

CULVERT SURVEY & HYDRAULIC DESIGN REPORT

N. C. DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
HYDRAULICS UNIT
RALEIGH, N. C.

State Proj. Reference No.

WBS Project No.

Proj. Station

County

Bridge Over

Struc. Inv. No.

On Highway

Between

and

Recommended Structure

Recommended Width of Roadway

Skew

Recommended Location is (Up, At, Down) Stream from Existing Crossing.

Longitude

Latitude

☐ Statewide Tier ☐ Regional Tier ☐ Sub-Regional Tier

Bench Mark is

Northing

Easting

Elev.

ft. Datum:

Temporary Crossing

Designed by:

Assisted by:

Date

QA Review by:

Date

Drainage Area

Source

River Basin

Character

Stream Classification (Such as Trout, High Quality Water, etc.)

Data on Existing Structure

Total Waterway Opening s.f.

Waterway Opening Below 100yr. WS EL. s.f.

Debris Potential: Low Moderate High

Data on Structures Up and Down Stream

Gage Station No.

Period of Records

Max. Discharge c.f.s.

Date

Frequency

Historical Flood Information:

Date Elev. ft. Est. Freq. yr. Source Period of Knowledge yrs.

Date Elev. ft. Est. Freq. yr. Source Period of Knowledge yrs.

Date Elev. ft. Est. Freq. yr. Source Period of Knowledge yrs.

Allowable HW Elev. Normal Water Surface Elev. ft.

Manning's n: Left O.B. Channel Right O.B. Source

Flood Study /Status

Flood Study 100 yr. Discharge c.f.s.; WS Elev.: With Floodway ft. Without Floodway ft. @River Station ?

DESIGN DATA

Hydrological Method

Hydraulic Design Method

Design Tailwater : Q₁₀ ft.; Q₂₅ ft.; Q₅₀ ft.; Q₁₀₀ ft.; Q₅₀₀ ft.

Total Proposed Waterway Opening s.f.

Outlet Velocity (V₀) f.p.s. Natural Channel Velocity (V₁₀) f.p.s.

Required Outlet Protection

State Floodway Compliance Type

INFORMATION TO BE SHOWN ON PLANS

HYDRAULIC DATA

DESIGN DISCHARGE C.F.S.

FREQUENCY OF DESIGN FLOOD YRS.

DESIGN HIGH WATER ELEVATION

DRAINAGE AREA SQ. MI.

BASIC DISCHARGE (Q100) C.F.S.

BASIC HIGH WATER ELEVATION

OVERTOPPING FLOOD DATA

OVERTOPPING DISCHARGE C.F.S.

FREQUENCY OF OVERTOPPING FLOOD YRS.

OVERTOPPING FLOOD ELEVATION

NOTE LOCATION OF OVERTOPPING

WS EL. Taken @ River Station ?

ADDITIONAL INFORMATION AND COMPUTATIONS

USGS REGRESSION EQUATIONS

SOURCE

Q₁₀ =

Q₂₅ =

Q₅₀ =

Q₁₀₀ =

Q₅₀₀ =

FEMA DISCHARGES

Q₁₀ =

Q₂₅ =

Q₅₀ =

Q₁₀₀ =

Q₅₀₀ =

NATIVE MATERIAL SPECIFICATION FOR BACKFILLING NOTE

The Engineer, in consultation with DEO staff, shall review all material to be used as backfill prior to conducting the backfill activity. Backfill shall consist of native material only unless the Engineer, in consultation with DEO staff, determines that (1) the native material is unsuitable, or (2) additional material is required to supplement the native material. The chosen backfill material shall not have adverse effects to aquatic life, aquatic life passage, or water quality. Native material consists of material that is excavated from the stream bed or floodplain at the project site during culvert construction.

PROFILE VIEW

EXISTING AND PROPOSED ROADWAY GRADE; NATURAL GROUND ALONG CENTERLINE; NATURAL GROUND RIGHT AND LEFT (IF NEEDED TO DEFINE FLOODPLAIN)
EXISTING STRUCTURE(S) (IF PRESENT)
VERTICAL CURVE INFORMATION
PROPOSED WS ELEVATIONS, NORMAL WS, UPSTREAM PROPOSED CULVERT PLOTTED AT THE UPSTREAM FACE.
PLOT EXISTING IF EXTENDING DOWNSTREAM

