CUDO® CUBES

Submittal Package
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Submittal Drawing
SECTION 2

Features & Benefits
RESHAPING THE FUTURE OF STORMWATER MANAGEMENT

A new approach to underground stormwater storage, infiltration, treatment, harvesting or other stormwater management needs, subject to availability.

Potential LEED® credits for Sustainable Sites (6.1, 6.2), Materials & Resources (4, 5 in CA, AZ, NV, OR, UT) and Water Efficiency (1, 3)
Modular Polypropylene Cubes for Underground Water Storage

Cubes incorporate an arched design that adds structural integrity, increased water storage and enhanced access for inspection and maintenance. Made in the USA of injection molded polypropylene plastic, a single CUDO assembly requires just two modules and two end caps.

Per application, either a filter fabric or plastic liner is wrapped around the CUDO modules, encasing the entire system. Geo-grid or other structural enhancement may be incorporated into the CUDO installation, depending on the loading requirements.

FEATURES AND BENEFITS

- Large interior openings offer ease of access for inspection and maintenance
- High water storage capacity (95%)
- CUDO size (24” x 24” x 24”) offers ease of handling and installation
- Unique shape offers superior strength
- Minimal number of components required for assembly
- May be integrated into bioretention systems (rain gardens)
SECTION 3

Accessories
The structural geogrid shall be an integrally formed grid structure manufactured of a stress resistant polypropylene material with molecular weight and molecular characteristics which impart: (a) high resistance to loss of load capacity or structural integrity when the geogrid is subjected to mechanical stress in installation; (b) high resistance to deformation when the geogrid is subjected to applied force in use; and (c) high resistance to loss of load capacity or structural integrity when the geogrid is subjected to long-term environmental stress.

The structural geogrid shall accept applied force in use by positive mechanical interlock (i.e. by direct mechanical keying) with: (a) compacted soil or construction fill materials; (b) contiguous sections of itself when overlapped and embedded in compacted soil or construction fill materials; and (c) rigid mechanical connectors such as bodkins, pins or hooks. The structural geogrid shall possess sufficient cross sectional profile to present a substantial abutment interface to compacted soil or particulate construction fill materials and to resist movement relative to such materials when subject to applied force. The structural geogrid shall possess sufficient true initial modulus to cause applied force to be transferred to the geogrid at low strain levels without material deformation of the reinforced structure. The structural geogrid shall possess complete continuity of all properties throughout its structure and shall be suitable for reinforcement of compacted soil or particulate construction fill materials to improve their long term stability in structural load bearing applications such as earth retention systems. The structural geogrid shall have the following characteristics:

**Product Specification - Structural Geogrid BX1200**

The structural geogrid shall be delivered to the jobsite in roll form with each roll individually identified and nominally measuring 3.0 meters (9.8 feet) or 4.0 meters (13.1 feet) in width and 50.0 meters (164 feet) in length. A typical truckload quantity is 165 to 220 rolls. On special request, the structural geogrid may also be custom cut to specific lengths or widths to suit site specific engineering designs.

**Notes**

1. Unless indicated otherwise, values shown are minimum average roll values determined in accordance with ASTM D-4759. Brief descriptions of test procedures are given in the following notes. Complete descriptions of test procedures are available on request from Tensar Earth Technologies, Inc.
2. Nominal dimensions.
3. True resistance to elongation when initially subjected to a load measured via ASTM D6637 without deforming test materials under load before measuring such resistance or employing “secant” or “offset” tangent methods of measurement so as to overstate tensile properties.
4. Load transfer capability measured via GRI-GG2-87. Expressed as a percentage of ultimate tensile strength.
5. Resistance to bending force measured via ASTM D-5732-95, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs (as a “ladder”), and of length sufficiently long to enable measurement of the overhang dimension. The overall Flexural Stiffness is calculated as the square root of the product of machine-and cross-machine-direction Flexural Stiffness values.
6. Resistance to in-plane rotational movement measured by applying a 20 kg-cm moment to the central junction of a 9 inch x 9 inch specimen restrained at its perimeter (U.S. Army Corps of Engineers Methodology for measurement of Torsional Rigidity).
7. Resistance to loss of load capacity or structural integrity when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW), and crushed stone classified as poorly graded gravel (GP). The geogrid shall be sampled in accordance with ASTM D5818 and load capacity shall be measured in accordance with ASTM D6637.
8. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments measured via EPA 9090 immersion testing.

