CITY OF FORT WAYNE MASTER UPDATED: 03/12/2018

SECTION 32 05 19.19

GEOGRIDS FOR EXTERIOR IMPROVEMENTS

NTS: This Section includes information on geogrids for surface protection and to provide structural support to unimproved surfaces. Products covered are plastic matrix structures that are commonly square units or cells with void space to allow infiltration and vegetation growth. There are various application types for these surfaces, including temporary driving surfaces for erosion control or permanent driving surface installation, pipe outfall protection, lake shoreline protection etc. This section covers general installation requirements pavement and erosion control, edit as required based on project application.

These products can also be used as Channel Protection Systems or Erosion and Sedimentation Control and should be coordinated with 31 32 20 Channel Protection Systems and 01 57 13 Erosion and Sedimentation Control respectively. Depending on project specific needs, careful coordination between the other Sections of the project manual is necessary.

1. GENERAL
	1. DESCRIPTION
		1. This section includes providing all material, labor, tools and equipment for installation of geogrids as shown in the Contract Documents and as specified in this Section.

NTS: Include at (--1--) type of system that should be used for surface protection.

* + 1. The (--1--) System shall be used for surface protection.

NTS: List below only sections covering products, construction and equipment that a user might expect to find in this section, but are specified elsewhere. Do not list administrative and procedural Division 01 sections. Insert at (--1--) the number and name of any referenced sections.

* + 1. Related Sections:
			1. Section 03 00 05, Concrete.
			2. Section 31 00 05, Trenching and Earthwork.
			3. Section 31 05 19, Geosynthetics for Earthwork.
			4. Section (--1--).

NTS: Section “1.2” is to be included if project is bid on unit price basis. Section to be deleted or revised if project is to be bid on lump sum basis.

NTS: Adjust Section “1.2” below for additional work item numbers as needed. Delete unused work items.

* 1. MEASUREMENT AND PAYMENT
		1. Surface Protection
			1. Work Item Title and Number

**32 05 19.19-A GeoRunner System**

 **32 05 19.19-B GeoGrid System**

 **32 05 19.19-C GeoTerra System**

 **32 05 19.19-D Flexamat System**

* + - 1. The quantity of surface protection systems installed shall be per the square foot of successfully installed protection systems.
			2. Payment shall constitute full compensation for laying and securing surface protection system according to the Contract Documents.
			3. These Work items shall include all costs to furnish all labor, materials, tools, and equipment, both permanent and temporary, to install the surface protection system as shown and specified. The Work includes, but is not limited to, surface protection surface treatment placement, required anchoring and jointing systems, infill material, infill material installation, surface preparation, restoration/replacement of all disturbed items not included under other Work items, protection of existing utilities and structures, incidentals for performing all Work as specified unless otherwise outlined as a separate Work item.
	1. REFERENCES

NTS: Retain applicable standards and add others as required.

* + 1. American Society of Testing and Materials (ASTM)
			1. ASTM D 1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique.
			2. ASTM D 1693 – Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
			3. ASTM D 5199 – Standard Test Method for Measuring Nominal Thickness of Geosynthetics.
	1. SUBMITTALS

NTS: Retain applicable submittals and add others as required.

* + 1. Action Submittals: Submit the following:
			1. Product Data
				1. Submit surface protection system manufacturer's data, installation instructions, and dimensions.
			2. Shop Drawings
				1. Submit Manufacturer’s shop drawings and section layout for surface protection system.
			3. Samples
				1. Submit Manufacturer’s product samples.
		2. Informational Submittals: Submit the following:
			1. Qualifications Data
				1. Certifying the installer is experienced in the installation of the specified products.
				2. Qualifications of Manufacturer’s field representative certifying the field representative is experienced in the installation of the specified products.

NTS: Delete certificates below if a cellular confinement system is not used.

* + - 1. Certificates
				1. Manufacturer's certification of polyethylene used to make cellular confinement system including;

Manufacturer's certification of percentage of carbon black.

Resin manufacturer's certification of polyethylene density and environmental stress crack resistance (ESCR).

