Section _____

FABRIC FORMED CONCRETE
EROSION CONTROL LINING SYSTEM SPECIFICATION

PART 1: GENERAL

1.01 Scope of Work

The Contractor shall furnish all labor, materials, equipment, and incidentals required and perform all operations in connection with the installation of the fabric formed concrete erosion control lining systems in accordance with the lines, grades, design, and dimensions shown on the Contract Drawings and as specified herein.

1.02 Description

The work shall consist of installing an unreinforced concrete lining by positioning specially woven, double-layer synthetic forms on the surface to be protected and filling them with a pumpable fine aggregate concrete (structural grout) in such a manner as to form a stable lining of required thickness, weight and configuration.

1.03 Referenced Documents

A. American Society for Testing and Materials (ASTM)

1.	ASTM D 5261	Test Method for Measuring Mass per Unit Area of Geotextiles
2.	ASTM D 5199	Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
3.	ASTM D 4595	Test Method for Tensile Properties of Geotextiles by the Wide Width Strip Method
4.	ASTM D 4632	Test Method for Breaking Load and Elongation of Geotextiles (Grab Method)
5.	ASTM D 4533	Standard Test Method for Trapezoidal Tearing Strength of Geotextiles
6.	ASTM D 4751	Test Method for Determining Apparent Opening Size for a Geotextile
7.	ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
8.	ASTM D 4759	Practice for Determining the Specification Conformance of Geotextiles
9.	ASTM D 4354	Practice for Sampling of Geotextiles for Testing
10.	ASTM D 4884	Test Method for seam Strength of Sewn Geotextiles
11.	ASTM D 4873	Standard Guide for Identification, Storage, and Handling of Geotextiles
12.	ASTM C 939	Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
13.	ASTM C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
14.	ASTM C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
15.	ASTM C 150	Standard Specification for Portland Cement
16.	ASTM C 33	Standard Specification for Concrete Aggregates
17.	ASTM C 618	Standard Specification for Coal Fly Ash and Calcined Natural Pozzolan for Use in Concrete
18.	ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
19.	ASTM C 260	Standard Specification for Air-Entraining Admixtures for Concrete

1.04 Submittal

A. The Contractor shall submit to the Engineer all manufacture's full-scale flume hydraulic testing and calculations in support of the proposed fabric formed concrete lining system and geotextile.

B. The Contractor shall furnish the manufacturer's certificates of compliance for the fabric formed concrete lining. The Contractor shall also furnish the manufacturer's specifications, literature, shop drawings for the layout of the lining, and any recommendations, if applicable, that are specifically related to the project.

C. Alternative materials may be considered. Such materials must be pre-approved in writing by the Engineer prior to the bid date. Alternative material packages must be submitted to the Engineer a minimum of fifteen (15) days prior to the bid date. Submittal packages must include, as a minimum, the following:

1. Full-scale laboratory testing and associated engineering calculations quantifying the hydraulic capacity of the proposed fabric formed concrete lining system in similar conditions to the specified project.

2. Material testing reports prepared by a certified geotextile laboratory attesting to the alternative material's compliance with this Specification.

Table 1.0 FILTER POINT (FP) CONCRETE LININGS								
Physical Properties	**Units**	**FP220**	**FP300**	**FP400**	**FP600**	**FP800**	**FP1000**	**FP1200**
Average Thickness	in	2.2	3.0	4.0	6.0	8.0	10.0	12.0
Mass Per Unit Area	lb/ft^2	25	34	45	68	90	113	135
Filter Point Spacing	in	5.0	6.0	8.0	10.0	12.0	14.0	16.0
Area Per Filter Point	in^2	2.0	2.0	2.0	6.3	6.3	12.2	12.2
Perimeter Per Filter Point	in	6.5	6.5	6.5	11	11	15	15
Hydraulic Design Properties								
Shear Resistance	lb/ft^2	11	15	20	30	40	50	60

PART 2: PRODUCT

2.1 General - Fabric Formed Concrete Lining

A. Fabric formed concrete lining(s) shall be Filter Point (FP) type and have a finished average thickness of (*see Table 1.0*) inches (mm), a nominal mass per unit area of (*see Table 1.0*) lb/ft^2 (kg/m^2), and a deeply cobbled surface appearance with cross shaped filter points on approximately (*see Table 1.0*) inch (mm) spacing when measured along the diagonal. The shear resistance of the concrete lining shall be (*see table 1.0*) lb/ft^2 (kg/m^2).