### Product Properties Index

**Product Type:** Integrially Formed Structural Geogrid  
**Load Transfer Mechanism:** Positive Mechanical Interlock

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<th>Units</th>
<th>MD Values</th>
<th>XMD Values</th>
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<tr>
<td>Aperture Dimensions&lt;sup&gt;2&lt;/sup&gt;</td>
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<tr>
<td>Minimum Rib Thickness&lt;sup&gt;2&lt;/sup&gt;</td>
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<td>Load Capacity</td>
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<td>True Initial Modulus in Use&lt;sup&gt;3&lt;/sup&gt;</td>
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<td>Structural Integrity</td>
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<td>93</td>
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<td>Aperture Stability&lt;sup&gt;6&lt;/sup&gt;</td>
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### Dimensions and Delivery

The structural geogrid shall be delivered to the jobsite in roll form with each roll individually identified and nominally measuring 3.0 meters (9.8 feet) or 4.0 meters (13.1 feet) in width and 50.0 meters (164 feet) in length. A typical truckload quantity is 165 to 220 rolls. On special request, the structural geogrid may also be custom cut to specific lengths or widths to suit site specific engineering designs.
PPL CONTAINMENT MEMBRANES

LONG TERM STORAGE/CONTAINMENT MEMBRANE

CONTAINMENT MEMBRANE QA\QC & INSTALLATION PROCEDURES

1.01 SCOPE OF WORK:

Furnish and install a flexible membrane lining as shown on engineering or contractor supplied drawings. All work shall be done in strict accordance with the drawings and related specifications and the membrane lining manufacturer's recommendations.

It is the intent of these specifications to insure a quality finished product as described on the plans and specifications and shall be the responsibility of the contractor to take whatever measures shall be deemed necessary to insure that this requirement shall have been met.

All interested governmental agencies shall provide inspection services throughout the installation procedure or provide written acceptance of the installation after final inspection.

1.02 PRODUCT:

The material supplied under these specifications shall be first quality goods specifically formulated and tested for the containment of the material(s) as set forth in the accompanying specifications.

The material used for the lining shall be a high density polyolefin reinforced low density polyethylene membrane and shall have been satisfactorily demonstrated by prior use and testing to be suitable, appropriate and durable for the purpose of this work.

The membrane shall be manufactured by the application of Low Density coating over High Density scrim's and shall be uniform in color, thickness, size and surface texture. The finished lining shall be a sunlight (UV), weather resistant (Cold temperature), plant and fish safe membrane that is a flexible, durable, liquid tight product free from pinholes, blisters, contaminates or other off specification defects.

The membrane shall be manufactured from a composition of high quality ingredients, specifically compounded for use in hydraulic structures. Only domestic resins and additives shall be used. Reprocessed materials will not be acceptable other than clean rework materials of the same virgin ingredients generated from the manufacturer's own production.

The finished membrane liner shall consist of 2/2.5 mils of LD polyethylene coating over 2 HD scrims followed by 2/2.5mils of LD coating creating a 5 layer impermeable membrane with tremendous strength and resistance to hydrocarbons. The finished thickness shall be plus or minus 10% based on the material type i.e. PPL20, PPL24, PPL36 etc.

1.021 ROLL SAMPLING:

Each roll upon delivery shall be visually inspected. Each roll shall be wrapped individually and each roll shall be clearly labeled with a roll number and lot number. Each load will be accompanied by a box of samples 6” x 12’, for each roll delivered, for archiving and sampling.

Prior to placing the roll into production, the roll number and lot number will be recorded on the inside of the core with permanent marker. A 6” wide sample taken from the entire width of the roll will be removed and cut into 2 pieces 6” x 6’ long and welded together for sampling and material integrity testing. Peel testing of the sample shall be done to insure weldability and careful inspection at weld separation shall be checked for delamination. If delamination failure is present, retest as described above, after removing 15 feet from the roll. If failure is still apparent the roll shall be labeled as rejected and removed from the production area. These procedures apply to all new rolls and roll splice joints.

All roll tests are to be recorded in the test log.
1.03 FABRICATION:

The individual widths of the PPL fabric shall be assembled into large sheets custom-designed for the specific project so as to minimize field seaming. All factory seams shall provide a bond between the sheet goods sufficiently strong to meet the test requirements of these specifications.

All machines used in the seaming process shall be tested daily, prior to any fabrication, by welding a 6’ long test sample of the material and manually peel testing along the entire length. Each test must show film tear bonding along the length of the seam to be considered a “pass”. All results shall be recorded in the test report log and must include Date, time, machine #, operator, temp and speed as well as pass/fail indication. If the sample fails the testing, make appropriate corrections to the equipment and retest as stated above.

Machines will be further requalified after the following: change of material, unexpected power loss, change of operator, or shutdowns of 45 minutes or longer.

The factory seaming shall be performed on thermal welding equipment with pressure wheels and shall consist of seams of 2” minimum width in the case of wedge welding, 1.5” width in the case of hot air welding, which will provide a film-tearing bond of 80% of the fabric tensile strength. All seams shall be visually inspected along there entire length, and destructive tested at an interval not to exceed 500 lineal feet of factory seam per machine.

1.04 PANEL PACKAGING AND HANDLING:

Factory fabricated panels shall be accordion folded during production to width of approximately 6’ wide. Upon completion each bundle shall be folded or rolled by hand or machine based on the total square footage of the panel. Panels 10,000 sq.ft. or larger are rolled by machine and include a core and continuous unroll strap. Each roll shall be secured to a pallet or export container designed to be moved by a forklift or similar piece of equipment. Each factory-fabricated panel shall be prominently and permanently marked with the panel size and installation location as per factory drawings. Each panel will then be wrapped with its own protective wrap and marked again as to size and installation location. Packaged factory liner sections, which are delivered to a project site, shall be stored in their original shipping wrappers and stored in a dry area and protected from harsh weather elements when at all possible. The liner sections shall not be stacked.

