending point for all fibers being tested.

Provide engineering calculations and tests for fiber-optic cable that demonstrate the loss budget where the fiber originates and where the fiber meets an electronic device. The calculations shall summarize the optical losses versus the allowable losses for the communications equipment between each pair of communications hardware. Provide a summary section or spreadsheet with a labeled tabular summary showing each test segment with begin and end points and actual versus allowable losses. Label the manufacturer's

make, model number and software version of the OTDR used for testing.

Furnish one hard copy of each of the OTDR trace results and one electronic pdf copy of all trace results along with digital photographs showing workmanship for each splice via the Department's File Transfer System (FTS). Furnish the manufacturer's make, model number and software version of the OTDR used for testing.

1731-4 MEASUREMENT AND PAYMENT

Interconnect Center will be measured and paid as the actual number of fiber-optic interconnect centers furnished, installed and accepted.

Splice Enclosure will be measured and paid as the actual number of fiber-optic splice enclosures furnished, installed and accepted. No measurement will be made between aerial, underground, manhole or junction box installation of the fiber-optic splice enclosure.

Modifying Splice Enclosure will be measured and paid as the actual number of fiber-optic splice enclosures modified and accepted. No measurement will be made between aerial, underground, manhole or junction box installation of the fiber-optic splice enclosure.

No measurement will be made of splice trays, pigtails, jumpers, connector panels, testing and any corrective actions, repairs and replacements needed for exceeding maximum allowable attenuation or other defects, as these will be incidental to furnishing and installing fiber-optic interconnect centers and splice enclosures and modifying splice enclosures.

Payment will be made under:

Pay Item	Pay Unit
Interconnect Center	Each
Splice Enclosure	Each
Modifying Splice Enclosure	Each

SECTION 1732
FIBER-OPTIC TRANSCEIVERS

1732-1 DESCRIPTION

Furnish and install fiber-optic transceivers with all necessary hardware.

1732-2 MATERIALS

Refer to Division 10.

Item	Section
Fiber-Optic Transceivers	1098-13

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1732-3 CONSTRUCTION METHODS

Install fiber-optic transceivers in each equipment cabinet and comply with manufacturer's installation instructions.

1732-4 MEASUREMENT AND PAYMENT

Fiber-Optic Transceiver - Drop and Repeat will be measured and paid as the actual number fiber-optic drop and repeat transceivers furnished, installed and accepted.

Fiber-Optic Transceiver - Self-Healing Ring will be measured and paid as the actual number of fiber-optic self-healing ring transceivers furnished, installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Fiber-Optic Transceiver - Drop and Repeat	Each
Fiber-Optic Transceiver - Self-Healing Ring	Each

SECTION 1733
DELINEATOR MARKERS

1733-1 DESCRIPTION

Furnish and install delineator markers with all necessary hardware.

1733-2 MATERIAL

Refer to Division 10.

Item	Section
Delineator Markers	1098-14

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1733-3 CONSTRUCTION METHODS

Submit sample of proposed delineator markers for approval before installation.

Install delineator markers using a method that firmly and securely anchors delineator marker in the ground to prohibit twisting and easy removal as directed by the plans.

1733-4 MEASUREMENT AND PAYMENT

Delineator Marker will be measured and paid as the actual number delineator markers furnished, installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Delineator Marker	Each

SECTION 1734
REMOVE EXISTING COMMUNICATIONS CABLE

1734-1 DESCRIPTION

Remove existing communications cable.

1734-2 CONSTRUCTION METHODS

Removal of existing aerial communications cable also includes proper disposal of communications cable, messenger cable and mounting hardware, including abandoned risers.

Removal of existing underground communications cable includes proper disposal of communications cable and junction boxes, if required. Where junction boxes have been removed, backfill hole with an approved material and compact hole as required in accordance with Subarticle 235-3(C).

Do not reuse any removed communications cable, messenger cable, junction boxes, pole attachment hardware or abandoned risers on the project, unless otherwise specified by the Engineer. In the event that any of the removed communications cable, junction boxes or pole attachment hardware is to be returned to the Engineer, it will be so noted in the plans.

1734-3 MEASUREMENT AND PAYMENT

Remove Existing Communications Cable will be measured in horizontal linear feet of existing communications cable removed and accepted. Payment will be in linear feet. Sag, vertical segments or spare segments of communications cable will not be paid as these distances will be incidental to the removal of existing communications cable.

No additional measurement will be made for multiple cables being removed from the same conduit or same pole. Where multiple adjacent conduits exist (each containing multiple cables), each conduit will be measured and paid separately. No payment will be made for cable that cannot be removed and is abandoned in place.

No measurement will be made of the removal of messenger cable, pole attachment hardware and junction boxes, as these will be incidental to removing existing communications hardware.

