Solid Concrete Masonry
Segmental Retaining Wall (SRW)
Quality Control/Quality Assurance Program

June 1, 2013

A joint effort of the
North Carolina Department of Transportation
and the
Carolinas Concrete Masonry Association

(Revised: January 14, 2014)

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I GENERAL DESCRIPTION

The Segmental Retaining Wall (SRW) Quality Control/Quality Assurance Program is designed to give producers more responsibility for controlling the quality of material they produce and to utilize the quality control information they provide in the acceptance process by the North Carolina Department of Transportation (NCDOT). It requires producers to perform quality control sampling, testing and record keeping on materials they ship for use by the Department. Also, it requires the Department to perform quality assurance sampling, testing and record keeping confirming the performance of the producer's quality control plan (QC plan), as set forth herein.

It is the intent of this program that acceptance or rejection of material be based on the total program. 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. All materials used at the time of casting SRW Units must be from an NCDOT approved source.

Participation in this program does not relieve the producer of the responsibility of complying with all requirements of the *NCDOT Standard Specifications for Roads and Structures.*

II PROGRAM REQUIREMENTS

A. Basic Requirements

There are three basic requirements for approval:

- The plant must have an approved in-house quality control plan (QC plan).
- The plant must have an approved laboratory or have written approval to utilize an approved off-site laboratory.
- The plant must have a qualified quality control individual approved by the Department.

B. Quality Control Plan

The Producer must prepare a written QC plan. The plan may be generic, but must be site specific. The plan must indicate in detail how the Producer proposes to control the equipment, materials, and production methods to insure that the specified products are obtained. The plan must list the personnel responsible for production and quality control at the site and include information on how to contact each person. The following specific information must also be included in the plan:

- Identification of the physical location of the plant, to include a description of the property and reference to the nearest identifiable points such as highways and towns.
- The method of identification each lot of material during manufacture, testing, storage, and shipment. The method identifying each lot as intended for the Department usage.
- The method of sampling and testing raw materials and the finished product, including lot sizes and tests performed.
- A plan for dealing with quality control sample failures. This plan must include how the Producer plans to initiate an immediate investigation and how the Producer will implement corrective action to remedy the cause of the problem. A description of the method used to insure that products not meeting the Department specification are not shipped to the Department projects shall also be included.
- A loading and shipping control plan which includes a description of the methods by which the products are to be loaded and shipped for use by the Department, including safeguards against loading non-specification material.

Two copies of the Producer's written QC plan signed by the Plant Manager and an executed Brand Registration and Guarantee must be submitted with the original request for plant approval.

Two copies of an updated plant QC Plan must be submitted when changes are made to the plant's operations or ownership. A copy of the Plant's Ownership Update Form and Brand Registration and Guarantee must be submitted by **December 31st** of each year.

C. Approved Laboratory

The Program requires all tests to be conducted at laboratories approved by the Department. Each plant may establish and maintain its own laboratory for the performance of quality control testing. The Department will consider a producer's request to utilize an approved off-site laboratory. The Producer must make this request in writing and have written Department approval before testing material off site. The equipment required for an approved laboratory shall be sufficient to perform the required test procedures referenced by the ASTM specifications listed in Section 1040-4 of the *NCDOT Standard Specifications for Roads and Structures*. Records on instrument calibration and maintenance and sample collection and analysis must be maintained at the laboratory. The Department may require a demonstration of the equipment and procedures.

D. Quality Control Individual

All samples must be taken and tested by quality control individual(s) approved by the Department. The Producer must designate and identify the quality control individuals responsible at each plant. The designated quality control individual(s) will be responsible for overall quality control at the plant. The Department may require a demonstration of the equipment and procedures used by the individual.

E. Plant Approval Process

The approval process requires the Producer to write the State Materials Engineer at NCDOT, Materials and Tests Unit, 1801 Blue Ridge Road, Raleigh, NC27607, requesting that the plant be considered for acceptance into the program. It must identify the specific products that are to be produced. Two copies of the Producer's written QC plan signed by the Plant Manager must be submitted with the request for approval.