2.2 Fabric Forms

A. The fabric forms for casting the concrete lining(s) shall be as specified, HYDROTEX® Filter Point (see Note A) fabric forms as manufactured by Synthetex, LLC; 4151 Ashford Dunwoody Road, Suite 510, Atlanta, Georgia 30319 Tel: 800.253.0561 (770.399.5051); or approved equal. The fabric forms shall be composed of synthetic yarns formed into a woven fabric. Yarns used in the manufacture of the fabric shall be composed of polyester. Forms shall be woven with a minimum of 50% textured yarns (by weight). Partially-oriented (POY), draw-textured, and/or staple yarns shall not be used in the manufacture of the fabric. Each layer of fabric shall conform to the physical, mechanical and hydraulic requirements listed in Table 2.0. The fabric forms shall be free of defects or flaws which significantly affect their physical, mechanical, or hydraulic properties.

Note A: The engineer shall indicate the Filter Point Lining size required (see Table 1.0). Example: FP400.

Table 2.0 PROPERTY REQUIREMENTS – FILTER POINT (FP) FABRIC [1, 2]			
	Test Method	**Units**	**Values**
Physical Properties			
Composition of Yarns			Polyester
Mass Per Unit Area (double-layer)	ASTM D 5261	oz/yd^2 (g/m^2)	11.3 (319)
Thickness	ASTM D 5199	mils (mm)	25 (0.6)
Mill Width		in (m)	83 (2.1)
Mechanical Properties			
Wide-Width Strip Tensile Strength	ASTM D 4595		
MD		lbs (kN/m)	295 (51.7)
TD		lbs (kN/m)	269 (45.7)
Elongation at Break	ASTM D 4595		
MD		%	13
TD		%	13
Grab Tensile Strength	ASTM D 4632		
MD		lbs/in	310 (54.3)
TD		lbs/in	228 (39.9)
Elongation at Break	ASTM D 4632		
MD		%	23
TD		%	20
Trapezoidal Tear Strength	ASTM D 4533		
MD		lbs(N)	125 (556)
TD		lbs (N)	105 (467)
Hydraulic Properties			
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Standard Sieve (mm)	16 (1.18)
Permittivity	ASTM D 4491	sec^{-1}	2.4
Flow Rate	ASTM D 4491	gal/min/ft^2 (l/min/m^2)	180 (7330)
Flow Rate through Filter Point	ASTM D 4491	gal/min/ft^2 (l/min/m^2)	7 (285)

Notes:

1. Conformance of fabric to specification property requirements shall be based on ASTM D 4759, “Practice for Determining the Specification Conformance of Geotextiles.”
2. All numerical values represent minimum average roll values (i.e., average of test results from any sample roll in a lot shall meet or exceed the minimum values). Lots shall be sampled according to ASTM D 4354, “Practice for Sampling of Geosynthetics for Testing.”

B. Fabric forms shall consist of double-layer woven fabric joined together by spaced, interwoven filter points to form a concrete lining with a deeply cobbled surface appearance. Filter points shall be formed by interweaving the double-layer fabric to form water permeable drains and attachment points for the control of concrete lining thickness. The interweaving of the fabric layers shall form an area of double density, high strength, single-layer fabric with an area of (*see Table 1.0*) in^2 (cm^2) and a perimeter of (*see Table 1.0*) inches (mm). All filter points shall be cross shaped and shall have twill weave centers designed to function as drains to relieve hydrostatic uplift pressure.

C. Mill widths of fabric shall be a minimum of 84 inches (2.13 m). Each selvage edge of the top and bottom layers of fabric shall be reinforced for a width of not less than 1.35 inches (34 mm) by adding a minimum of 6 warp yarns to each selvage construction. Mill width rolls shall be cut to the length required, and the double-layer fabric separately joined, bottom layer to bottom layer and top

layer to top layer, by means of sewing thread, to form multiple mill width panels with sewn seams on not less than 80 inch (2.03 m) centers.

D. All factory-sewn seams shall be downward facing as shown on the Contract Drawings. All seams sewn in the factory shall be not less than 100 lbf/in (17.4 kN/m) when tested in accordance with ASTM D 4884. All sewn seams and zipper attachments shall be made using a double line of U.S. Federal Standard Type 401 stitch. All stitches shall be sewn simultaneously and be parallel to each other, spaced between 0.25 inches (6 mm) to 0.75 inches (19 mm) apart. Each row of stitching shall consist of 4 to 7 stitches per inch (per 25.4 mm). Thread used for seaming shall be nylon and/or polyester.

E. Baffles shall be installed at predetermined mill width intervals to regulate the distance of lateral flow of fine aggregate concrete. The baffle material shall be nonwoven filter fabric. The grab tensile strength of the filter fabric shall be not less than 90 lbf (400 N) when tested in accordance with ASTM D 4632.