* + - 1. Source Quality Control
				1. As requested, Submit Manufacturer’s certification of compliance to all applicable testing procedures and related specifications. Request for certification shall be submitted no later than the date of order placement.
		1. Closeout Submittals: Submit the following:
			1. Warranty Documentation
				1. Submit written warranty, signed by Contractor and installer, as specified.
	1. QUALITY ASSURANCE
		1. The geogrid system material shall be provided from a single Manufacturer for the entire project.
		2. The Manufacturer shall have a minimum of 10 years’ experience producing geogrid systems.
		3. Pre-Installation Meeting: Prior to installation of any materials, conduct a pre-installation meeting to discuss the scope of work and review installation requirements. The pre-installation meeting shall be attended by all parties involved in the installation of the geogrid system.
		4. Manufacturer's Field Representative Qualifications:
			1. Manufacturer shall provide a qualified field representative on site at the start of construction to ensure the surface protection system is installed in accordance with the Contract Documents.
			2. Manufacturer’s field representative shall have a minimum 5 years installation experience with the specified products in the specified application.
	2. DELIVERY, STORAGE, AND HANDLING
		1. Material delivery, storage and handling must conform to requirements in Contract Documents. Refer to Section 01 65 00 Product Delivery Requirements and Section 01 66 00 Product Storage and Handling Requirements.

NTS: Various products are listed below coordinate the products and locations with the Drawings. Delete products not required for project.

1. PRODUCTS

NTS: Article “2.1” below contains specifications for Geoweb cellular confinement systems, this product has many different applications, including slope armoring, channel storage area and driving surface. Careful editing of the materials and installation requirements is needed based on the project specific application. Include the material and installation information in other sections as required. The product is specified in Section 31 32 20- Channel Protection Systems, the installation requirements are different. If project required both applications, coordinate between each Section.

* 1. CELLULAR CONFINEMENT SYSTEM
		1. Cellular Confinement System General
			1. Cellular confinement system shall be polyethylene stabilized black and a perforated textured cell, and shall control shearing lateral and vertical movement of the surface. Carbon Black content shall be 1.5 to 2 percent by weight, through addition of a carrier with certified carbon black content.
			2. Cellular confinement system shall conform to the Drawings and the following:

|  |  |  |  |
| --- | --- | --- | --- |
| **Geoweb Property** | **Test Method** | **Unit** | **Min****Value** |
| Density | ASTM D 1505 | lb/ft3 | 58.4-60.2 |
| ESCR | ASTM D 1693 | hours | 5000 |
| Strip Sheet Thickness | ASTM D 5199 | mil | 50(-5%,+10%) |
| Textured Sheet Thickness | ASTM D 5199 | mil | 60 ± 6 |

* + 1. Cellular Confinement System Manufacturer:
			1. Geoweb by Presto Geosystems
			2. Or equal
		2. Base Materials
			1. Polyethylene Stabilized with Carbon Black
		3. Cell Properties
			1. Individual cells shall be uniform in shape and size when expanded.
			2. Individual cell dimensions (nominal) shall be dimensions ± 10%.

NTS: Retain one version of Paragraph “3” below, based on project specific requirements. Cell properties dimensions vary based on intended application and infill material. Coordinate with manufacturer for appropriate cell sizing and application.

* + - 1. GW20V-Cell Dimensions
				1. Length shall be 8.8 inches
				2. Width shall be 10.2 inches.
				3. Nominal area shall be 44.8 in2± 1%.

NTS: Insert at (--1--) the appropriate cell depth for project. Product is manufactured in 3, 4, 6 and 8-inch depths. Coordinate with supplier for application and availability:

* + - * 1. Nominal depth shall be (--1--)-inches.
			1. GW30V-Cell Dimensions
				1. Length shall be 11.3 inches
				2. Width shall be 12.6 inches.
				3. Nominal area shall be 71.3 in2± 1%.
		1. Strip Properties and Assembly
			1. Perforated Textured Strip/Cell
				1. Strip sheet thickness shall be 50 mil, minus 5 percent, plus 10 percent in accordance with ASTM D 5199. Determine thickness flat, before surface disruption.
				2. Polyethylene strips shall be textured surface with a multitude of rhomboidal (diamond shape) indentations.
				3. Textured sheet thickness shall be 60 mil plus or minus 6 mil.
				4. Indentation surface density shall be 140 to 200 per in2.
				5. Perforated with horizontal rows of 0.4 inch diameter holes.
				6. Perforations within each row shall be 0.75 inches on-center.
				7. Horizontal rows shall be staggered and separated 0.50 inches relative to hole centers.
				8. Edge of strip to nearest edge of perforation shall be a minimum of 0.3 inches.
				9. Centerline of spot weld to nearest edge of perforation shall be a minimum of 0.7 inches.
				10. A slot with a dimension of 3/8 inch x 1-3/8 inch is standard in the center of the non-perforated areas and at the center of each weld.
		2. Integral components:
			1. ATRA® Clip
				1. The ATRA Clip is a molded, high-strength polyethylene device available in standard (0.5 inch).
				2. ATRA clips can be installed as an end cap on standard (0.5 inch) steel reinforcing rods to form ATRA Anchors.
			2. ATRA® Key
				1. ATRA keys shall be constructed of polyethylene and provide a high strength connection.
				2. ATRA keys shall be used to connect cellular confinement panels together at each interleaf and end to end connection.