The Department will review the Producer's written QC plan and if it is approved an on-site inspection will be scheduled. This on-site inspection will verify that the Producer's QC plan has been implemented and is being followed and at least one qualified quality control individual is on-site and will be present when material is being produced or shipped under this program. The laboratory will be inspected and approved provided it meets the requirements and has not already been approved. If either the Producer's quality control plan or laboratory does not meet the Departments requirements, the Producer will be informed of the deficiencies in writing. Once the

deficiencies have been addressed, the Producer may again request approval in writing to the State Materials Engineer.

F. Certification for Participation in the QC/QA Program

If the Department has approved the Producer's written QC plan and the on-site inspection confirms that the initial program requirements have been met, The Department will issue a certificate, valid for one year, certifying the plant for participation in the program. At the end of the year, upon receipt of a Plant Ownership Update Form and an executed Brand Registration and Guarantee, the Department will conduct another on-site inspection and if all requirements are continuing to be met, the plant will be recertified for participation in the program for another year. Random inspections may be conducted at any time by the Department to verify compliance with the program requirements.

G. Notification of Production of Materials for use by the Department

The Producer shall notify the Department when production of material for use by the Department is scheduled. This notification shall be made to the Section Materials Specialist assigned to the plant by telephone, facsimile, or by electronic mail. The notification shall include a product technical detail sheet of the product(s) to be manufactured. Manufacture of products for the Department may commence as soon as the notification is made. The telephone numbers and electronic mail addresses for the Section Materials Specialists are given in Exhibit C.

H. Identification of QC/QA Product

The Producer will identify each cube of SRW Units with a label. The label shall have, as a minimum, the following information: company name, plant name, NCDOT number, date of manufacture, and QC lot number. A sample label shall be submitted with the Plant Ownership Update Form. The SRW Units shall be concrete gray in color unless specified otherwise, by Project Specifications or Project Special Provisions.

III SAMPLING AND TESTING PROCEDURES

A. Producer's Quality Control

The Producer's Quality Control (QC) samples are used by the Producer to monitor the quality of material being produced.

1. Standard Specifications - The Producer is to perform all sampling and testing in accordance with current specifications and procedures referenced in the *NCDOT Standard Specifications for Roads and Structures*.

2. Lot Size – QC lot sizes for SRW Units will be a continuous plant run, or 10,000 units, whichever occurs first.

3. Sampling –The approved plant quality control individual is to obtain a sample set from each lot. QC samples will consist of one sample set per lot. The sample set will consist of minimum of twelve (12) whole SRW Units.

The units shall be randomly sampled throughout the lot plant run, and such that samples are collected at the beginning of production, middle of production and end of production. For example, over a 5 hour product run units may be collected every 0.5 hour. Each unit will be marked with the day and time it was sampled. Every other unit will be used by the Producer for testing, while the corresponding sample will be retained for use by the department. Units shall be exposed to similar curing time and conditions during manufacture, and similar storage conditions after manufacture.

4. Freeze Thaw Testing- Freeze-thaw durable SRW units shall be tested in accordance with ASTM C1262 on a per mix design basis by a third party laboratory. If the mixture proportions change within an approved mix design (greater than 5%), or there is a material change at the facility, a new mix design and freeze-thaw data will be required. Freeze-thaw testing shall be conducted every three years.

5. Check Samples – If the test results for a sample indicate the material does not meet the specification requirements the Producer is to notify the department. In the event that the producer collected "additional" units during production these units may be used for check testing.

If the check sample indicates the material does not meet the specification requirements the Producer is to reject this lot or days production.

6. Test Procedures – Required test procedures shall be those required to meet the ASTM specifications referenced in Section 1040-4 of the *NCDOT Standard Specifications for Roads and Structures*.

7. Sample Identification and Record Keeping – It is critical that care be taken to properly label samples and record test data accurately.

Producer's Quality Control samples are to be identified corresponding to the sample date and time. SW##-MMDDYY. For example a sample collected on October 15, 2012 would be identified as SW20-101512.

All Quality Control test results are to be entered on an approved Quality Control Test Summary Form. The form shall indicate the Quality Control sample number, type, and quantity of material represented by the sample.

Quality Control and Quality Assurance data is to be retained by the Producer for at least one year and made available to the NCDOT upon request.