F. The fabric forms shall be kept dry and wrapped such that they are protected from the elements during shipping and storage. If stored outdoors, they shall be elevated and protected with a waterproof cover that is opaque to ultraviolet light. The fabric forms shall be labeled as per ASTM D 4873, "Guide for Identification, Storage and Handling of Geosynthetic Rolls."

G. The Contractor shall submit a manufacturer's certificate that the supplied fabric forms meet the criteria of these Specifications, as measured in full accordance with the test methods and standards referenced herein. The certificates shall include the following information about each fabric form delivered:

Manufacturer's name and current address;
full product name;
style and product code number;
form number(s);
composition of yarns; and
manufacturer's certification statement.

2.3 Fine Aggregate Concrete

A. Fine aggregate concrete shall consist of a proportioned mixture of Portland cement, fine aggregate (sand) and water. The consistency of the fine aggregate concrete delivered to the concrete pump shall be proportioned and mixed as to have an efflux time of 9-12 seconds when passed through the 0.75 inch (19 mm) orifice of the standard flow cone that is described in ASTM C 939. Pozzolan, fluidifier or pumping aid conforming to this Specification may be used at the option of the Contractor. The mix shall exhibit a compressive strength of 2,000 lb/in^2 (13.8 MPa) at 28 days, when made and tested in accordance with ASTM C 31 and C 39.

B. Portland cement shall conform to ASTM C 150, Type I or Type II.

C. Fine aggregate shall conform to ASTM C 33, except as to grading. Aggregate grading shall be reasonably consistent and shall not exceed the maximum size which can be conveniently handled with available pumping equipment.

D. Water for mixing shall be clean and free from injurious amounts of oil, acid, salt, alkali, organic matter or other deleterious substances.

E. Pozzolan, if used, shall conform to ASTM C 618, Class C, F or N.

F. Plasticizing and air entraining admixtures, if used, shall conform to ASTM C 494 and ASTM C 260, respectively.

2.4 Filter Fabrics

A. The geotextile filter fabrics shall be composed of synthetic fibers or yarns formed into a nonwoven or woven fabric. Fibers and yarns used in the manufacture of filter fabrics shall be composed of at least 85% by weight of polypropylene, polyester or polyethylene. They shall be formed into a

network such that the filaments or yarns retain dimensional stability relative to each other, including selvages. These materials shall conform to the physical requirements listed in Table 3.0 of these Specifications. The geotextile shall be free of defects or flaws which significantly affect its mechanical or hydraulic properties.

B. The geotextile filter fabric must be permitted to function properly by allowing relief of hydrostatic pressure; therefore fine soil particles shall not be allowed to clog the geotextile.

C. The geotextile filter fabric shall be kept dry and wrapped such that they are protected from the elements during shipping and storage. If stored outdoors, they shall be elevated and protected with a waterproof cover that is opaque to ultraviolet light. The fabric forms shall be labeled as per ASTM D 4873, "Guide for Identification, Storage and Handling of Geosynthetic Rolls."

Table 3.0 PROPERTY REQUIREMENTS – FILTER FABRIC

	Test Method	**Units**	**Minimum Value**
Mechanical Properties			
Grab Tensile Strength	ASTM D 4632	lbf/in	90 (in any principal direction)
Elongation at Break	ASTM D 4632	%	50 max. (in any principal direction)
Trapezoidal Tear Strength	ASTM D 4533	lbf	40 (in any principal direction)
Puncture Strength	ASTM D 4833	lbs	55 (in any principal direction)
CBR Puncture Strength	ASTM D 6241	lbs	250 (in any principal direction)
Hydraulic Properties			
Apparent Opening Size (AOS)	ASTM D 4751	US Sieve	60 max.
Permittivity	ASTM D 4491	sec^{-1}	1.0
Flow Rate	ASTM D 4491	$gal/min/ft^2$	50

Notes:

1. Conformance of fabric to specification property requirements shall be based on ASTM D 4759, "Practice for Determining the Specification Conformance of Geotextiles."
2. All numerical values represent minimum average roll values (i.e., average of test results from any sample roll in a lot shall meet or exceed the minimum values). Lots shall be sampled according to ASTM D 4354, "Practice for Sampling of Geosynthetics for Testing."

PART 3.0: DESIGN REQUIREMENTS

3.1 Certification (Open Channel Flow)

A. Fabric formed concrete lining will only be accepted when accompanied by documented hydraulic performance characteristics that are derived from tests under controlled flow conditions. Test guidelines shall conform to testing protocol as documented in "Hydraulic Stability of Fabric Formed Concrete Lining and Mat Systems During Overtopping Flow."

B. The average thickness, mass per unit area and hydraulic resistance of each concrete lining shall withstand the hydraulic loadings for the design discharges along the structure(s). The stability analysis for each concrete lining shall be accomplished using a factor-of-safety methodology. A minimum factor of safety of 1.5 shall be required.