NTS: Select the desired stake anchorage and delete the others. No stake anchorage may be necessary. Use the Glass Fiber Reinforced Polymer anchors where there is a corrosion potential.

* + 1. Stake anchorage:
			1. ATRA® Anchors
				1. ATRA Anchors shall consist of standard (0.5 inch) or metric (10–12 mm) steel reinforcing rod with an ATRA® Clip attached as an end cap.
				2. ATRA anchors shall be assembled by inserting the ATRA Clip onto the reinforcing rod so that the end is flush with the top of the ATRA Clip. Prior to attaching the ATRA Clip, the reinforcing rod shall be free from all burrs and beveled.
				3. Stake length shall be as shown in the Drawings.
			2. ATRA® Glass Fiber Reinforced Polymer (GFRP) Anchors
				1. ATRA GFRP Anchors shall be pre-assembled units consisting of the ATRA Stake Clip inserted onto a GFRP stake.
				2. The glass reinforcement content shall be 75% minimum by weight and shall be continuous longitudinal filament.
				3. Polymer shall be vinyl ester, isophthalic polyester or other matrix material.
				4. The outer surface shall be sand coated and deformed by a helical wrap of glass.
				5. The minimum compressive strength shall be 95 kips in accordance with ASTM D 638.
				6. The anchor shall be non-magnetic, non-conducting and corrosion resistant.
				7. The anchor length and placement shall be as shown in the Drawings.
		2. Tendon anchorage:

NTS: Retain one Paragraph “a” below, select the desired tendon and corresponding break-strength and delete the others. Coordinate with the manufacturer as required for appropriate break strength based on project specific conditions. Note that if a greater break strength that 2,90lbf needs to be obtained the manufacture can supply three different strength woven Kevlar, with break strengths ranging from 2,000 to 4, 00lbf, include product requirements below based on project specific needs.

* + - 1. Tendon Type
				1. Woven Polypropylene - TPP‑55

Material shall be bright yellow, high-tenacity, industrial-continuous-filament, polypropylene yarn woven into a braided strap.

Minimum break strength shall be 1250 lbf

* + - * 1. Woven Polyester - TP‑67

Material shall be bright, high-tenacity, industrial-continuous-filament, polyester yarn woven into a braided strap.

Elongation shall be 9 to 15 percent at break.

Minimum break strength shall be 1506 lbf for TP-67.

* + - * 1. Woven Polyester -TP‑93

Material shall be bright, high-tenacity, industrial-continuous-filament, polyester yarn woven into a braided strap.

Elongation shall be 9 to 15 percent at break.

Minimum break strength shall be 2090 lbf for TP-93.

* + - 1. Tendon Anchorage
				1. The ATRA Tendon Clip is a molded, high-strength polyethylene device with a locking member and post with minimum pull-through of 420 lbs.
				2. The ATRA Tendon Clip is the recommended anchorage connection method for securing sections with tendons for additional system hold-down.

NTS: Insert at (--1--) below the appropriate geosynthetic material for aggregate separation between the concrete units and subbase. Typically, a non-woven geo synthetic used for aggregate separation is appropriate. The geosynthetic material requirements are specified in Section 31 05 19, which is referenced below, careful coordination and editing is required based on selected geosynthetic.

* + 1. Geo-synthetic Separation Layer:
			1. Provide the following (--1--) as specified in Section 31 05 19-Geosynthics for Earthwork.

NTS: Insert at (--1—) below the appropriate cell infill material based on the intended use. Typical infill materials are INDOT #53, #8, topsoil or concrete. Number 53 gravel contains fines that will compact a create more of a smooth driving surface, but will limit infiltration. Number 8 stone does not contain the fines, but creates void space for water storage. Edit article as required based on project specific requirements.

* + 1. Cell Infill Materials:
			1. Provide the following material for cell infill:
				1. (--1--)

NTS. Paragraph “2” below references Section 31 00 05, Trenching and Earthwork, based on selected infill material coordinate the material requirements with the Trenching and Earthwork Section. Edit or delete as required.

* + - 1. Cell infill material shall meet the requirements specified in Section 31 00 05, Trenching and Earthwork.
			2. Infill material shall be free of any foreign material.
			3. Infill material shall be free-flowing and not frozen when placed in the cellular confinement system sections.

NTS: If required, select the desired additional components and delete the others. Insert at (--1--) through (--4--) the project specific requirements. Reference and coordinate with the other Sections in the Project Manual.