1.05 INSTALLER:

The installer of the lining fabric shall be experienced in the installation of flexible membrane linings and shall be approved in writing by the fabricator and the manufacturer of the material.

1.06 LINING BASE MATERIAL:

A base shall be prepared on the bottom and slopes of the area to be lined. This base shall be free of all sharp objects, roots, grass and vegetation. Unsuitable material found during the pre-installation inspection by the installer shall be removed prior to the installation of the liner.

The base (subgrade) material shall be native materials or materials obtained from a borrow source compacted to a minimum 95% compaction or an approved construction fabric of at least 100 mils thickness, weighing 8 ozs. per square yard with a grab tensile strength of at least 200 lbs. per square inch and a Mullen burst strength of at least 350 pounds per square inch, which will provide a finished sub grade suitable for the flexible membrane lining.

Foreign materials, vegetation, protrusions, voids, cracks and other penetrating or raised sources shall be removed from the sloping areas as well as the base. Loose rocks, rubble and other foreign matter shall be collected and deposited in the appropriate site out of the area to be lined. The excavated and filled areas shall be trimmed to elevations and contours shown on the drawings and shall be smooth, uniform and free of all foreign matter, vegetation and sudden changes in grade.

A pre-installation inspection shall be called for and ALL interested parties, including governmental agencies, shall be present for this inspection. Any parties not participating in this inspection shall be construed as accepting the site preparation and will acknowledge this defacto acceptance in writing at the appropriate time.
1.07 FINAL SUBGRADE PREPARATION:

The sub grade shall be prepared immediately prior to the placing of the liner. The surface on which the liner is to be placed is to be firm, clean, dry and smooth. Anchor trench excavation and any structure seal preparation should be completed before the lining installation begins.

1.08 LINING INSTALLATION:

A continuous sheet of liner shall be installed throughout the installation site as according to the drawings. The lining shall be placed over the prepared surfaces to be lined in such a manner as to assure a minimum of handling. The sheets shall be of prescribed lengths and widths and shall be placed in such a manner as to minimize field seams. Only those pieces of fabric that can be installed and anchored in place during the workday shall be unpacked and placed in position.

Sandbags and or other suitable weights may be used as required to hold the lining in position during the installation. The weights shall not have any sharp edges, which may snag or otherwise penetrate the liner fabric. Care should be taken to keep the seam areas as clean as possible. It may be necessary to wipe down the edges prior to heat-sealing the panels together.

No materials or equipment shall be dragged across the face of the liner nor shall the workmen while installing the liner subject the liner to abuse. All installation party members shall wear soft-soled shoes or boots while working on the surface of the liner.

Lining sheets shall be closely fit around all penetrations through the liner. Lining to concrete seals shall be affected with mechanical anchors as shown on drawings. All piping, structures and irregular projections shall be sealed and flashed with the fabricated boots or other approved sealing methods.

A meeting of all interested parties shall proscribe the method of backfilling of the site with the appropriate materials. The lining installation manager prior to commencement of the backfilling program shall approve all actions undertaken to place the top cover material.

1.09 FIELD SEAMS:

All seaming shall be done with thermal heat-sealing equipment or with the adhesives of the lining fabric manufacturer's brand. Heat-sealing with automatic wedge welding is the preferred method of field seaming whenever possible.

Wedge welders for field seams shall be qualified prior to beginning field seaming. A 6’ section of material, at current ambient temperature, shall be welded and manually torn apart to insure proper welding adhesion.

Lap joints require a minimum of 2.5” overlap of the factory fabricated panels. The contact surfaces of the panels must be cleaned and all moisture and other foreign material must be removed prior to heat sealing.

If the sub-surface area is not capable of 95% compaction it may require the placement of a back board or rub sheet under the liner to give a firm, dry and clean welding surface.

Extreme caution should be taken throughout the installation to avoid wrinkling the edge of the liner. These “fish mouths” must be slit back sufficiently to remove them and the liner sealed to assure total integrity.

Any portion of the liner damaged or hurt for any reason shall be repaired or replaced by the installation crew before it departs. Normally the ends of the panels can be used for a patching source.
1.10 PATCHING:

Any repairs resulting from damage during installation shall be repaired with like fabric and heat sealing to ensure a secure lining. It is recommended that at least 2”-4” of overlap be used on any penetrations. It is suggested that any major scuffing be replaced with undamaged liner.

1.11 INSPECTION:

A thorough inspection of the completed liner installation shall be undertaken by a representative of the installer and a representative of the owner or the engineer in charge of the project. All government agencies involved in the project should also have an inspector or designated representative on site during the installation and after completion of same so as to register any complaints at that time. Any and all discrepancies to the permit process or license shall be attended to at this time.

1.12 FIELD TESTING:

All field seams shall be visually inspected along their entire length for integrity. If required by contract seams and repairs may additionally require non destructive testing using the Air Lance method (ASTM D4437) as outlined:

A Installer will supply a compressor and air wand with a fixed nozzle tip with an opening approx. 3\4” wide x 1\8” high.
B Compressor shall be equipped with an output gauge and the ability to continuously supply 30 psi of air pressure.
C The non destructive test involves running the nozzle of air 1\4” to 1\2” away from the outside edge of the field seam for its entire length. If air penetrates the seam area the audible noise or visual puffing of the seam indicates an area of concern and should be marked and repaired accordingly.