C.

3.2 Performance (Open Channel Flow)

A. The Contractor shall provide to the Engineer calculations and design details, provided by the manufacturer or a professional engineer, attesting to the suitability of each fabric formed concrete lining for the purpose contemplated. Each concrete lining shall be accepted only when

accompanied by the documented hydraulic performance characteristics derived from tests performed under controlled flow conditions.

PART 4.0: CONSTRUCTION AND INSTALLATION REQUIREMENTS

4.1 Site Preparation

A. Areas on which fabric forms are to be placed shall be constructed to the lines, grades, contours, and dimensions shown on the Contract Drawings. All obstructions such as roots and projecting stones shall be removed. Where such areas are below the allowable grades, they shall be brought to grade by placing compacted layers of select material. The thickness of layers and the amount of compaction shall be as specified by the Engineer. Where required by the Contract Specifications, soft and otherwise unsuitable subgrade soils shall be identified, excavated and replaced with select materials in accordance with the Contract Specifications.

B. Excavation and preparation of aprons as well as anchor, terminal or toe trenches shall be done in accordance with the lines, grades, contours, and dimensions shown on the Contract Drawings.

C. Immediately prior to placing the fabric forms, the prepared area shall be inspected by the Engineer, and no forms shall be placed thereon until the area has been approved.

4.2 Fabric Form Placement

A. A filter fabric shall be placed on the graded surface approved by the Engineer.

B. Fabric forms shall be placed over the filter fabric and within the limits shown on the Contract Drawings. Anchoring of the fabric forms shall be accomplished through the use of anchor, terminal and toe trenches.

C. Adjacent fabric forms shall be joined before filling with fine aggregate concrete by field sewing or zippering the two bottom layers of fabric together and the two top layers of fabric together. All field seams shall be made using two lines of U.S. Federal Standard Type 101 stitches. All sewn seams shall be downward facing, and all zipper seams shall be fastened as shown on the Contract Drawings, except with the approval of the Engineer.

D. When conventional joining of fabric forms is impractical or where called for on the Contract Drawings, adjacent forms may be overlapped a minimum of 3 ft (1 m) to form a lap joint, pending approval by the Engineer. Based on the predominant flow direction, the downstream edge of the form shall overlap the upstream edge of the next form. In no case shall simple butt joints between forms be permitted.

E. Expansion joints shall be provided as shown on the Contract Drawings, or as specified by the Engineer.

F. Immediately prior to filling with fine aggregate concrete, the assembled fabric forms shall be inspected by the Engineer, and no fine aggregate concrete shall be pumped therein until the fabric seams have been approved. At no time shall the unfilled fabric forms be exposed to ultraviolet light (including direct sunlight) for a period exceeding five days.

4.3 Fine Aggregate Concrete Placement

A. Following the placement of the fabric forms, small slits shall be cut in the top layer of the fabric form to allow the insertion of the filling pipe at the end of the fine aggregate concrete pump hose. These slits shall be of the minimum length to allow proper insertion of the filling pipe. Fine aggregate concrete shall be pumped between the top and bottom layers of fabric, filling the forms to the recommended thickness and configuration.

B. Fine aggregate concrete shall be pumped in such a manner that excessive pressure on the fabric forms and cold joints are avoided. A cold joint is defined as one in which the pumping of the fine

aggregate concrete into a given form is discontinued or interrupted for an interval of forty-five or more minutes.

C. Holes in the fabric forms left by the removal of the filling pipe shall be temporarily closed by inserting a piece of nonwoven fabric or similar material. The nonwoven fabric shall be removed when the concrete is no longer fluid and the concrete surface at the hole shall be cleaned and smoothed by hand. Foot traffic on the filled form shall be restricted to an absolute minimum for one hour after filling.

D. After the fine aggregate concrete has set, all anchor, terminal and toe trenches shall be backfilled and compacted, as specified by the Engineer.

PART 5: MEASUREMENT AND PAYMENT

The fabric formed concrete erosion control lining shall be measured by the number of square feet (square meters) computed from the payment lines shown on the Contract Drawings or from payment lines established in writing by the Engineer. This includes fabric forms, fine aggregate concrete, and filter fabric used in the aprons, overlaps, and anchor, terminal, or toe trenches. Slope preparation, excavation and backfilling, and bedding are separate pay items.

Hydrotex products are manufactured and sold by:

Synthetex, LLC
4151 Ashford Dunwoody Road
Suite 510
Atlanta, Georgia 30319
Tel: ...1.800.253.0561 or 770.399.5051
Fax: 770.394.5999
www.synthetex.com • e-mail: info@synthetex.com