A geotextile separation layer is typically recommended for separation between the native soil and infill material. Separation is important to prevent contamination and loss of shear strength of the infill material and to prevent punching or migration of the infill material into the subgrade. The geotextile may also be part of the design to provide additional support.

Additional subbase materials may be required under the Geoweb layer to support loading or for additional stormwater storage requirements.

A minimum surface wearing course of 2 inches is typically recommended to prevent trafficking directly on top of the Geoweb cell walls. If an asphalt or concrete surface is desired over the Geoweb, a minimum one inch separation layer of infill material shall be provided over the Geoweb to provide minor consolidation of the surface cover and to prevent contact of the asphalt or concrete with the Geoweb cell walls. Contact manufacturer for assistance

* + 1. Additional Components:
			1. Geotextile:
				1. (--1--)
			2. Subbase Material:
				1. (--2--)
			3. Surface Wearing Course:
				1. (--3--)
			4. Vegetation:
				1. (--4--)
		2. Source Quality Control - Cell Seam Strength Tests
			1. Minimum seam strengths are required by design and shall be reported in test results. Materials submitted with average or typical values will not be accepted. Written certification of minimum strengths must be supplied to the Engineer at the time of submittals.
			2. Short-Term Seam Peel-Strength Test
				1. Cell seam strength shall be uniform over full depth of cell.
				2. Minimum seam peel strength shall be 480 lbf for 6 inch depth
			3. Long-Term Seam Peel-Strength Test
				1. Conditions: Minimum of 7 days in a temperature-controlled environment that undergoes change on a 1 hour cycle from room temperature to 130 degrees F.
				2. Room temperature shall be in accordance with ASTM E41.
				3. Test samples shall consist of two, 4 inch wide strips welded together.
				4. Test sample consisting of 2 carbon black stabilized strips shall support a 160 pound load for test period.

NTS: The following turf reinforcement mat is called GeoRunner and is manufactured by Presto. And is a constructed polymer grid material that is lightweight and flexible and is intended for light duty traffic to protect the underlying surface from disturbance and erosion. Edit requirements as required based on project specific applications.

* 1. TURF REINFORCEMENT MAT (TRM)
		1. TRM Materials:
			1. Provide the following TRM:
				1. GeoRunner as manufactured by Presto Geoystems
				2. Or equal.
		2. Material Properties:
			1. Material shall be constructed of polymer.
			2. Color shall be green.
			3. Color shall be uniform throughout all units in a pallet.
			4. Mats shall provide corrosion and chemical resistance.
		3. Unit Dimensions:
			1. Nominal Width shall be 24 inches.
			2. Nominal Length shall be 48.75 inches.
			3. Nominal Depth shall be 0.5 inches.
			4. Nominal Area shall be 8 ft2.
			5. Nominal mesh openings shall be 0.84 inches square.
			6. Mesh open area shall be 55% of total area.
			7. Nominal weight shall be 8 pounds.

NTS: Edit or delete as required. Additionally, coordination location and spacing of anchoring accessories with the drawings.

* + 1. Accessories
			1. Connection Accessories:
				1. Nylon, X-mas tree rivets shall be used to secure the panels together on the short end (2 feet). Three rivets are required for each panel. The rivets shall be 0.312 inches thick by 1.163 inches long.
				2. Heat treated metal side clips are used to secure the panels together on the long end (4 feet). Two side clips are required for each panel to panel connection. The side clips shall be 22 gauge heat treated steel with zinc clear chromate plate.
			2. Earth Anchor:
				1. The earth anchor consists of Duckbill® anchor, 3/32 galvanized cable, ferrule, Gripple® and anchor brace. Duckbill anchor break strength shall be 300 lb.
				2. Four anchors shall be provided for each surface protection mat. Six anchors are required on the row of panels on the upstream/upslope end of the project.
				3. The anchors shall be located per Manufacturer’s instructions.
				4. The drive rod is used to engage and drive the Duckbill anchor head to the depth of the cable or until the desired resistance is achieved.

NTS: The product can be laid on top of the existing surface, or can be seeded or sod. Insert project specific finishes at (--1--) below. Delete if not required. Coordinate with Section 32 92 00- Lawns and Grasses.

* + 1. Finishing
			1. Provide (--1--), refer to Section 32 92 00- Lawns and Grasses.

NTS: The following structural mat is called GEOTERRA and is manufactured by Presto. And is a constructed polyethylene grid material that is lightweight and flexible and is intended for structural pervious paving. Edit requirements as required based on project specific applications.