1.13 SOIL COVER:

PPL geomembranes may be covered by soil if desired. In areas of high traffic or areas with a high water table covering the entire liner is often recommended.

Care should be taken when covering the liner to prevent any damage to the geomembrane or geosynthetics. At no time will construction equipment be allowed to drive directly on the liner. Access roads for soil cover should be maintained to provide 12” minimum, between the excavation equipment and liner at all times. Damage to the liner, shall be repaired prior to proceeding with cover. Costs associated with repairs are the contractor’s responsibility.

**Cover material shall be 1\2” minus particles, clean rounded soils or gravels free of sharp edges, sticks, rubbish and debris or foreign materials. The cover material shall be placed as soon as practical, upon completion of the liner installation, or in conjunction with, as the installation progresses to minimize traffic.**

Cover soils should be dumped and leveled over the liner and not pushed from one end to the other to minimize rolling of the geomembrane beneath the soils. Cover soil should always be placed from the base up on slopes never pushed from the top of the slope downwards. Equipment should be turned in long sweeping turns and not spun quickly to eliminate the chance of digging down to the liner thru the cover soil.

When covering or initially filling a liner it is important not to lock the liner into the perimeter anchor trench prior to covering. This can cause undue stress and tension on the liner slopes during the covering process. The anchor trench or perimeter shelf area should be the last area covered to complete the cover process.

**Site specific materials or sizes may be acceptable. It is recommended that the contractor receive prior written approval for acceptance of the cover materials, from a BTL representative, before covering the liner.**
Thank you for purchasing your pond liner from BTL, Inc. Hopefully, when you received your liner you carefully inspected the exterior packaging for signs of damage or abuse. If not, and damage to the packaging is apparent, please contact BTL before proceeding. Please note: due to the durability of our products, it is likely that even if the cover material is damaged, the liner may not be affected.

Once the liner is delivered and inspected, please remove the banding and outer cover. It may be necessary to CAREFULLY cut the geo-textile wrapper to gain access to the bundle. Do not cut the bands on the liner itself at this time.

Once the bundle has been exposed, the top of the liner should be labeled with 2 dimensions with directional arrows. The first number and arrow signify the length and “unroll” direction. The second number and arrow signify the width and “unfold” direction.

Example: $100' \uparrow X 68' \rightarrow$

This signifies that your bundle will unroll 100’ and then unfold 68’

Based on the above numbers the liner bundle can be placed at any of the following StormCapture locations:

Place the bundle in the indicated spot (top or bottom) and unroll in the direction of the arrow 100’. Once the bundle is laying flat along the ground, have all available helpers spread out evenly and pick up the top/leading edge, and pull the liner across the pond (to the left or right) 34’. Return to the middle fold and repeat the process in the other direction the other 34’. It is recommended that you place people at a minimum of every 15-20 feet along the edge, deploying evenly across the excavation.
Typical Pipe Penetration Procedure

**Please note BTL, Inc. recommends only smooth wall pipes to be used to penetrate the liner – corrugated pipes are not recommended.**

Installation of Pipe Boot with Tape:

1. After installation of pond liner, carefully cut hole to allow pipe to slide through liner. Allow liner to fit flat on ground.
2. Slide boot over pipe and push down to pond floor/wall, etc...
3. Carefully cut boot flange base so that it exceeds the cut in the liner by 4 to 6 inches in all directions.
4. Clean liner and flange. Use water, MEK, Xylene, etc... Do NOT use soap.
5. Mark a line around flange and remove boot.

**Please note some versions of our tape on boots now come with fully adhesive coated base plates identified by a white peel off layer on the entire bottom of the boot. If applicable please skip step #6 below and proceed to step #7**

6. Place 2” wide double-sided tape on liner (bottom view drawing). Be sure to overlap at corners by ¼”. Leave film layer on the top of the tape. Use a rag to firmly press down the tape and work out any wrinkles.
7. Replace boot remove protective covering and press down on the tape and work out the wrinkles.
8. Place the 4” single-sided tape completely over the edge of the boot, centering on the seam.
9. Place band clamp on boot riser approximately 1” from top of boot. Tighten and cover with 4” single-sided tape.
**Typical Tape on Boot Detail**

- **Bottom View**
  - 2' - 2 Sided Tape
  - Typical Boot

- **Side View**
  - Pipe size varies.
  - Hose Clamp
  - 4" Single Sided Tape
  - Liner
  - 2' - 2 Sided Tape
  - Caulking

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**Typical Pipe Penetration Procedure**

- **Existing Liner**
  - Field weld boot. Minimum 3" wide around entire flange.

- **Prefabricated slope boot**
  - (size varies) 15° or 90° manufactured of similar material as liner.

- **Apply sealant to joint if required**

- **Stainless Steel Band**

- **Existing Pipe**
  - Field weld boot flange.