Payment will be made under:

Pay Item	Pay Unit
Remove Existing Communications Cable	Linear Foot

SECTION 1735
CABLE TRANSFERS

1735-1 DESCRIPTION

Remove and reinstall existing communications cable for pole relocations.

1735-2 MATERIAL

Refer to Division 10

Item	Section
Pole Line Hardware	1098-7

1735-3 CONSTRUCTION METHODS

During project, transfers of existing communications cable to new poles may be required. Perform transfers as directed by the Engineer. Remove existing cables from pole to be removed and reinstall these cables and any existing attachment hardware on new pole. Remove all communications hardware from existing pole. Furnish and install any new attachment hardware as required.

1735-4 MEASUREMENT AND PAYMENT

Cable Transfer will be measured and paid as the actual number of cable transfers with attachment hardware to new poles furnished, installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Cable Transfer	Each

SECTION 1736
SPREAD SPECTRUM RADIO

1736-1 DESCRIPTION

Furnish and install a spread spectrum radio system (900 MHz Serial or 900 MHz Serial /Ethernet) with all necessary hardware and signage in accordance with the plans and specifications to provide a data link between field devices (i.e. traffic signal controllers, dynamic message signs, etc.). Provide a radio system with a bi-directional, full duplex communications channel between 2 “line-of-sight” antennas using license free, spread spectrum technology operating in the 902-928 MHz frequency band.

Furnish material and workmanship conforming to the NEC, the NESC, UL or a third-party listing agency accredited by the North Carolina Department of Insurance and all local safety laws. Comply with all regulations and codes imposed by the owner of affected utility poles.

1736-2 MATERIAL

Refer to Division 10.

Item	Section
Pole Line Hardware	1098-7
Retroreflective Sheeting	1092-2
Signs and Hardware	1092-1
Spread Spectrum Radio	1098-19
Wire	1091-2

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1736-3 CONSTRUCTION METHODS

(A) General

Perform a radio path Site Survey test before installing any equipment. Ensure the test evaluates the signal strength (dBm), fade margin (dB), signal-to-noise ratio, data integrity (poll test) and a complete frequency spectrum scan. Ensure the radio path site survey test is performed using the supplied brand of radio equipment to be deployed. During the initial radio path signal strength test it may be determined that a repeater station may be necessary to complete the intended link. Provide the test results to the Engineer for review and approval. Submit copies of the test results and colored copies of the frequency spectrum scan along with an electronic copy of this information. The Engineer will approve final locations of antennas and any necessary repeater stations.

For 900 MHz serial radios install a data interface cable (Type 1, Type 2, Type 3), radio frequency signal jumper, lightning arrestor, coaxial cable, coaxial cable shield grounding and weatherproofing kit, antenna and antenna mounting hardware. If the installation requires a dual antenna configuration to accommodate communications in multiple directions install a power divider (splitter), antenna splitter cables and additional antenna and mounting hardware.

For 900 MHz Serial/Ethernet radios install an Ethernet cable, radio frequency signal jumper, lightning arrestor, coaxial cable, coaxial cable shield grounding and weatherproofing kit, antenna and antenna mounting hardware. If the installation requires a dual antenna configuration to accommodate communications in multiple directions install a power divider (splitter), antenna splitter cables and additional antenna and mounting hardware.

Install the antenna in such a manner that avoids conflicts with other utilities (separation distances in accordance with the guidelines of the NESC) and as specified in the antenna manufacturer's recommendations. Secure the antenna mounting hardware to the pole and route the coaxial cable such that no strain is placed on the N-Type male coaxial connectors. On wood pole installations, bond the antenna mounting hardware to the pole ground using #6 AWG bare copper wire using split bolt or compression type fitting.

Install the coaxial cable shield grounding system by carefully removing the outer jacket of the coaxial cable without damaging the cable shield. Install the shield grounding system following the cable manufacturer's recommendations. Install and weatherproof the connection using the appropriate weatherproofing materials and following the manufacturer's recommendations. On wood poles, secure the #6 AWG grounding lead cable to the pole ground using split bolt or compression type fitting or a method approved by the Engineer. On metal poles, secure the #6 AWG grounding lead cable to the pole using a method approved by the Engineer.

Do not exceed the one inch bend radius of the coaxial cable as it traverses from the cabinet to the antenna assembly. Connect the lightning arrestor to the coaxial cable in the equipment cabinet. Properly ground and secure the arrestor in the cabinet. Permanently label all cables entering the cabinet. Ensure the power supply for the radio system is not connected to the GFCI receptacle circuit located in the cabinet. Place a copy of all manufacturer equipment specifications and instruction and maintenance manuals in the equipment cabinet.