* 1. OPEN STRUCTURAL MAT
		1. Structural Mat Materials:
			1. Provide the following:
				1. GEOTERRA as manufactured by Presto Geoystems
				2. Or equal.
		2. Material Properties:
			1. Material shall be constructed high-performance polyethylene.
			2. Color shall be black.
			3. Mats shall provide corrosion and chemical resistance.
		3. Unit Dimensions:
			1. Nominal Width shall be 3.15 feet.
			2. Nominal Length shall be 1.57 feet.
			3. Nominal Depth shall be 2 inches.
			4. Cell size shall be 3.1 inches x 3.2 inches.
			5. Nominal weight shall be 9.05 pounds.

NTS: Edit or delete as required. Additionally, coordination location and spacing of anchoring accessories with the drawings.

* + 1. Accessories
			1. Connection Accessories:
				1. Provide PadLoc® Connection Device to join the mats together.
			2. Earth Anchor:
				1. Provide GEOTERRA Earth Anchor 800-33 with 800 lbf resistance against pullout and (33 in) cable length.
				2. Earth anchor shall have a steel cable with a formed (stamped) steel anchor head at one end and a tensioning loop at the other end. A washer and cable stop move freely along the cable.

NTS: Insert at (--1--) below the appropriate geosynthetic material for aggregate separation between the units and subbase. Typically, a non-woven geo synthetic used for aggregate separation is appropriate. If the mat is required for high loading situations coordinate with the manufacturer for appropriate geosynthetic. The geosynthetic material requirements are specified in Section 31 05 19, which is referenced below, careful coordination and editing is required based on selected geosynthetic.

* + 1. Geo-synthetic Separation Layer:
			- 1. Provide the following (--1--) as specified in Section 31 05 19-Geosynthics for Earthwork.

NTS: The product can be laid on top of the existing surface, and if needed can be filled with top soil, or aggregate. Insert project specific infill at (--1--) below. Insert at (--2--) a section where the project specific cell infill material is identified. Delete if not required.

* + 1. Finishing
			1. Provide (--1--) to fill in the structural mat system cells. Refer to Section (--2--).

NTS: Flexamat consists of concrete shapes, locked together with a high strength, polypropylene geogrid. Flexamat can be used for boat ramps, bridge abutments, channel stabilization, detention basins, outlet stabilization, parking pads, and shoreline armoring.

* 1. TIED CONCRETE BLOCK MAT
		1. Structural Mat Materials:
			1. Provide the following:
				1. FLEXAMAT as manufactured by Motz Enterprises, Inc.
				2. Or equal.
		2. Material Properties:
			1. Tied concrete block mat shall be manufactured from individual concrete blocks tied together with high strength polypropylene bi-axial geogrid. Each block is tapered, beveled and interlocked and includes connections that prevent lateral displacement of the blocks within the mats when they are lifted for placement.
			2. Blocks
				1. Furnish blocks manufactured with concrete conforming to the cement requirements of ASTM C150 and to the aggregate requirements of ASTM C33. Meet a minimum compressive strength of 4,000 psi at 28 days. Furnish blocks that have a minimum weight of 3 lb. per block. Blocks shall be placed no further than 2 in. apart.
			3. Polypropylene Bi-axial Geogrid
				1. Provide revetment mat that is constructed of a high tenacity, low elongating, and continuous filament polypropylene fibers that is securely cast into and embedded within the base of the concrete blocks and obtains connection strength greater than that of the geogrid.

Polypropylene Geogrid shall have 2% carbon black for UV stabilization.

Polypropylene Geogrid shall have an Ultimate Tensile Strength of 2000 lb./ft.

NTS: Retain one version of Paragraph “4” below, based on project specific requirements. Backing material properties vary based on intended application and infill material. Coordinate with manufacturer for appropriate sizing and application.

* + - 1. Backing Material - Standard
				1. Erosion control blanket (ECB) consists of a specific cut of naturally seed free Great Lakes Aspen curled wood excelsior with 80% six-inch fibers or greater fiber length. It is of consistent thickness with fibers evenly distributed throughout the entire area of the blanket. The top and bottom of each blanket is covered with degradable polypropylene netting.
			2. Backing Material – Plus
				1. Erosion control blanket (ECB) consists of curled wood excelsior with 80% six-inch fibers or greater fiber length. It is of consistent thickness with fibers evenly distributed throughout the entire area of the blanket. The top and bottom of each blanket is covered with degradable polypropylene netting.
				2. Permanent non-degradable Turf Reinforcement Mat (TRM), consists of 100% post-consumer recycled polyester (green or brown bottles) with 80% five-inch fibers or greater fiber length. It is of consistent thickness with fibers evenly distributed throughout the entire area of the TRM. The top and bottom of each TRM is covered with heavy duty polypropylene net. Fibers are tightly crimped and curled to allow fiber interlock, and to retain 95% memory of the original shape after loading by hydraulic events. Fibers have a specific gravity greater than 1.0; therefore, the blanket will not float during hydraulic events.
			3. Backing Material – Filter Fabric
				1. Non-woven filter fabric backing.

