

## SECTION 3: LIVING WALLS

### Filtrex GreenLoxx<sup>®</sup> Non-MSE LivingWall™ / Severe Slope Stabilization (GroSoxx<sup>®</sup>)

#### PURPOSE & DESCRIPTION

Filtrex GreenLoxx<sup>®</sup> Non-MSE Living Wall allows for the stabilization of eroded or damaged slopes while creating attractive vegetated landscapes without the use of hard materials such as concrete and steel. Through the use of Filtrex GroSoxx<sup>®</sup>, the GreenLoxx Non-MSE system provides superior soil retention and erosion protection while providing an optimum environment for vegetation establishment. GroSoxx consists of Filtrex<sup>®</sup> Soxx™ mesh, filled with composted Filtrex<sup>®</sup> GrowingMedia™. GreenLoxx Non-MSE shall be designed as a plantable fascia providing two functions – structural wall or slope facing, and plant growth. GreenLoxx Non-MSE



Project site, installation



GreenLoxx Non-MSE, after

is designed to be installed in accordance with these specifications and the manufacturer's installation manual, to follow the lines and grades designated on the drawings/plans. Work shall include light excavation, GroSoxx, reinforcement (geogrid), anchoring system, irrigation components (optional), specified vegetation and related system accessories per engineering and landscape specifications.

#### APPLICATION

Before commencing construction of the GreenLoxx Non-MSE Wall, it is recommended that the specification guidelines and standard drawings found in this document be reviewed and that any site documentation and engineering documents be consulted. A decision must be made as to whether the wall will be a 'critical' application or 'non-critical' structure which will fall under basic design and construction guidelines. Encountering any of the following will require an engineer's review of the site and site-specific design prior to construction of a GreenLoxx Non-MSE Wall:

- Projected wall height exceeds 6 ft (1.8 m) depending on cut/slope situation and local jurisdiction requirements.
- GreenLoxx Non-MSE is to be built on unstable soils such as clays or organic materials.
- There is a possibility of hydrostatic loading or erosion from wave action, drainage or site runoff.
- Loading conditions from slopes or structures on or behind the wall will be exerted on the GreenLoxx Non-MSE
- Geogrid or other mechanical stabilization devices will be incorporated into the GreenLoxx Non-MSE system

Constructing a GreenLoxx Non-MSE Wall involves stacking GroSoxx on top of one another in a recessed fashion on steep slopes to near vertical situations. When required, a variety of grades of geogrid are seamlessly incorporated into the system giving it added structural support and integrity to meet specific environmental and site requirements.



Although the central focus of the GreenLoxx Non-MSE system is to stabilize earth and reduce erosion, the secondary objective is to provide for the establishment and sustainability of vegetation and an aesthetic landscape feature. This goal is evidenced through the design and function of the wall fascia of GroSoxx as well as the GrowingMedia™ that fills the wall fascia.

GreenLoxx Non-MSE can be used for a wide variety of non-structural applications including:

- Steep Slope Stabilization
- Streambank Stabilization
- Pond bank stabilization
- Slip Repairs
- Culvert Headwalls
- Bridge Abutments
- Dikes/Berm
- Flood Protection

**ADVANTAGES AND DISADVANTAGES**

**Advantages**

The GreenLoxx Non-MSE system offers many advantages including:

- Lightweight components
- Highly efficient, certified installation
- No footing or leveling pad required
- Seed injection into GroSoxx
- Filtrexx® GrowingMedia™
- Easily reinforced for severe applications
- Improved drainage/reduction of hydrostatic pressure
- Customizable vegetation with plants, plugs, live stakes or seed

| ADVANTAGES                      |     |     |      |
|---------------------------------|-----|-----|------|
|                                 | LOW | MED | HIGH |
| <b>Installation Difficulty</b>  |     | ✓   |      |
| <b>Soil Retention Ability</b>   |     |     | ✓    |
| <b>Vegetation Establishment</b> |     |     | ✓    |
| <b>Aesthetic Quality</b>        |     |     | ✓    |
| <b>Aesthetic Quality</b>        |     |     | ✓    |
| <b>Drainage</b>                 |     |     | ✓    |

- Concrete footings are not required
- GreenLoxx Non-MSE may assist in qualification for LEED® Green Building Rating and
- Certification credits under LEED Building Design & Construction (BD+C), New Construction, and Awarded credits may be possible from the categories of Sustainable Sites, Water Efficiency, Materials & Resources, and Innovation. Note: LEED is an independent program offered through the U.S. Green Building Council. LEED credits are determined on a per project basis by an independent auditing committee. Filtrexx neither guarantees nor assures LEED credits from the use of its products. LEED is a trademark of the U.S. Green Building Council.