- **Apply 4" tape over stainless steel band and boot sleeve (center on band and pipe).**
**BTL™ -40**

**DOUBLE SCRIM - LOW TEMPERATURE - HYDROCARBON STABLE**

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<thead>
<tr>
<th>DESCRIPTION</th>
<th>BLACK 16 X 16 COUNT PER INCH</th>
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<tr>
<td>FABRICATION &amp; WAREHOUSE</td>
<td>PRINEVILLE, OREGON</td>
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<td>WEIGHT</td>
<td>18.5 OZ./SQ.YD. (+/-5%) ASTM D 751</td>
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<tr>
<td>THICKNESS</td>
<td>40 MILS (+/-10%) ASTM D 5199</td>
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<tr>
<td>COATING THICKNESS</td>
<td>2.5 MILS EACH (+/-10%)</td>
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<td>TENSILE STRENGTH (GRAB METHOD)</td>
<td>WARP 710 LBS. ASTM D 5034</td>
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<td>WEFT 650 LBS.</td>
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<tr>
<td>ELONGATION TO BREAK</td>
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<tr>
<td>TEAR STRENGTH (TONGUE METHOD)</td>
<td>WARP 155 LBS/INCH ASTM D 2261</td>
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<td></td>
<td>WEFT 155 LBS/INCH</td>
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<tr>
<td>BURSTING STRENGTH (MULLEN)</td>
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<td>HYDROSTATIC RESISTANCE</td>
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<td>PUNCTURE RESISTANCE</td>
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<td>347 LBS.</td>
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<td>MOISTURE VAPOR TRANSMISSION</td>
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<td>LOW TEMPERATURE COLD CRACK</td>
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<tr>
<td>PERMEABILITY</td>
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<td>CARBON BLACK DISPERSION</td>
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<tr>
<td>UV RESISTANCE</td>
<td>90% STRENGTH RETAINED AFTER 2000 HRS. ASTM G-151</td>
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ALL DATA IS DRAWN FROM U.S. TESTING AND PRECISION LABORATORIES. AVAILABLE UPON REQUEST.

12-2012
Mirafi® 140N is a nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that the fibers retain their relative position. 140N is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

### Mechanical Properties

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Unit</th>
<th>Minimum Average Roll Value</th>
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<tbody>
<tr>
<td>Grab Tensile Strength</td>
<td>kN (lbs)</td>
<td>0.53 (120) 0.53 (120)</td>
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<tr>
<td>Grab Tensile Elongation</td>
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<tr>
<td>Trapezoid Tear Strength</td>
<td>kN (lbs)</td>
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<td>Mullen Burst Strength</td>
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<td>Puncture Strength</td>
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<td>Apparent Opening Size (AOS)</td>
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<td>Permittivity</td>
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<td>Permeability</td>
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<tr>
<td>Flow Rate</td>
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<tr>
<td>UV Resistance (at 500 hours)</td>
<td>% strength retained</td>
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### Physical Properties

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<tr>
<th>Test Method</th>
<th>Unit</th>
<th>Typical Value</th>
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<tr>
<td>Weight</td>
<td>g/m(^2) (oz/yd(^2))</td>
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<td>Thickness</td>
<td>mm (mils)</td>
<td>1.4 (55)</td>
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<tr>
<td>Roll Dimensions (width x length)</td>
<td>m (ft)</td>
<td>3.8 x 110 (12.5 x 360)</td>
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<tr>
<td>Roll Area</td>
<td>m(^2) (yd(^2))</td>
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<tr>
<td>Estimated Roll Weight</td>
<td>kg (lb)</td>
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SECTION 4

Product Specifications
CUDO Stormwater System
Underground Retention/Detention/
Infiltration/Water Reuse Systems

Product Specifications

PART 1 – GENERAL

1.01 General Provisions
A. The Conditions of the Contract and all Sections of Division 1 are hereby made a part of this Section.

1.02 Description of Work
A. Work Included:
   1. Provide excavation and base preparation per Geotechnical Engineer’s recommendations and/or as shown on drawings, to provide adequate support for project design loads and safety from excavation sidewall collapse. See 2.02 Materials.
   2. Provide CUDO cube modular system products, and install per the manufacturer’s instructions furnished under this section.

B. Related Work:
   1. Subgrade excavation and preparation under Section 02300 – Earthwork.
   2. Surface Drainage materials – Section 02700 – Subsurface Drainage and Structures, as needed.

1.03 Quality Assurance
A. Follow Section 01340 requirements.

B. Installation: Performed only by skilled work people with satisfactory record of performance on bulk earthworks, pipe, chamber, or pond/landfill construction projects of comparable size and quality.
CUDO Technical Specifications

1.04 Submittals
   A. Submit manufacturer’s product data and installation instructions.
   
   B. Submit CUDO module for review. Reviewed and accepted samples will be returned to the Contractor.
   
   C. Submit material certificates for geotextile, geogrid, base course and backfill materials.

1.05 Delivery, Storage, and Handling
   A. Protect CUDO cube modular system products from damage during delivery, and store under tarp to protect from sunlight when time of delivery to installation exceeds one week. Storage should occur on smooth surfaces, free from dirt, mud and debris.
   
   B. Handling is to be performed with equipment appropriate to the size (height) of cubes and site conditions, and may include hand, hand cart, forklifts, extension lifts, etc.