NTS: Edit or delete as required. Flexamat is manufactured in standard widths of 4', 5.5', 8', 10', 12, & 16'. Insert at (--1--) required width. Lengths can be cut to order per project requirements. Stocked lengths are 30', 40', & 50'. 4' x 4' mats stacked on pallets are also available. Insert at (--2--) required length.

* + 1. Unit Dimensions:
			1. Width shall be (--1--) feet.
			2. Length shall be (--2--) feet.
			3. Concrete blocks shall be 6.5" x 6.5" x 2.25". There is 1.5" spacing between the blocks.
			4. Weight per square foot shall be 10 pounds.
1. EXECUTION
	1. EXAMINATION
		1. Verify site conditions are as indicated on the drawings. Notify the Engineer if site conditions are not acceptable. Do not begin preparation or installation until unacceptable conditions have been corrected.
		2. Verify layout of structure is as indicated on the drawings. Notify the Engineer if layout of structure is not acceptable. Do not begin preparation or installation until unacceptable conditions have been corrected.
	2. INSTALLATION OF THE CELLULAR CONFINEMENT SYSTEM – LOAD SUPPORT SYSTEM
		1. Prepare subgrade and install load support system in accordance with Manufacturer's recommendations.
		2. Subgrade Preparation:
			1. Excavate and shape foundation soils as indicated on the Drawings.
			2. Ensure foundation soil meets minimum strength requirements through proof rolling or other conventional method and is approved by the Engineer. If unacceptable foundation soils are encountered, excavate and replace with suitable quality material as directed by the Engineer.
			3. Compact to a minimum 95 percent Standard Proctor.

NTS: Delete Paragraph “4” below if a geotextile separation layer is not required.

* + - 1. Install non-woven geotextile separation layer on prepared surfaces ensuring required overlaps are maintained and outer edges of geotextile are buried at least 4-inches into the surrounding surface.
		1. Cellular Confinement Section Placement and Connection
			1. Place cellular confinement sections and verify all sections are expanded uniformly to required dimensions and that outer cells of each section are correctly aligned. Interleaf or overlap edges of adjacent sections. Ensure upper surfaces of adjoining cellular confinement sections are flush at joint and adjoining cells are fully aligned at the cell wall slot.
			2. Connect the cellular confinement sections with ATRA keys at each interleaf and end to end connection. Insert the ATRA key through the cell wall slot before inserting through the adjacent cell. Turn the ATRA key 90 degrees to lock the panels together.

NTS: Retain one paragraph “D” below based on the preferred anchorage method and delete the others. Listed below are common installation requirements for slope protection systems. Based on project conditions if a different installation method is preferred, coordinate with the manufacturer.

* + 1. Anchorage with ATRA and ATRA GFRP Anchors
			1. Position collapsed cellular confinement sections in place and partially drive appropriate anchors in the outer edge cells and expand sections into place. Partially drive appropriate anchors in the perimeter cells to keep sections fully expanded.
			2. With cellular confinement sections fully expanded, drive appropriate anchors so the arm of the ATRA Clip is through the internal slots in the cellular confinement cell wall and anchors do not protrude over the top of the cell wall.
			3. Anchorage pattern and stake length shall be as indicated on the Contract Documents.
		2. Anchorage with Tendons
			1. Position collapsed cellular confinement sections into place.
			2. Feed precut lengths of specified tendon material through the integral slots in cellular confinement cell walls before expanding individual sections into position. The number of tendons per section shall be in accordance with the Contract Documents. Connect the trailing edge of the tendons to ATRA Tendon Clips.
			3. Expand the cellular confinement sections and hold the sections open with temporary stakes, sandbags or stretcher frames.
			4. Install the ATRA Tendon Clips at the locations indicated on the Contract Documents.
			5. Hold the tendon and connect to each ATRA Tendon Clip. Refer to the Channel Installation Manual for ATRA Tendon Clip tie-off instructions.
		3. Anchorage with Tendons, ATRA or ATRA GFRP Anchors
			1. Position collapsed cellular confinement sections into place.
			2. Feed precut lengths of specified tendon material through the integral slots in cellular confinement cell walls before expanding individual sections into position. The number of tendons per section shall be in accordance with the Contract Documents. Connect the trailing edge of the tendons to appropriate anchors.
			3. Expand the cellular confinement sections and partially drive appropriate anchors in the perimeter cells and expand sections in place.
			4. Attach appropriate anchors to the tendons at locations as indicated on the Contract Documents.
			5. Drive appropriate anchors so the arm of the ATRA Clip is over the tendon, or the tendon is wrapped around the ATRA Clip head.
			6. Anchorage pattern and stake length shall be as indicated on the Contract Documents.