At certain locations it may be necessary to integrate the radio system with a fiber-optic system. Follow the details shown in the fiber-optic splice plans.

(B) Disconnect Switch

At all locations, where the antenna is mounted on a joint use pole, install a double pole, snap switch to remove power from the spread spectrum radio system. Do not mount weatherproof box on the traffic signal cabinet door. Drill a hole in the side of the traffic signal cabinet. Mount the outlet box over the hole using a half inch chase nipple and bushings. Ensure sealing gaskets are in place and no water can enter the cabinet. Securely mount the weatherproof outlet box with additional mounting screws. Bond the outlet box to the equipment ground bus. See plans for approximate mounting height. Run the power supply cord of the spread spectrum radio unit into the outlet box and connect to switch. Securely attach power supply cord to equipment rack. Install disconnect switch with lockout tag cover. If the antenna is mounted on a joint use pole, the “disconnect switch” is required.

Do not install power supply for the radio in a GFCI protected outlet.

(C) Warning Sign(s) and Decal(s)

At all locations, where the antenna is mounted on a joint use pole, secure a warning sign to pole. Mount warning sign(s) at locations called for in the plans. Ensure there are no conflicts between the warning sign and surrounding utilities. Mount warning sign to be easily viewed. Do not mount warning sign under pole grounds or conduit. If the antenna is mounted on a joint use pole, the RF warning sign is required.

Clean and remove any dirt or oil on traffic cabinet before placing decal. Place decal adjacent to the disconnect switch located on the outside of traffic cabinet. If the antenna is mounted on a joint use pole, the decal is required.

1736-4 MEASUREMENT AND PAYMENT

900MHz Serial Spread Spectrum Radio will be measured and paid as the actual number of 900 MHz serial spread spectrum radios furnished, installed and accepted. This item includes the appropriate sized antenna(s), radio, power supplies, disconnect/snap switch, signs, decals, data interface cable, coaxial cable, lightning arrestor, radio frequency signal jumper, coaxial cable power divider (splitter), coaxial cable connectors, coaxial cable shield grounding system with weatherproofing, labeling and any integration between the radio system and a fiber-optic network if necessary, and installation materials necessary to complete this work, including the radio path signal strength test and warranties.

900 MHz Serial/Ethernet Spread Spectrum Radio will be measured and paid as the actual number of 900 MHz Serial/Ethernet spread spectrum radios furnished, installed and accepted. This item includes the appropriate sized antenna(s), radio, power supplies, disconnect/snap switch, signs, decals, Ethernet cable, coaxial cable, lightning arrestor, radio frequency signal jumper, coaxial cable power divider (splitter), coaxial cable connectors, coaxial cable shield grounding system with weatherproofing, labeling and any integration between the radio system and an Ethernet switch if necessary, and installation materials necessary to complete this work, including the radio path signal strength test and warranties.

Payment will be made under:

Pay Item	Pay Unit
900MHz Serial Spread Spectrum Radio	Each
900MHz Serial/Ethernet Spread Spectrum Radio	Each

SECTION 1737
MODIFY SPREAD SPECTRUM WIRELESS RADIO

1737-1 DESCRIPTION

Make modifications to existing Spread Spectrum Radio installations.

1737-2 MATERIAL

Refer to Division 10.

Item	Section
Pole Line Hardware	1098-7
Retroreflective Sheeting	1092-2
Signs and Hardware	1092-1
Spread Spectrum Radio	1098-19
Wire	1091-2

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1737-3 CONSTRUCTION METHODS

This item of work involves making modifications to existing wireless installations which include relocating an existing radio from an existing cabinet to a new cabinet, and/or relocating existing components of the radio system from an existing pole to new poles (wood poles, metal strain poles, metal poles with mast arms, etc.). This item of work includes, but may not be limited to, the following:

(A) Relocating existing radio from an existing cabinet to a new cabinet

(B) Relocating or installing new Coaxial Cable

(C) Furnishing and installing new N-Type Connectors

(D) Furnishing new Coaxial Cable and Shield Grounding Kits

(E) Relocating Antenna Mounting Hardware

(F) Relocating Antennas

This item of work may also involve converting an existing standalone radio site to a repeater site. This item of work includes, but may not be limited to, the following:

(A) Furnishing and installing new antenna(s)

(B) Furnishing and installing new antenna mounting hardware kits

(C) Furnishing and installing new 6 foot coaxial cable jumpers with N-Type Connectors

(D) Furnishing and installing new coaxial cable – power divider (Splitters)

1737-4 MEASUREMENT AND PAYMENT

Modify Radio Installation will be measured as the actual number of modified radio installations that are modified and accepted.