LABEL ELEVATIONS
AT
10 FT INCREMENTS

XX

XX

XX

Roadway Cross Section/Culvert Profile View

EXISTING AND PROPOSED ROADWAY CROSS SECTION, CULVERT AND STREAM BED PROFILE, TOP OF BANKS LEFT/RIGHT, PROPOSED/NORMAL WS AT INLET, CENTER LINE STATION, SIZE, TYPE, SKEW ANGLE, CULVERT INVERT, INVERT ELEVATION AT ROADWAY I.D. STATION AND SLOPE

PLAN VIEW

(Culveret Must align with Cross Section View as much as practicable)

Include (but not limited to) the following

Existing/Proposed Structures, Proposed Roadway Design, Existing Roadway, Existing Topography, Proposed Slope Stakes, Rip Rap (Label Class), Land Use Description, Proposed/Existing RW, Wetland Boundaries, Buffers Zones, Name of Steam and Direction of Flow, Location Description (Arrows to Nearest Intersecting Road or City), North Directional Arrow

DETAILS

(IF NEEDED)

ARMORING DETAILS, EXCAVATION DETAILS, SILL DETAILS

Culvert Label at Roadway Station

(Cross Section View, along culvert centerline)
Roadway I.D. Station (example -L- 10+00.0)
Skew Angle
Proposed Structure Type and Size
Roadway Grade Point Elevation

NCDOT PERFORMANCE TABLE					
FREQUENCY					
	10yr.	25yr.	50yr.	100yr.	500yr.
NATURAL	?	?	?	?	?
EXISTING	?	?	?	?	?
PROPOSED	?	?	?	?	?
@SECTION ? ? FT. FROM US FACE OF BRIDGE					

FEMA PERFORMANCE TABLE	
100yr.	
DUPLICATE EFFECTIVE	?
CORRECTED EFFECTIVE	?
REVISED	?
@SECTION ? ? FT. FROM US FACE OF BRIDGE	

Culvert Survey & Hydraulic Design Report Key

- 1 **State Proj. Reference No.** - Specify ID No. Example: B-4494 (for TIP projects) BD-5112k (For Low Impact bridge project), SF-890095 (State funded bridge projects), FA-770077(Division Force Account projects).
- 2 **WBS Project No.** - Specify Project WBS Number.
- 3 **Proj. Station** - Specify centerline bridge station to the nearest foot along survey line (typically –L- or -Y- line).
- 4 **County** - Specify County Name
- 5 **Bridge Over** - Specify name of stream or body of water
- 6 **Bridge Inv. No.** - Specify six digit bridge number, e.g., 500050.
- 7 **On Highway** - Specify Route number bridge is located on and for SR routes specify road name if there is one. (e.g., NC 211, SR 1742 (N. McMullen Rd).
- 8 **Between_____ and _____** - Specify Route bridge is located between. For SR routes specify road name if there is one. (e.g., **Between NC 211 and SR 1742 (N. McMullen Rd)**
- 9 **Recommended Structure** - Specify the number, size and type of culvert(s) proposed; additionally, include any other design features, e.g., sill height, embedded depth, baffle placement. If structure is being extended, specify extension length and direction of extension (up and/or downstream). Note culvert sizing is listed as Width x Height.
- 10 **Recommended Width of Roadway** - Specify shoulder point to shoulder point width (e.g., 72'-0" shld. pt. to shld. pt.)
- 11 **Skew** - Specify skew of Structure (angle based on line ahead to the right of the proposed alignment). For existing culverts that will be extended, report the skew with as much precision as necessary, including to DDMMSS. For proposed new locations, generally reporting to the nearest degree is sufficient.
- 12 **Recommended Location is** - circle either Up, At, or Down based on location relative to existing Structure and specify location of proposed bridge in relation to existing bridge, e.g., 50 ft. downstream, At Existing, New Location.
- 13 **Longitude/Latitude Coordinates:** Specify as decimal degrees (preferably to the 5th decimal place), e.g. -79.74686, 36.01297. This is useful for locating on GIS maps.
- 14 Specify Statewide, Regional, or Sub-Regional Tier based on transportation facility.
- 15 **Bench Mark** - Specify Bench mark description, should be located outside of the construction limits. Can use L&S Bench marks, preferably referenced to -L- or -Y- line (rather than to -BL- line). Also
- 16 Specify the Northing and Easting State Plane coordinates of the benchmark.
- 17 **Elev.** - Specify bench mark elevation.