NTS: Retain one paragraph “E” below based on the required infill material and delete the other. The “Infill Placement” paragraph is intended for Topsoil, Aggregate and Engineered infill materials. Edit paragraphs as required based on project specific conditions.

* + 1. Infill Placement
			1. Place the specified aggregate infill with suitable material handling equipment.
			2. Infill material shall be free-flowing and not frozen when placed in the cellular confinement sections.
			3. Overfill cells with aggregate infill material. Limit the drop height of infill material to 3 feet to avoid damage or displacement of the cell wall.
			4. Level surface approximately 2 inches above cell walls. Maintain the 2 inch wear surface over the cellular confinement sections to prevent damage to the cell walls.
			5. Compact infill to a minimum of 95 percent Standard Proctor.
			6. Shape compacted surface to required elevation as indicated on the Drawings.

NTS: Paragraph “E” below references Section 03 00 05 – Concrete, include in Project manual as required. If project is using concrete as the infill material, coordinate Paragraph “E” below with the Concrete Section for required concrete material and finishes.

* + 1. Concrete Infill Placement
			1. Concrete shall be placed, finished and cured in accordance with Section 03 00 05- Concrete.
			2. Once placing operation commences, it shall be carried out as a continuous operation until a designated section is completed or as approved by the Engineer.
			3. Limit the drop height of concrete to 3 feet to prevent panel distortion. Elephant trunks and/or tremies shall be used to prevent free fall of concrete.
			4. Where concrete chutes are used, the end of the chute shall be baffled to prevent segregation of the concrete.
			5. The concrete shall be thoroughly compacted by means of an approved vibrator. The period of vibration shall not be less than 2 seconds nor more than 5 seconds at any one point.
			6. Concrete shall be flush with the top of the walls.
			7. Apply specified finish.
		2. Surface Treatment

NTS: Retain one version of Paragraph “1” below, delete the other. If planting vegetation is required coordinate with Section 32 90 00 – Planting.

* + - 1. Vegetation shall be as specified in Section 32 90 00 - Planting, and installed immediately after the infill is placed and protected with mulch.
			2. Surface protection shall be installed immediately after placement of the infill material and secured per the Manufacturer’s instructions.
	1. TURF REINFORCEMENT MAT (TRM) INSTALLATION
		1. General Installation
			1. Verify site conditions are as indicated on the drawings. Notify the Engineer if site conditions are not acceptable. Do not begin preparation or installation until unacceptable conditions have been corrected.
		2. Sub Grade Preparation
			1. Prepare sub grade as specified and install protection system in accordance with Manufacturer's instructions. No depressions should exist that can retain water.
			2. Excavate or fill foundation soils as required to elevations and dimensions as indicated on the Drawings or as directed by the Engineer.
			3. Ensure foundation soil meets specification requirements and is examined by the Engineer. If unacceptable foundation soils are encountered, excavate affected areas and replace these areas with suitable quality material as directed by the Engineer.

NTS: Delete paragraph “C” below if not required for project. If required coordinate with Section 32 92 00- Lawns and Grasses.

* + 1. Surface Treatment
			1. The specified surface treatment shall be installed immediately after the sub grade is prepared.
			2. The surface treatment shall be fertilized and watered in accordance with the Contract Documents.
			3. The TRM shall be placed after the surface treatment is installed and in accordance with Manufacturer’s instructions. TRMs will be secured by the anchors.
		2. Placement and Connection
			1. Verify all surface protection panels are installed correctly and in accordance with Manufacturer’s instructions.
			2. Adjacent units should not protrude above the desired surface elevation.
			3. The panels shall be placed with the long direction (4 foot length) in the direction of surface.
			4. Interconnect the 2 foot ends of adjoining sections by nesting the overlapping tabs and connect with 3 rivets in the pre-drilled holes.
			5. Interlock the 4 foot side connections and secure together with 2 side clips equally spaced.
			6. The mat protection system can be assembled in-place or pre-assembled at an off-site area and moved into place. Individual units may be used to join pre-assembled mats.
			7. The mats can be cut with a hand or power saw to custom fit contours and around obstructions.
		3. Anchoring
			1. If required, secure the mats to the surface with earth anchors.
			2. Provide 4 anchors per mat per Manufacturer’s instructions, with additional anchors to be placed at the high end of the slope.
			3. Engage the drive rod with the Duckbill anchor head and drive into the soil to the length of the tendon or until the desired resistance is achieved.
			4. Twist and remove the drive rod and slide the anchor brace/Gripple into panel opening.
			5. Using a wire gripper or other method, pull the trailing end of the cable tight engaging the cable and Gripple. The Gripple will be recessed into the panel opening and below the top of the panel when tensioned.