This item includes relocating the radio, and furnishing and/or relocating and installing coaxial cable, N-Type Connectors, coaxial cable shield grounding kits, antenna mounting hardware, antennas, coaxial cable and power dividers. This item of work may also involve furnishing and

installing new decals and furnishing or relocating signs. This item of work may also involve re-programming the radio.

Payment for new risers will be covered separately.

Payment will be made under:

Pay Item	Pay Unit
Modify Radio Installation	Each

SECTION 1738
BACK PULL FIBER-OPTIC CABLE

1738-1 DESCRIPTION

Back pull and store or back pull and reinstall existing communications cable.

1738-2 CONSTRUCTION METHODS

During project construction where instructed to back pull existing aerial sections of fiber-optic communications cable, de-lash the cable from the messenger cable and back pull the cable to a point where it can be stored or re-routed as shown on the plans. If instructed, remove and discard the existing messenger cable and pole mounting hardware once the cable is safely out of harm's way.

During project construction where instructed to back pull existing underground sections of fiber-optic communications cable, back pull the cable to a point where it can be stored or re-routed as shown on the plans. If instructed, remove abandoned junction boxes and backfill with a suitable material to match the existing grade. Leave abandoned conduits in place unless otherwise noted.

Where instructed, re-pull the fiber-optic cable back along messenger cable or through conduit systems.

1738-3 MEASUREMENT AND PAYMENT

Back Pull Fiber-Optic Cable will be paid for as the actual linear feet of fiber-optic cable back pulled and either stored or back pulled and rerouted. Payment is for the actual linear feet of cable back pulled and accepted.

No payment will be made for removing messenger cable and pole mounting hardware or removing junction boxes and back filling to match the surrounding grade as these items of work will be considered incidental to back pulling the fiber-optic cable.

Payment will be made under:

Pay Item	Pay Unit
Back Pull Fiber-Optic Cable	Linear Feet

SECTION 1743
PEDESTALS

1743-1 DESCRIPTION

Furnish and install the size and type of support assembly for vehicular or pedestrian signal heads, pedestrian pushbuttons, Intelligent Transportation System technologies or other traffic control devices as shown in the plans. Furnish assembly with foundation, grounding system and all necessary hardware as shown in the *Roadway Standard Drawings*. Provide a pedestal assembly that meets *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, and the Interim Specifications as shown on the plans. Unless otherwise required by the plans, install signal pedestals and pedestrian pushbutton posts on FHWA-approved breakaway support or anchor systems.

Furnish and install screw-in helical foundation as an alternative to the standard reinforced concrete foundation for supporting Type I and Type II Pedestals. Do not use for Type III Pedestals.

1743-2 MATERIAL

Refer to Division 10.

Item	Section
Grounding Electrodes	1091-6
Signal Pedestals	1098-15
Wire	1091-2

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

Pedestals are defined as follows:

(A) Type I - Pedestrian Pushbutton Post

(B) Type II - Normal-Duty Pedestal

(C) Type III - Heavy-Duty Pedestal

1743-3 CONSTRUCTION METHODS

(A) Type I Pedestrian Pushbutton Post

Install pushbutton post for mounting pedestrian pushbutton or an accessible pedestrian signal (APS) assembly (refer to Section 1705).

Install underground conduit for pushbutton lead-in cable in the pushbutton post's foundation.

Attach or anchor pushbutton post to the top of foundation via a breakaway support in a vertical plumb orientation. Ensure post is of sufficient length to accommodate the pushbutton, accessible pedestrian signals and any associated pedestrian informational signing at the mounting heights shown in the plans.

(B) Type II and III Pedestals

Locate foundations, determine elevation and submit findings for normal-duty and heavy-duty pedestals. Obtain the Engineer's approval of foundation locations and elevations before constructing foundations.

Excavate in accordance with Section 410. If encountered, remove rock or boulders to a sufficient depth to obtain stability necessary to support the structure for design loads. Ensure ground is level before installing foundations.

Construct foundations in accordance with Section 825. Cast concrete for pole foundations against undisturbed soil unless otherwise permitted. Provide forms with chamfer strips that measure one inch along diagonal face at all corners above ground level. Do not install foundations over uncompacted fill or muck.

Install conduit in foundations.

Securely place, position and align anchor bolts symmetrically about the center of foundation.

Give exposed vertical concrete surfaces a broom finish. Give exposed horizontal surfaces a float finish.

Level tops of concrete foundations. Do not allow tops to exceed 4 inches above adjacent ground surface. Pour and finish foundation to a level that is flush with the surrounding sidewalk when possible.

Do not erect pedestals until concrete has attained a minimum compressive strength of 2,500 psi as determined by cylinder breaks.

Refer to *Roadway Standard Drawings*.