- 18 **Datum** - Specify Vertical Datum used for this project, e.g., NAVD 88, NGVD 29.
- 19 **Temporary Crossing** - Specify whether or not a temporary crossing is required at the project site. e.g., Not Required, Off-Site detour provided, or Required (note size and type of) detour Structure and location (upstream or downstream of existing Structure).
- 20 **Photo** - Use this space for photograph of proposed site, showing centerline, direction of flow and other important points on photograph.
- 21 **Designed by** - Specify Design Engineer.
- 22 **Assisted by** - Specify any person who assisted.
- 23 **P.E. Seal** - of responsible NC-licensed Design or Project Engineer
- 24 **Date**- Date project is sealed
- 25 **Company Logo/Name**
- 26 **QA Review by** – The QA reviewer will sign.
- 27 **Date** – Date QA review signed
- 28 **Drainage Area** - Specify Drainage Area at stream crossing. Specify in Square miles if area is 1.0 Square miles or greater. Specify in Acres if less than 1 square mile.
- 29 **Source** - Specify Source of Drainage Area. Typically from USGS Quad Maps or Stream Stats. Can also come from, LIDAR data, drainage areas of Selected Sites verified with Quad Maps, or FEMA FIS. Drainage areas should always be verified for accuracy.
- 30 **River Basin** - Specify River Basin
- 31 **Character** - Specify the character of the drainage area, e.g., Region 3-Sand Hills, rural, urban, etc.
- 32 **Stream Classification** - Specify any classifications listed in the NRTR, e.g., B, WS-II, NSW and any additional classification such as Tr, HQW, NSW, OWR
- 33 **Data on Existing Structure** - Specify existing structure detail. Bridges include the number of spans and length, type of structure, and pile type, shape, and width. Culverts include number of barrels, structure size, and type.
- 34 **Total Waterway Opening** - Specify total square foot of waterway opening for the existing Structure.
- 35 **Waterway Opening below 100yr WSEL** - Specify total square foot of waterway opening between 100yr WSEL and stream bed.
- 36 **Debris Potential** - Specify possible debris severity based on Inspectors rating of item 41 on the Bridge Inspection Record and Summary and observations made in the field such as large trees leaning on banks, debris build up on the bents, or foliage in existing structure.
- 37 **Data on Structures Up and Down Stream** - Specify distance up or down stream from proposed structure if relatively close (within 1000') otherwise list location by feature carried (eg. SR 1005), type of structure, number of spans, substructure information, and overall length if bridge; if culvert, number of barrels, size, and type. Include 6-digit bridge number, if in NCDOT inventory.

- 38 **Gage Station No.** - If available, report nearest gage station I.D. number.
- 39 **Period of Records** - Specify the stream gage periods of activity and total number of active years. (e.g., May 1974 to May 1981, 7 yrs.)
- 40 **Max. Discharge** - Specify the maximum discharge recorded by the stream gage.
- 41 **Date** - Specify the date of the maximum discharge recorded by the stream gage.
- 42 **Frequency** - Specify the frequency of the storm event for maximum discharge recorded by the stream gage.
- Historical Flood Information** - Record any the flood or overtopping events obtained from local residents, county maintenance or bridge inspectors, or other local individuals familiar with area. Also previous Bridge Inspection Reports, past Bridge Survey and Hydraulic Design Reports, or local news sources can be utilized to determine any flood or overtopping events. Record as much information as is available.
- 43 **Date** - Specify date of the flood event.
- 44 **Elev.** - Specify estimated WSEL of the flood event.
- 45 **Est. Freq.** - Specify the estimated storm event frequency of the flood event.
- 46 **Source-** Specify individual or source of flood event information.
- 47 **Period of Knowledge-** If information is from an individual, specify the total number of years the source has been acquainted with the bridge location.
- 48 **Allowable HW Elev.** - Specify the allowable HW elevation based on Chapter 9 Guidelines concerning allowable headwater, freeboard, FEMA compliance, etc. Provide justification.
- 49 **Normal Water Surface Elev.** - Specify the Normal WSEL (vegetation line) observed during the field inspection. If unavailable report WSEL during day of survey.
- 50 **Manning's n: Left** -Specify Manning's 'n' for the left overbank.
- 51 **Channel** - Specify Manning's 'n' for the channel.
- 52 **Right** - Specify Manning's 'n' for the right overbank.
- 53 **Source** - Specify source of Manning's 'n' value. (e.g., Flood Insurance Study or Field Observation)
- 54 **Flood Study** - Specify the type of Flood Insurance Study (FIS) the bridge crossing is within (e.g., Detailed, Limited). State 'Not in Flood Study' if crossing is not within a study.
- 55 **Flood Study 100yr Discharge** - Specify the FIS published BFE (100yr) discharge.
- 56 **WSEL with Floodway (or Non-Encroachment)** - Specify the FIS published Base Flood Elev. (100yr).
- 57 **WSEL without Floodway (or Non-Encroachment)** - Specify the FIS published Floodway Elevation
- 58 **@ River Station** - Specify the river station upstream of the bridge used to obtain 'With Floodway / With Non-Encroachment' and 'Without Floodway / Without Non-Encroachment' elevations.