After a QC Test Summary Form is completely filled with data, a copy is to be given to the NCDOT Materials Inspector and the Producer is to retain the original. At such a time when it becomes possible for the Producer to transmit data directly into the Department's computerized database, or when the volume of QC tests does not result in at least one completely filled form per month, copies of these summaries are to be provided to the NCDOT at a minimum frequency of once per month.

B. NCDOT's Quality Assurance

The NCDOT's Quality Assurance (QA) samples are used by the NCDOT to verify the performance of the Producer's quality control plan.

1. Standard Specifications – The NCDOT shall perform all sampling and testing in accordance with current specifications and procedures referenced in the *NCDOT Standard Specifications for Roads and Structures.*

2. Lot Size – Quality Assurance lot sizes for Segmental Retaining Wall (SRW) units will be a maximum of 10,000 units, or fraction thereof.

3. Sampling – The NCDOT's Quality Assurance samples are to be taken randomly from each lot and tested by the NCDOT. QA samples will consist of one sample per lot. The sample will consist of Six (6) units.

4. QC/QA Comparison – If the results of the Quality Assurance sample are not in agreement with the results of the corresponding Quality Control sample, i.e. greater than five percent difference, an investigation will be made to determine the source of the difference. The investigation will include a review of the sampling and testing procedures and the testing equipment. The results of the investigation will be recorded on the Plant Quality Assurance Form.

5. Resolution System – In the event the above referenced investigation does not resolve the difference and the results of the next Quality Assurance sample are not in agreement with the corresponding Quality Control sample, a resolution system will be employed. The resolution system will require that two additional samples be taken from the same location in the stockpile, and in the same manner that the original Quality Control samples were taken by the approved plant individual. The samples are to be twice the number of the original samples. The samples are to be taken by NCDOT Materials and Tests Unit personnel and are to be shared, with one half to be tested by the Producer and the other half taken by the NCDOT to be tested at its facility. The average test results of the two Quality Control samples and the average test results of the two Quality Assurance samples are to be within the appropriate specification limits and the comparison of the two averages

is to be within five percent of each other. If these results are not within the appropriate specification limits and the comparison of the average test results is not within five percent, the material will be rejected. If rejected, the material is to be disposed of in a manner approved by the NCDOT.

If the test results indicate that the material is within the specification requirements but the comparison of the Quality Control samples and the Quality Assurance samples are not within five percent, the material will be accepted for use. However, the Producer, with the assistance of the Department, must determine the cause of the differences in test results. If the cause is determined to be improper sampling or testing procedures by the Producer or the Department, the appropriate approved individual will be notified. If the problem continues, the individual's approval may be revoked. If the cause is determined to be in the Producer's testing equipment or handling of the material, the Producer is to take corrective action. If this problem continues, the Producer's approval to provide material to NCDOT may be revoked. If the cause is determined to be in the Department's testing equipment, the Department will take corrective action.

6. Sample Identification and Record Keeping – It is critical that care be taken to properly label samples and record test data accurately.

The Quality Assurance samples are to be numbered with a number corresponding to the appropriate Quality Control sample. The number following "QA" is the number of the corresponding Quality Control split sample, QA-SRW1, QA-SRW6, etc.

C. Independent Assurance

Independent Assurance (IA) samples are to be taken at least annually from each production site by a representative of the Materials and Tests Unit. Samples may also be taken when supplying materials to an NCDOT project.

Exhibit A Sampling Procedures

Sampling Procedures

I. Introduction

In order to reduce the number of variables that affect the correlation between, it is important that all samples be obtained following procedures outlined in the *Standard Specifications*, or as outlined in this program.

II. Sampling Procedures

The Designated Quality Control Individual will obtain Quality Control Samples by randomly selecting SRW Units from the finished product line prior to placement of these SRW Units in the designated storage area. The Designated Quality Control Individual shall obtain Twelve (12) whole SRW Units for testing purposes. These samples shall be taken randomly 1 unit equally throughout the Lot of production. Each unit will be marked with the time or day that it was sampled. Six (6) SRW Units will be tested for compliance, the remaining Six (6) SRW Units will be held for check sampling by the plant if necessary or for NCDOT testing. The units selected for compliance testing shall consist of one SRW Unit from any pair.