(C) Screw-In Helical Foundation Anchor Assembly:

Advance or mechanically screw foundation into soil until top of attachment plate is level with finished grade. Slide the anchor bolt heads through the keyhole openings and under the attachment plate with threads pointing up. Bolt the pedestal base to the foundation attachment plate.

For further construction methods, see manufacturer's installation drawings.

1743-4 MEASUREMENT AND PAYMENT

Type I Post with Foundation will be measured and paid as the actual number of pedestrian pushbutton posts furnished, installed and accepted.

Type II Pedestal with Foundation will be measured and paid as the actual number of normal-duty pedestals with foundations furnished, installed and accepted.

Type III Pedestal with Foundation will be measured and paid as the actual number of heavy-duty pedestals with foundations furnished, installed and accepted.

No measurement will be made for pedestal foundations, pedestal screw-in helical foundations, grounding systems and any peripheral pedestal mounting hardware as these are incidental to furnishing and installing pedestals.

Payment will be made under:

Pay Item	Pay Unit
Type I Post with Foundation	Each
Type II Pedestal with Foundation	Each
Type III Pedestal with Foundation	Each

SECTION 1745
SIGNS INSTALLED FOR SIGNALS

1745-1 DESCRIPTION

Furnish and install signs for signals with cable hangers, rigid sign mounting brackets, U-channel posts and all necessary hardware.

1745-2 MATERIAL

Refer to Division 10.

Item	Section
Signs and Hardware	1092-1
Retroreflective Sheeting	1092-2

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

Use Grade C retroreflective sheeting, except for black sheeting. Use non-reflective for black sheeting.

Conform to the message layout, size and color as required in the MUTCD.

For messenger cable mounting, furnish either messenger cable hangers with free-swinging, 360° adjustable sign brackets or 3-bolt clamps as directed by the Engineer. Furnish aluminum, galvanized steel or stainless steel sign supporting hardware.

For ground mounting, furnish steel, 3-lb, U-channel posts with hardware for ground mounting. Comply with Section 903.

For mast-arm mounting, furnish rigid aluminum, galvanized steel or stainless steel sign mounting brackets.

1745-3 CONSTRUCTION METHODS

Install signs with applicable mounting hardware. Comply with sign offsets and mounting heights as shown in the MUTCD and the *Roadway Standard Drawings*.

For messenger cable mounting, install signs 6 inches minimum from signal heads.

For ground mounting, comply with Article 903-3.

For mast arm mounting, install attachment brackets to allow adjustment so signs:

(A) Are aimed in required direction,

(B) Are plumb as viewed from respective approaches,

(C) May be tilted forward or backward as required, and

(D) May be raised or lowered on mast arm throughout full length of sign.

1745-4 MEASUREMENT AND PAYMENT

Sign for Signals will be measured and paid as the actual number of signs for signals, regardless of mounting method, furnished, installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Sign for Signals	Each

SECTION 1746
RELOCATE EXISTING SIGN

1746-1 DESCRIPTION

Relocate existing signs.

1746-2 CONSTRUCTION METHODS

As directed by the plans, relocate existing signs. Comply with Article 1745-3.

1746-3 MEASUREMENT AND PAYMENT

Relocate Existing Sign will be measured and paid as the actual number of existing signs, regardless of mounting method, relocated and accepted.

Payment will be made under:

Pay Item	Pay Unit
Relocate Existing Sign	Each

SECTION 1747
LED BLANKOUT SIGN

1747-1 DESCRIPTION

Furnish and install Light Emitting Diode (LED) blankout signs with all necessary hardware as set forth in the plans and specifications. Fabricate the sign such that the legend elements, text size, font type, and overall size of the sign comply with the applicable provisions for the static version of the sign conforming to the MUTCD.

1747-2 MATERIAL

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1747-3 CONSTRUCTION METHODS

Install LED blankout signs with wire entrance fittings, span wire cable mounting assemblies, pedestal mounting assemblies, rigid mounting assemblies, signal cable, lashing wire and all necessary hardware.

Relocate existing blankout signs with all necessary hardware.

1747-4 MEASUREMENT AND PAYMENT

LED Blankout Signs will be measured and paid as the actual number of LED blankout signs with mounting hardware furnished, installed and accepted.

Relocate Existing Blankout Sign will be measured and paid as the actual number of blankout signs relocated and accepted.

Payment will be made under:

Pay Item	Pay Unit
LED Blankout Signs	Each
Relocate Existing Blankout Sign	Each

SECTION 1750
SIGNAL CABINET FOUNDATIONS

1750-1 DESCRIPTION

Furnish and install signal cabinet foundations and all necessary hardware.

Furnish either poured concrete foundations or preformed cabinet pad foundations and all necessary hardware. Obtain approval of foundation type from the Engineer.