1.06 Project Conditions
   A. Review installation procedures and coordinate CUDO cube installation with other work affected, such as grading, excavation, utilities, construction access and erosion control to prevent all non-installation related construction traffic over completed CUDO cube installation, especially with loads greater than design load.
   
   B. Cold weather:
      1. Do not use frozen materials or materials mixed or coated with ice or frost.
      2. Do not build on frozen, wet, saturated or muddy subgrade.
      3. Care must be taken when handling CUDO cubes when air temperature is at 40 degrees or below as plastic becomes brittle.

   C. Protect partially completed CUDO cube installation against damage from other construction traffic when work is in progress and following completion of backfill by establishing a perimeter with highly visible construction tape, fencing, or other means until construction is complete.

   D. Protect adjacent work from damage during CUDO cube installation.
CUDO Technical Specifications

PART 2 – PRODUCTS

2.01 Availability
  A. Manufactured by Oldcastle Infrastructure, 7100 Longe Street, Stockton, California, 95206.

2.02 Materials
  A. Base of excavation: Shall be smooth, level and free of lumps or debris.
  B. Geotextile: Use non-woven geotextile with weight of at least 4 oz per square yard, appropriate for the soil type and depth conditions. Fabric shall be placed on the floor of the excavation, and the sides and top of the modular system.
  C. CUDO cube modular units: The CUDO product will arrive onsite with the required number of components to complete your project. Those components will consist of (as required) CUDO half cubes, top/bottom grates, stacking couplers, side plugs, and/or lateral connectors. Assembly of the completed system will be done onsite per project specific assembly details with their simple snap together feature.
  D. Side and top backfill: Using structural fill, sand or other free-draining material material as specified by the project engineer, backfill the sides of the CUDO system evenly in 12” lifts to a minimum of 95% with a mechanical compactor. Bring the backfill to the top of the CUDO system and then continue backfill placement in accordance with the project’s specific requirements for the type and location of Geogrid over the top of the CUDO system.
  E. Geogrid: Use Tensar BX-1200 or equivalent to reinforce backfill above CUDO cubes to support H20 loads (otherwise not required). Geogrid should extend 3 feet beyond the cube footprint.
  F. Utility marker: Use metallic tape at corners of install to mark the area for future utility detection.

PART 3 – EXECUTION

3.01 Site Excavation
  A. The contractor shall excavate the site to the width, depth and length necessary to accommodate and install the CUDO stormwater system including provisions for cover over the system and depth below the system in accordance with the project engineer’s specifications.
  B. Examine prepared excavation for smoothness, compaction and level. Do not start installation of CUDO cubes until unsatisfactory conditions are corrected. Check for presence of high water table, which must be kept at levels below the bottom of the CUDO structure at all times.
CUDO Technical Specifications

C. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance. If existing conditions are found unsatisfactory, contact Project Manager for resolution.

3.02 Base Preparation
   A. Generally a base material of sand or stone should be used and be compacted to 95%. The specific nature of the material will depend upon a myriad of factors, including but not limited to soil reports and end use of system (detention or retention). The base must be finished evenly to provide a level surface for the CUDO installation.

   B. It is helpful to identify the outline of the structure on the floor of the excavation, using spray paint or chalk line, to ensure squareness during cube placement.

3.03 Installation of CUDO Cubes
   A. Either a non-woven filter fabric material or an impermeable liner will be required to surround the perimeter of the CUDO system. Either product shall be laid to the contour of the excavation bottom and side walls with a minimum of 12" overlapping, or as specified by the project engineer.

   B. The assembled CUDO cubes shall be placed on top of the fabric/liner material in accordance with the project’s specific layout details. Maintain a level top at all times and keep the units in a straight line in each direction. Complete any inlet/outlet pipe connections in accordance with the project’s details. Connect the inspection/cleanout port riser material to the top of the CUDO as shown on the project layout detail. Pull the fabric/liner material taut around the CUDO cubes to completely seal the system, using duct tape to temporarily secure the material overlaps in place.

   C. Start backfilling with recommended backfill, compacting in 12" maximum lifts. Place backfill carefully to avoid shoving or damaging cubes. Use a powered mechanical compactor to compact backfill on structure sides with care to avoid damage to geotextile or liner.

   D. Backfill above system should be compacted in 6" lifts. When backfill reaches an elevation 12" above the system, place a layer of geogrid directly over the top of the backfill (required only when there will be traffic loads (H20 loads) above the cubes), extending 3’ beyond the cube footprint.

   E. Place sufficient backfill (Section 2.02 E) material over geogrid to ensure support of design loads. Place cover backfill in 6" lifts and compact with vibrating plates or walk behind rollers (do not use drivable rolling compactors) to a minimum of 95% compaction. Take care to place backfill on top of structure to avoid damage to structure, geotextile or liner, using low pressure tire or track vehicles.

   F. Ensure that all unrelated construction traffic be kept away from the limits of excavation until project is complete and final surface materials are in place.

   G. Place surfacing materials, such as groundcovers (no shrubs or trees), or paving materials over the structure with care to avoid displacement of cover fill and damage to surrounding areas.
3.04 Cleaning
A. Perform cleaning during the installation of work and upon completion of the work. Remove from site all excess materials, debris, and equipment. Repair any damage to adjacent materials and surfaces resulting from installation of this work.