NTS: Retain one version of Paragraph “6” below based on project specific installation application. Note the extra cable is the recommended method to allow for future re-tensioning.

* + - 1. Cut the cable approximately 2 inches above the panel and loop the end back into the Gripple head.
			2. Cut the cable flush with the Gripple.
	1. OPEN STRUCTURAL MAT INSTALLATION
		1. Sub Grade Preparation:
			1. Prepare sub grade as specified and install protection system in accordance with Manufacturer's instructions. No depressions should exist that can retain water.
			2. Excavate or fill foundation soils as required to elevations and dimensions as indicated on the Drawings or as directed by the Engineer.
			3. Ensure foundation soil meets specification requirements and is examined by the Engineer. If unacceptable foundation soils are encountered, excavate affected areas and replace these areas with suitable quality material as directed by the Engineer.
		2. Placement on Geotextile Fabric:
			1. Install geotextile directly on the prepared area, in intimate contact with the subgrade, and free of folds or wrinkles.
			2. The geotextile filter fabric will be placed so that the fabric overlaps 10-inches minimum.
		3. Placement of Plastic Units:
			1. Assemble mat system in place by connecting individual units or use pre-assembled, mats and connect adjoining mat sections using the PadLoc connection devices.
			2. Install PadLoc straps at each one of the PadLoc sizes groove.
			3. Place the first unit or assembled mat section in position and place PadLoc straps at all grove locations under the unit mat edge.
			4. Insert the lifting lever under the PadLoc strap, utilize multiple levers as required.
			5. Make sure that the lifting lever is directly under the PadLoc strap. Step on the lifting lever to hold up the strap firmly against the bottom of the unit.
			6. While stepping on the lifting lever, place the adjoining unit or mat section in position and over the in-place PadLoc strap.
			7. Place the PadLoc clamp over the adjoining unit walls and into the groove such that it engages with the PadLoc strap.
			8. Place the slotted end of the torsion tool over the end of the strap so it is fulle engaged. Twist the torsion tool 90-deg so the ends of the PadLoc strap secure the PadLoc clamp and strap together.
		4. Anchoring Structural Mat System:
			1. Earth Anchors
				1. Install earth anchors after the structural units system is fully assembled.
				2. Engage the drive rod with the anchor head.
				3. Holding the drive rod and cable together, place the anchor head in on of the openings in the bottom of the structural units.
				4. Using a sledge hammer, drive the anchor head through the geosynthetic layer system into the soil to the length of the cable or until resistance is reached.
				5. Remove the drive rod.
				6. Position the washer in the bottom of the structural unit cell.
				7. Attached the hook of the earth anchor set tool to the tensioning loo on the end of the cable.
				8. Hold the handle and lift vertically to set the earth anchor.
	2. TIED CONCRETE BLOCK MAT INSTALLATION
		1. Prior to installing tied concrete block mat, prepare the subgrade as detailed in the plans. All subgrade surfaces to be smooth and free of all rocks, stones, sticks, roots, and other protrusions or debris of any kind that would result in an individual block being raised more than 3/4 in. above the adjoining blocks. When seeding is shown on the plans, provide subgrade material that can sustain growth.
		2. Ensure the prepared subgrade provides a smooth, firm, and unyielding foundation for the mats. The subgrade shall be graded into a parabolic or trapezoidal shape in order to concentrate flow to middle of mat or mats.
		3. When vegetation is required, distribute seed on the prepared topsoil subgrade before installation of the concrete mats in accordance with the specifications.
		4. Install mats to the line and grade shown on the plans and per the manufacturer’s guidelines. The manufacturer or authorized representative will provide technical assistance during the slope preparation and installation of the concrete block mats as needed.
		5. Provide a minimum 18 in. deep concrete mat embedment toe trench at all edges exposed to concentrated flows. Recess exterior edges subject to sheet flow a minimum of 3 in.
		6. When needed, provide fastening or anchoring as recommended by the manufacturer or engineer for the site conditions.
		7. For seams, parallel to the flow line in ditch or channel applications, center a minimum 3 ft. wide strip of soil retention blanket under the seam. Fasten along the seam at 5 ft. maximum spacing. Parallel seams in the center of the ditch shall be avoided when possible.
		8. Shingle seams perpendicular to the flow line with the downstream mat recessed a minimum of 2 blocks under the upstream mat and fastened together along the seam at 2 ft. maximum spacing if required by manufacturer or engineer.

++END OF SECTION++