1750-2 MATERIAL

Refer to Division 10.

Item	Section
Signal Cabinet Foundation	1098-16
Portland Cement Concrete	1000-3

Furnish preformed cabinet pad foundation material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1750-3 CONSTRUCTION METHODS

Comply with Section 825.

When using poured concrete foundations and preformed cabinet pads, use procedures, equipment and hardware as follows:

(A) Locate new cabinets so as not to obstruct sight distance of vehicles turning on red.

(B) Obtain approval for final cabinet foundation locations before pouring concrete base.

(C) Do not install foundations over uncompacted fill or muck.

(D) Hand tamp soil before placing concrete and ensure ground is level.

(E) Maintain 12 inches minimum from service pole to closest point on foundation unless otherwise approved by the Engineer.

(F) Use a minimum of four 1/2 inch diameter expanding type anchor bolts to secure cabinet to foundation.

(G) Install minimum 4 inches above and 4 inches below finished grade.

(H) Locate external stubbed out conduit at cabinet foundation so conduit is in middle of cabinet. Provide service conduit as the rightmost conduit coming into cabinet. Provide 2 spare conduits stubbed out; one pointed toward service pole and the other toward direction of lead in cable. Inscribe identification arrow in foundation indicating direction of spare conduits.

(I) Give cabinet foundation a broom finish and chamfered edges.

(J) Seal space between cabinet base and foundation with permanent, flexible, waterproof sealing material.

1750-4 MEASUREMENT AND PAYMENT

Signal Cabinet Foundation will be measured and paid as the actual number furnished, installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Signal Cabinet Foundation	Each

SECTION 1751
CONTROLLERS WITH CABINETS

1751-1 DESCRIPTION

Furnish and install controllers with cabinets and all necessary hardware. Furnish all pole or foundation mounting hardware, detector sensor cards, external electrical service disconnects, one Corbin Number 2 cabinet key, one police panel key, conflict monitors or malfunction management units, surge protection, grounding systems, AC/DC isolator cards and all necessary hardware.

1751-2 MATERIAL

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1751-3 CONSTRUCTION METHODS

(A) General

Remove existing controllers and cabinets where required. Remove maintenance diary from cabinet and place in new cabinet or deliver to the Engineer. Take existing equipment out of service only at the time directed by the Engineer.

Locate new cabinets so as not to obstruct sight distance of vehicles turning on red.

Install controllers, cabinets, detector sensor units and hardware that provide required phasing, color sequence, flash sequence, interconnection, railroad clearance and preemption and emergency vehicle clearance and preemption.

Stencil signal inventory number on cabinet side facing roadway. Use 3 inch black characters.

Provide external electrical service disconnect at all new and existing cabinet locations unless otherwise specified.

Do not program controller for late night flashing operation at railroad preemption installations. For all other installations, do not program controller for late night flashing

operation unless otherwise directed by the Engineer. Ensure all signal heads for same approach flash concurrently during flashing operation.

Provide serial number and cabinet model number for each new controller and controller cabinet installed.

Install pole mounted cabinets so height to cabinet middle is 4 feet.

Activate controllers with proposed phasing and timing.

(B) System Interconnection

When interconnection of signals is required (via fiber optic, ethernet, wireless, etc.), install communications interface equipment and hardware for signals. Demonstrate proper operation of interconnection using manual commands and bidirectional communication capability to each local controller from the respective master controller after interconnection is complete.

Program telemetry command sequences and enable devices necessary for testing of communication between local controllers and field master controllers and between field master controllers and Department-furnished central computer. Where master controllers are not used, demonstrate proper operation of interconnection between local intersections controllers and a central system server.

(C) Workshop

Provide enclosed workshop to set up and test new controllers and cabinets before installation. Locate workshop within Division responsible for project administration. Ensure workshop provides protection from weather and sufficient space to house 2 test observers, all necessary test equipment and material, controllers and cabinets.

Configure and test each controller and cabinet to match the proposed signal design. Ensure all equipment furnished and installed or modified by the Contractor at each location operates in full compliance with the plans and specifications. Test each controller and cabinet for proper color sequence, flashing operation, phase timings, preemption, coordination and conflict monitor programming or malfunction management unit programming. Ensure that simultaneous conflicting phase outputs will cause the cabinet to revert to flashing operation. For intersections with any type of preemption, submit a completed *Preemption Test Procedure Checklist*. The checklist is located on the Department's website.

Test the cabinet and controller for 8 hours minimum. Following this test and before installation, the Engineer will inspect the equipment in operation. The Engineer may require other tests to ensure proper operation. These tests shall be at no additional cost to the Department.