Sample Installation Detail
SECTION 5

Installation Manual
CU DO Stormwater System
Underground Retention/Detention/
Infiltration/Water Reuse Systems

Installation Manual
CUDO Installation Guide

CUDO Cube Modular Stormwater System

CUDO Assembly
The CUDO product will arrive onsite with the required number of components to complete your project. Those components will consist of (as required) CUDO half cubes, top/bottom grates, stacking couplers, side plugs, and/or lateral connectors. Assembly of the completed CUDO system will be done onsite per project specific assembly details with their simple snap together feature.
Site Excavation
The contractor shall excavate the site to the width, depth and length necessary to accommodate and install the CUDO stormwater system including provisions for cover over the system and depth below the system in accordance with the project engineer's specifications.

Base Preparation
Generally a base material of sand or stone should be used and be compacted to 95%. The specific nature of the material will depend upon a myriad of factors, including but not limited to soil reports and end use of system (detention or retention). The base must be finished evenly to provide a level surface for the CUDO installation.

Fabric/Liner Placement
Either a non-woven filter fabric material or an impermeable liner will be required to surround the perimeter of the CUDO system. Either product shall be laid to the contour of the excavation bottom and side walls with a minimum of 12” overlapping, or as specified by the project engineer.

CUDO Placement
The assembled CUDO cubes shall be placed on top of the fabric/liner material in accordance with the project’s specific layout details. Maintain a level top at all times and keep the units in a straight line in each direction. Complete any inlet/outlet pipe connections in accordance with the project’s details. Connect the inspection/cleanout port riser material to the top of the CUDO as shown on the project layout detail. Pull the fabric/liner material taut around the CUDO’s to completely seal the system, using duct tape to temporarily secure the material overlaps in place.

Backfilling/Geogrid Placement
Using a compactable material as specified by the project engineer, backfill the sides of the CUDO system evenly in 12” lifts to a minimum of 95% with a mechanical compactor. Bring the backfill to the top of the CUDO system and then continue backfill placement in accordance with the project’s specific requirements for the type and location of Geogrid over the top of the CUDO system.

Sample Installation Detail
SECTION 6

Operations & Maintenance
CUDO® CUBES

Operations and Maintenance Manual
(Underground Retention/Detention/Infiltration/Water Reuse Systems)
**CUDO® Stormwater Cube - Modular Stormwater Systems**

**Description / Basic Function**
CUDO is a modular stormwater system comprised of a grouping of modular polypropylene or concrete cubes that when constructed form an underground storage area for stormwater. This system can be used for infiltration, retention, detention or water reuse. CUDO can help achieve runoff detainment and storage to help attenuate the peak flow to pre-construction levels and can help conform to current Low Impact Development requirements.

**Infiltration**
The purpose of a CUDO infiltration system is to capture stormwater runoff, store the runoff, and then allow it to percolate into the ground via the open space area of the cubes and perforations in the side wall. The system is backfilled with a Class I material defined by ASTM D2321 as a cleaned open graded rock or a Class II permeable sand. The rock or sand provide additional storage capacity but also allow for a percolation interface with the native material. The ground water is "recharged" with this type of system.

**Detention**
The purpose of a CUDO detention system is to capture stormwater runoff, store the runoff, and then allow it to be released at a controlled rate through an appropriately sized orifice control. A detention system helps attenuate the peak flow from the site assuring that pre-development runoff flows are not exceeded as a result of the development. A CUDO detention requires the cubes to be encapsulated with an impermeable liner for the polypropylene system or the seams of the concrete system to be sealed with a water proof mastic.

**Retention**
A CUDO retention system is a hybrid system. It is a combination of a detention system and an infiltration system. A retention system is utilized to attenuate peak flow as well as promote groundwater re-charge. A retention system is outfitted with an overflow pipe at the top of the system which allows the system to fill for infiltration but also outlet if the ground is saturated.

**Water Reuse**
The purpose of a water-reuse CUDO system is to capture and store water for future use. The system is constructed in a similar fashion to a detention system but instead of a controlled outlet the system is constructed with an emergency overflow. A water reuse system is a Low-Impact Development (LID) device that helps attenuate peak flows as well as conserve water. Water may be reused through an active pump system or passive irrigation.

**Inspection/Cleanout Ports**
Inspection and cleanout ports are 18-inch diameter vertical risers connected to the uppermost polypropylene CUDO cubes or up to 30-inch manhole access connected to the concrete CUDO. They are used for entrance into the system, or for access to place vacuum truck hoses or water-jetting devices or CCTV equipment. Ports are strategically located near inlet and outlet pipes and in other areas or probable deposition in the system. It is recommended to keep surface level access lids sealed and bolted at all times when the system is in service.