The samples will be labeled appropriately and transported to an NCDOT approved testing laboratory.

III. Sample Retention

Samples taken by the Designated Quality Control Individual that are not used for testing will be retained for at least three months before being discarded.

Exhibit B Quality Control Test Forms

Quality Control Test Form

State of North Carolina
Department of Transportation - Materials and Tests Unit
Raleigh, North Carolina

Producer's Segmental Retaining Wall Quality Control Test Summary

Producer /Supplier: _____ **Date Sampled:** _____

Plant Name: _____ **Date Received:** _____

Material /Description: _____ **Date Tested:** _____

Sampled By: _____ **Tested By:** _____

Quantity Represented _____ **Freeze/Thaw Required?** No ☐ Yes ☐

Testing Laboratory: _____

Testing Laboratory Address: _____

	Overall Dimensions			Coupon Dimensions		
Sample Number	**Length (in.)**	**Width (in.)**	**Thickness (in.)**	**Length (in.)**	**Width (in.)**	**Thickness (in.)**
Average						

Sample Number	**Strength (PSI)**	**Density (lb/ft^3)**	**Absorption (%)**	**Freeze/Thaw (%)**
Average[a]				

Remarks: _____

a) Average of three units

_____
QC Individual

Quality Control Test Form

State of North Carolina
Department of Transportation - Materials and Tests Unit
Raleigh, North Carolina

Producer's Segmental Retaining Wall (SRW) Unit Quality Control Test Summary

Laboratory Number:			Date Sampled:		
Report on sample of:			Date Received:		
Identification marks:			Date Reported:		
Sampled by:			Furnished by:		
Sample taken from:			Location of supply:		
Quantity represented:					
Testing Laboratory:					
Address:					
Number	Length (in.)	Width (in.)	Thickness (in.)	P.S.I.	
Average					
Number	Length (in.)	Width (in.)	Thickness (in.)	Density	Abs. (#/ft^3)
Average					
Remarks:					

QC Individual

Exhibit C Contact Information for Notification Prior to Production of NCDOT Products

Prior to manufacturing Segmental Retaining Wall (SRW) Units for NCDOT use, the Producer shall contact the local Section Materials Specialist assigned to the plant. Manufacture of products for the NCDOT may commence as soon as the notification is made.

Section Materials Specialists

Name	DOT Divisions/Office Location	Phone number/email
Maria Long	Division 1 1740 Prison Camp Rd. Williamston, NC 27892	(252) 792-7627 FAX (252) 792-3308 mmlong@ncdot.gov
Milton Rudd	Division 2 490 Ward Blvd. Wilson, NC 27895	(252) 235-7069 FAX (252) 237-0804 mrudd@ncdot.gov
Dan Allen	Division 3 300 Division Dr. Wilmington, NC 28401	(910) 343-6356 FAX (910) 343-6460 danallen@ncdot.gov
Bobby Watkins	Division 4 490 Ward Blvd. Wilson, NC 27895	(252) 296-3576 FAX (252) 237-0804 bwatkins@ncdot.gov
Darrell Lumley	Division 5 1801 Blue Ridge Rd. Raleigh, NC 27607	(919) 329-4200 FAX (919) 733-8742 dlumley@ncdot.gov
Guy Christian	Divisions 6 500 Transportation Drive Fayetteville, NC 28301	(910) 485-7213 FAX (910) 437-0224 gchristian@ncdot.gov
Robert Fosque	Division 7 24A Battleground Ct. Greensboro, NC 27429	(336) 256-2567 FAX (336) 256-2569 rfosque@ncdot.gov