1751-4 MEASUREMENT AND PAYMENT

Controllers with Cabinet (____) will be measured and paid as the actual number of each type of controllers with cabinets furnished, installed and accepted.

Detector Card (____) will be measured and paid as the actual number furnished, installed and accepted.

No measurement will be made of conflict monitors, malfunction management units, external electrical service disconnect, grounding systems, modems, meter bases and workshop as these will be incidental to furnishing and installing controllers with cabinets.

Payment will be made under:

Pay Item	Pay Unit
Controllers with Cabinet (____)	Each
Detector Card (____)	Each

SECTION 1752
MODIFY CABINET FOUNDATIONS

1752-1 DESCRIPTION

Where approved by the Engineer, install conduit entrances into existing foundations in accordance with the plans and specifications. Modify existing foundations in accordance with the plans and specifications.

1752-2 MATERIAL

Refer to Article 1750-2.

1752-3 CONSTRUCTION METHODS

(A) Install Conduit Entrance into Existing Foundation

Install Conduit Entrances into existing cabinet foundations by core drilling foundations to install additional conduit.

Maintain a minimum of 3 inches of cover between new conduit and edge of foundation. Maintain minimum clearances of 1 inch from the flange of the base adapter and 2 inches from existing conduits. Avoid damaging existing conduit, conductors and anchor bolts. Repair all such damages. Where approved by the Engineer, the foundation may be chipped instead of drilled for conduit entrance. Maintain traffic signal operations while drilling is performed unless approved by the Engineer.

Bond new metallic conduit to the equipment ground bus.

After installation of conduit, place grout to seal around conduit and return the foundation to normal appearance.

(B) Modify Foundation

Enlarge existing cabinet foundations to accommodate the new cabinet and/or to provide a maintenance technician pad.

Excavate the ground around the existing foundation to a depth sufficient to expose a minimum of 4 inches of the foundation below existing grade.

Rough the sides of the existing foundation from the top to a point 4 inches below grade by means of a chisel or other method approved by the Engineer.

Wash the sides of the foundation with water pressurized at 50 psi and thoroughly dry with compressed air.

Drill holes approximately 12 inches deep on 12 inches centers into the existing foundation. Install #4 dowels and epoxy into place. Provide dowels of the lengths in Table 1752-1.

TABLE 1752-1
LENGTH OF DOWEL

Foundation Extension	Length of Dowel
> 16"	24"
> 6" and < 16"	17"
= 6"	14"

Use concrete to install the maintenance technician pad.

Form the sides of the modified foundation to a minimum depth of 4 inches below grade.

Position forms so that all existing exposed foundation surfaces at or above grade level will be matched.

Apply a coating of approved epoxy bonding agent to all exposed roughened concrete surfaces as recommended by the manufacturer.

Enlarge the foundation to the distance specified for new cabinet foundations. Provide a one inch chamfer on all new outside edges.

Maintenance technician pads should be added to the foundation to provide a minimum work area of 24 inches [length] x 30 inches [width] from both the front and rear doors of the cabinet.

1752-4 MEASUREMENT AND PAYMENT

Conduit Entrance into Existing Foundation will be measured and paid as the actual number of conduit entrances drilled into existing cabinet foundations furnished, installed and accepted.

Modify Foundation for Controller Cabinet will be measured and paid as the actual number of existing cabinet foundations modified and accepted.

Payment will be made under:

Pay Item	Pay Unit
Conduit Entrance into Existing Foundation	Each
Modify Foundation for Controller Cabinet	Each

SECTION 1753
CABINET BASE ADAPTER/EXTENDER

1753-1 DESCRIPTION

Furnish and install cabinet base adapters and extenders with all necessary hardware for Type 170 cabinets.

1753-2 MATERIAL

Refer to Division 10.

Item	Section
Cabinet Base Adapter/Extender	1098-17

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1753-3 CONSTRUCTION METHODS

Install cabinet base adapter at locations requiring new Model 332 cabinet on existing/modified foundation.

Install cabinet base extender at locations requiring new Model 332 cabinet on new foundation or existing Model 332 cabinet that does not have cabinet base extender.

Where new Model 336 cabinet is used as base mount cabinet, install adapter or extender, as required.

Use permanent, flexible waterproof sealing material to:

(A) Seal between cabinet base and cabinet base adapter/extender,

(B) Seal 2-piece cabinet base adapter/extender seams, and

(C) Seal space between cabinet base adapter/extender and foundation.

1753-4 MEASUREMENT AND PAYMENT

Cabinet Base Adapters will be measured and paid as the actual number furnished, installed and accepted.

Cabinet Base Extenders will be measured and paid as the actual number furnished, installed and accepted.