**Inlet Bay**
Some systems are configured so that pretreatment of the stormwater occurs within the CUDO system. In this case, the CUDO system will house an inlet bay. The inlet bay is separated from the rest of the CUDO system by sidewall plugs and is intended to separate gross pollutants, trash and debris and floatables from the CUDO system and pre-treatment device. The bay contains its own sump area and unique access ports.
**Maintenance Overview for CUDO**

State and Local regulations require that stormwater storage systems be maintained and serviced on a recurring basis. The purpose of maintaining a clean and obstruction free CUDO system is to ensure the system performs the intended function of the primary design. Trash and debris, floatables, gross pollutants and sediment can build up in the CUDO leading to clogging of the native soil interface or blockage of the inlet or outlet pipes. This can cause the system to function improperly by limiting storage volume, limiting the design percolation rates or impeding flow in and out of the system. Downstream and upstream, areas could run the risk of flooding and deleterious environmental impact.

**Recommended Frequency of Service**

It is recommended that the CUDO stormwater systems be serviced on a regularly occurring basis. Ultimately the frequency depends on the amount of runoff, pollutant loading, and interference from trash, debris and gross pollutants as well as proper maintenance of upstream pretreatment devices. However, it is recommended that each installation be inspected at least two times per year to assess service needs.

**Recommended Timing of Service**

Guidelines for the timing of service are as follows:

1. For areas with a definite rainy season the system should be serviced prior to and following the rainy season.
2. For areas subject to year-round rainfall service should occur on a regularly occurring basis. (A minimum of two times per year.)
3. For areas with winter snow and summer rain the system should be serviced prior to and after the snow season.
4. For installed devices that are subject to dry weather flows only (i.e. wash racks, parking garages, etc...) the unit should be serviced on a regularly occurring basis. (A minimum of two times per year.)

**Inspection**

An inspection should be performed when the system is new. This allows the owner to establish a baseline condition for comparison to future inspections. Sediment build up can typically be monitored without entering the system. (No confined space entry.) Initial and subsequent inspection data should be recorded and filed for reference. Some regulatory agencies require that the results of the inspections be documented and reported. Inspection reports should comply with regulatory requirements and be submitted as required.

**Inspection Procedures**

5. Locate the inspection, cleanout and access ports. Inspection and cleanout ports are typically 18-inch diameter. Access ports are typically 24-inch or 30-inch diameter. Pictures should be taken to document the location or a site map should be generated to detail the as-built locations of the ports.
6. Unbolt and remove the access port lids.
7. Insert a measuring device into the opening making note of a point of reference to determine the quantity of sediment and other accumulated material. If access is required to measure, ensure only certified confined space entry personnel having appropriate equipment are allowed to enter the system.
8. In addition, for accessible concrete CUDO systems personnel should utilize appropriate confined space entry procedures to enter the system and photograph its condition.
9. Inspect inlet and outlet locations for obstructions. Obstructions should be removed at this time.
10. Inspect the structural components of the system.
11. Fill in the CUDO Inspection/Maintenance Data Sheet and send a copy to the regulatory agency if necessary.

**Disinfection of Water Reuse System**

Periodic disinfection of water held for reuse may be required to abate bacteria and algae growth. This may be done using calcium hypochlorite tablets or by the addition of an ozone generator in a small recirculation system.
Maintenance
Cleanout of the CUDO system should be considered if there is sediment buildup of two or more inches at over 50% of the inspection ports. Cleaning shall be performed if sediment buildup is two inches or more over 75% of the system floor. In the event of a spill of a foreign substance, cleanout of the system should be considered.

Maintenance Procedures
1. Locate the inspection, cleanout and access ports. Inspection and cleanout ports are typically 18-inch diameter. Access ports are typically 24-inch or 30-inch diameter. Pictures should be taken to document the location or a site map should be generated to detail the as-built locations of the ports.
2. Unbolt and remove the access port lids.
3. Measure the sediment buildup at each port. If access is required to measure ensure only certified confined space entry personnel having appropriate equipment are allowed to enter the system.
4. A thorough cleaning of the system (inlets, outlets, ports, and inlet bays) shall be performed by either a vacuum truck or by manual methods.
5. Inspect inlet and outlet locations for obstructions. Obstructions should be removed at this time.
6. Inspect the structural components of the system.
7. Fill in the CUDO Inspection/Maintenance Data Sheet and send a copy to the regulatory agency if necessary.

Inspection / Maintenance Requirements
Below are some recommendations for equipment and training of personnel to inspect and maintain a CUDO system.

Personnel: OSHA Confined Space Entry Training is a prerequisite for entrance into a system. In the state of California personnel should be CalOSHA certified.

Equipment: Record Taking (pen, paper, voice recorder)
Proper Clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
Flashlight
Tape Measure
Measuring Stick
Pry Bar
Traffic Control (flagging, barricades, signage, cones, etc.)
First Aid Materials
Debris and Contaminant Containers
Vacuum Truck

Disposal of Gross Pollutants, Hydrocarbons, and Sediment
The collected gross pollutants, hydrocarbons, and sediment shall be offloaded from the vacuum truck into DOT approved containers for disposal. Once in the container the maintenance contractor has possession and is responsible for disposal in accordance with local, state and federal agency requirements.

Note: As the generator, the landowner is ultimately responsible for the proper disposal of the collected materials. Because the material likely contains petroleum hydrocarbons, heavy metals, and other harmful pollutants, the materials must be treated as EPA class 2 Hazardous Waste. Proper disposal is required.