Rusty Tucker	Division 8 300 DOT Dr. Asheboro, NC 27204	(980) 521-0939 FAX (336) 318-4030 rtucker@ncdot.gov
Sandra Potts	Division 9 1580 Henderson Grove Church Rd. Salisbury, NC 28147	(704) 636-3367 FAX (704) 636-3368 spots@ncdot.gov
Mark Thomas	Division 10 12033B E. Independence Blvd. Matthews, NC 28105	(704) 847-1314 FAX (704) 847-0136 markthomas@ncdot.gov
Tracy Church	Divisions 11 PO Box 250 North Wilkesboro, NC 28659	(336) 903-9105 FAX (336) 667-5919 tchurch@ncdot.gov
Charles Bullock	Division 12 840 Wallace Grove Dr. Shelby, NC 28150	(704) 480-5472 FAX (704) 480-5476 cbullock@ncdot.gov
Rob Rhymer	Division 13 P. O. Box 128 Asheville, NC 28802	(828) 298-1516 FAX (828) 299-7914 rrhymer@ncdot.gov
Michael Wood	Division 14 4142 Haywood Rd. Mills River, NC 28759	(828) 891-1732 FAX (828) 891-5026 dmwood@ncdot.gov

Daniel I. (Dan) Miller, EI Quality Assurance Engineer 919-329-4200 dimiller@ncdot.gov	Samuel J. (Sam) Frederick, Quality Systems Engineer 919-329-4200 sjfrederick@ncdot.gov

Exhibit D Sample Brand Registration and Guarantee

Each plant will submit copies of an annual brand registration and guarantee prior to December 31, of each calendar year to the State Materials Engineer.

[COMPANY NAME]
[COMPANY ADDRESS]
[COMPANY TELEPHONE NUMBER]

BRAND REGISTRATION AND GUARANTEE
FOR SOLID CONCRETE MASONRY BRICK AND BLOCK MATERIALS

This guarantee verifies that Segmental Retaining Wall (SRW) Units furnished by [COMPANY NAME] conforms to the requirements of the Segmental Retaining Wall (SRW) Unit Quality Control/Quality Assurance Program, and the NCDOT Standard Specifications, for the material specified in the contract or purchase order.

Any material found not in conformance will be replaced at no cost to the North Carolina Department of Transportation.

DATE:_____ BY:_____

NOTARY:

Exhibit E Plant Ownership Update Form

Plant Ownership Update Form

Name of
Company: _____

Corporate Address and Contact Information:

Street: _____
Street: _____
City: _____ State: _____ ZIP _____
Telephone: _____ FAX: _____
Email: _____
Name and Title of Contact: _____

Name of Plant: _____
NCDOT Plant SW
Number: _____ _____

Plant Mailing Address and Contact Information:

Street: _____
Street: _____
City: _____ State: _____ ZIP _____
Telephone: _____ FAX _____
Telephone: _____
Email: _____
Name and Title of Contact: _____

Plant Physical Address:

Street: _____

Street: _____

City: _____ State: _____ ZIP _____

Driving Directions from Major Landmark: _____

_____

_____

Plant Personnel Responsible for Quality:

	Name	Title	Cert. Number[1]
1)			
2)			
3)			
4)			
5)			

The Quality Control Plan for this Plant HAS been revised since it was YES/NO NCDOT Approved?

If YES, attach copy of current Quality Control Plan to this document and submit for review.

I certify that the foregoing entries are correct.

Signature _____

Title: _____

Date: _____

[1] List NCDOT assigned Technician Certification Number if applicable.

Exhibit F Testing Procedures

Testing Procedures

Test Segmental Retaining Wall (SRW) units in accordance with ASTM C140.

The option to cut the block as described within ASTM C140 shall be utilized and the preparation methods as described within the specification will be utilized. The block will be cut in accordance to ASTM C140. One half is to be tested for absorption and the other half is to be tested for compressive strength.

For absorption, test in accordance with ASTM C140.

For compressive strength, test in accordance with ASTM C140.

The Units will be air dried for 48 hours before capping.

Freeze-thaw durable SRW units shall be tested in accordance with ASTM C1262 on a per mix design basis by a third party laboratory. If the mixture proportions change within an approved mix design (greater than 5%), or there is a material change at the facility, a new mix design and freeze-thaw data will be required. Freeze-thaw testing shall be conducted every three years.

Exhibit G Photos of SRW Units

Exhibit H Example Shipping Tag

The Producer will identify each cube of SRW Units with a label. The label shall have, as a minimum, the following information:

- Company Name
- Plant Name
- NCDOT Plant ID
- Date of Manufacture
- QC Lot Number