Payment will be made under:

Pay Item	Pay Unit
Cabinet Base Adapter	Each
Cabinet Base Extender	Each

SECTION 1755
BEACON CONTROLLER ASSEMBLIES

1755-1 DESCRIPTION

Furnish and install beacon controller assemblies with cabinets. Furnish all pole mounting hardware, solid state flashers, one Corbin Number 2 cabinet key, surge protection, grounding systems and all necessary hardware.

1755-2 MATERIAL

Refer to Division 10.

Item	Section
Beacon Controller Assemblies	1098-18
Grounding Electrodes	1091-6
Wire	1091-2

Furnish material, equipment and hardware under this section that is pre-approved on the ITS and Signals QPL available on the Department's website.

1755-3 CONSTRUCTION METHODS

Remove existing beacon controller assemblies where required. Remove maintenance diary from cabinet and place in new cabinet or deliver to the Engineer. Take existing equipment out of service only at the time directed by the Engineer.

Locate new beacon controller assemblies so as not to obstruct sight distance of turning vehicles.

Install new beacon controller assemblies. Provide external electrical service disconnect at new and existing cabinet locations unless otherwise specified by the Engineer.

Stencil signal inventory number on cabinet side facing roadway. Use 3 inch black characters. Provide serial number and cabinet model number for each new beacon controller assembly.

Install pole mounted cabinets so height to cabinet middle is 4 feet.

1755-4 MEASUREMENT AND PAYMENT

Beacon Controller Assembly and Cabinet (____) will be measured and paid as the actual number furnished, installed and accepted.

No measurement will be made of surge protectors, external electrical service disconnect, grounding systems and removing existing beacon controller assemblies as these are incidental to furnishing and installing beacon controller assemblies.

Payment will be made under:

Pay Item	Pay Unit
Beacon Controller Assembly and Cabinet (____)	Each

SECTION 1757
REMOVAL OF EXISTING TRAFFIC SIGNALS

1757-1 DESCRIPTION

Remove existing traffic signal materials and associated signal hardware.

1757-2 CONSTRUCTION METHODS

(A) General

Remove existing traffic signals at the locations indicated in the contract. Maintain and repair traffic signal equipment within the limits of the project until the traffic signal equipment is disconnected and stockpiled.

(B) Removal

Dismantle and remove existing traffic signal equipment and material, excluding joint use poles. Disconnect and remove all Department equipment from joint use poles in a manner that will not damage the poles or existing utilities. Cut electrical conduit and remove to at least 18 inches below finished ground elevation unless otherwise directed by the Engineer.

Install the required regulatory signs in accordance with Sections 900, 901 and 903 of the *Standard Specifications* before deactivating the traffic signal. Cover the signs with burlap bags until the traffic signal is removed or put into flashing operation.

If necessary to flash the traffic signal before removal of the signal equipment, immediately uncover the signs before placing the traffic signal into flashing operation. Operate the flashing operation for a period of time as directed by the Engineer.

Deactivate, dismantle and remove the traffic signal after the period of flashing operation or as directed by the Engineer.

Use methods to remove the traffic signal that will not result in damage to other portions of the project or facility. Repair damage that results from the Contractor's actions at no additional cost to the Department.

Final acceptance of the project is contingent upon the removal of the existing traffic signal. Removal of the existing traffic signal is part of the work required by the final completion date.

(C) Disposal

Remove all Department traffic signal equipment, span poles, messenger cable, interconnect cable and supporting hardware. Assume ownership and promptly transport the removed span poles, messenger cable, interconnect cable and supporting hardware. Return traffic signal equipment and material listed in Subarticle 1700-3(N) to the Traffic Services Office within the Division responsible for the administration of the project.

Return the removed equipment and material between the hours of 8:00 a.m. and 12:00 p.m. Monday through Thursday to the Traffic Services Office within the Division responsible for administration of the project or at a time mutually agreed upon by the Contractor and the Engineer. Replace or repair all material lost or damaged during its removal and transit. Label all returned equipment and material to indicate its original location.

1757-3 MEASUREMENT AND PAYMENT

Traffic Signal Removal will be measured and paid as the actual number of intersections that were completely cleared of all traffic signal equipment. The traffic signal equipment shall have existed along the roadway before the start of construction on the project, shall have had no changes made to the phasing or timing by the Contractor, shall have had no additional equipment installed by the Contractor during the life of the project (excluding equipment for maintenance) and shall have been removed as a part of the project.

Payment will be made under:

Pay Item	Pay Unit
Traffic Signal Removal	Each

INDEX

This index is not intended to be a complete concordance, but is intended to provide general reference where a word or term may be found. It is not intended to express emphasis on that particular referenced location. This index references the Division, Section, Article, or Subarticle. The entire book is available online and may be searched extensively and specifically for particular words and phrases.