- 59 **Hydrological Method** - Specify the Hydrological method used for the hydraulic design of the Structure, e.g., FEMA Discharges, USGS SIR 2014-5030.
- 60 **Hydraulic Design Method** - Specify the Hydraulic Design method used for design of the Structure, e.g. HEC-RAS 4.1.0, HDS-5.
- 61 **Design Tailwater** -Specify tailwater for each frequency
- 62 **Culvert Hydraulic Design Computations** – Use either HDS-5 methodology table or HEC-RAS output table.

Size & Type	Q (c.f.s.)	K _e	Inlet Control		Outlet Control						Remarks
			HW/D	H.W. (ft.)	dc	$\frac{dc+D}{2}$	h _o	H	LS _o	H.W. (ft.)	

INV. IN EL. = ?, INV. OUT EL. = ?										
SIZE & TYPE: ?			@STATION ?, APPROX. ? UPSTREAM OF CULVERT.							
FREQUENCY	Q (cfs)	Inlet Control			Outlet Control		Remarks			
		HW/D	H.W.	WSEL	H.W.	WSEL				
10 YR	?	?	?	?	?	?				
50 YR	?	?	?	?	?	?				
100 YR	?	?	?	?	?	?				
500 YR	?	?	?	?	?	?				

- 63 **Total Proposed Waterway Opening** - Specify total square feet of waterway opening provided in structure.
- 64 **Outlet Velocity (V₁₀)** - Specify the outlet velocity for the 10yr event. To ensure this number is accurately accounting for channel stability requirements, use partial depth velocity.
- 65 **Natural Channel Velocity (V₁₀)** - Specify the natural channel velocity for the 10yr event.
- 66 **Required Outlet Protection** - If needed, specify type (e.g., "Class I rip rap along banks only" or "Energy dissipator basin required, see detail" and provide detail and quantity inside report. If none required, state "none required".
- 67 **State Floodway Compliance Type** – Specify the SFC type (A, B, or C) or N/A
- 68 **Design Discharge** - Specify discharge for the design frequency.
- 69 **Frequency of Design Flood** - Specify the design frequency.
- 70 **Design High Water Elev.** - Specify the WSEL for the design frequency, round to tenth ft.
- 71 **Drainage Area** - Specify Drainage Area at stream crossing. Specify in Square miles if area is 1.0 Square miles or greater. Specify in Acres if less than 1 square mile. (Should match Item 28)

- 72 **Basic Flood Discharge** - Specify the discharge for the base flood (100yr event).
- 73 **Basic High Water Elev.** - Specify the WSEL for the base flood (100yr event), round to tenth ft.
- 74 **Overtopping Discharge** - Specify the discharge for the overtopping event.
- 75 **Frequency of Overtopping Flood** - Specify the overtopping frequency.
- 76 **Overtopping Flood Elev.** - Specify the WSEL for the overtopping event, round to tenth ft
- 77 **Note Location of Overtopping** - Specify the roadway overtopping location, e.g., left shoulder at STA. 15+69 -L- .
- 78 **WS EL. Taken @ River Station** - Specify the river station upstream of the bridge used to obtain the Hydraulic design quantities for the various discharges and WSELs.
- 79 **Discharge Equations used for Hydrological Method and FEMA Discharges** - Specify the method and equations used to calculate the various frequency discharges. Specify discharges used in the FIS.
- 80 **Additional Information and Computations** - Specify any additional information (e.g., TVA compliance, Datum adjustments) or other pertinent information related to the H&H design.
- 81 **Native Material Specification for Backfilling** – Note per Guidelines section 9.6.1.6.2
- 82 **NCDOT Performance Table** – Provide the WSEL to nearest tenth of a foot for each plan and frequency. Also, specify the station at the upstream face used to obtain the WSELs and specify the distance in feet the river station is from the Face of the Bridge
- 83 **FEMA Performance Table** – Provide the 100 yr. WSEL to nearest hundredths of a foot for each plan. Also, specify the station at the upstream face used to obtain the WSELs and specify the distance in feet the river station is from the Face of the Bridge