**Disadvantages**

- If GreenLoxx Non-MSE does not use Filtrexx® GrowingMedia™, performance may be diminished.
- If not installed correctly, maintained or used for a purpose or intention that does not meet specifications, performance may be diminished.
- If vegetation does not establish or cover density is low, performance may be diminished.
- GreenLoxx Non-MSE should not be the only form of site or watershed storm water management.
- GreenLoxx Non-MSE may need to be reseeded or live stakes replaced if establishment is poor.
- GreenLoxx Non-MSE performance may be lower prior to vegetation establishment and maturity.
- GreenLoxx Non-MSE installation is a land disturbing activity and can increase sediment loading to surface waters if appropriate sediment control measures are not established during construction phase.
- GreenLoxx Non-MSE should not be used on bank and shoreline slopes greater than ¼:1.
- GreenLoxx Non-MSE should not be used on banks where mowing will be performed to maintain vegetation.

**MATERIAL SPECIFICATIONS**

GreenLoxx Non-MSE is comprised of 5 primary components: Filtrexx GroSoxx® fascia, Filtrexx® GrowingMedia™, geogrid, earth anchoring system, and vegetation. These components work together to establish a stabilization system of reinforced vegetation. For design drawing details of the GreenLoxx Non-MSE system see Figures 1.1 through 1.3.

**Definitions:**

**1. GroSoxx:** Multifilament Polypropylene mesh en-



capsulating Filtrexx GrowingMedia used for a soft vegetative fascia.

- 2. Geosynthetic Reinforcement:** Geogrid fabric used to provide stability and protection to the GroSoxx
- 3. Filtrexx Certified GrowingMedia:** Blended growth media, appropriate to the site and the plant list, placed in GroSoxx Fascia Unit that meets the strict requirements of the Filtrexx program.
- 4. Irrigation Components:** Drip tape, and all connection accessories, used internally in the GreenLoxx Non-MSE Wall
- 5. Earth Anchor:** Earth Anchors are a cable tendon with a zinc aluminum anchor head, and a zinc alloy anchor. Each anchor is driven with a mechanical driver.

#### References:

- 1. GroSoxx Mesh:** Multifilament polypropylene: ASTM G-155
- 2. Geosynthetic reinforcement:** ASTM D 6637, ASTM D 5262, ASTM D 5261, GRI GG-4 (b)
- 3. Anchors:** ASTM B-240-10, ASTM A-1023, ASTM B-240-10, ASTM B-240-10, MS51844
- 4. Filtrexx Certified Growing Media:** PH – 5.0-8.0 in accordance with TMECC 04.11-A, moisture content of less than 60% in accordance with standardized test methods for moisture determination, 100% passing a 2 in (50mm) sieve, 99% passing a 1 in (25mm) sieve, minimum of 60% passing a 1/2 in (12.5mm) sieve in accordance with TMECC 02.02-B, “Sample Sieving for Aggregate Size Classification”.

#### Filtrexx® GroSoxx®

*As locally produced by a licensed manufacturer*

GroSoxx is comprised of tubular mesh netting material specifically designed to retain Filtrexx® GrowingMedia™, seed and other materials. This finished product, stacked during construction, promotes healthy vegetation growth. Moisture flows freely to both reduce hydrostatic pressure and increase drainage of subsurface moisture to the vegetated fascia. The openings in GroSoxx are such that they allow for root growth while retaining GrowingMedia for healthy vegetation from either seed, live plugs or stakes. Soxx wall fascia units are available in diameters of 8 in (200mm), 12 in (300mm), 18 in (450mm), 24 in (600mm), and 32 in (800mm) and are constructed of a variety of materials and characteristics (see Table 1.1). The specific size of the Soxx for each site will vary based on intended height of the application, intended batter (backfill), and spacing of geogrid or any other anchoring/tieback

system. Generally speaking, GroSoxx will decrease in diameter from the base of the wall to the top, creating a firm footer for the wall while decreasing the load of the successive layers.

GroSoxx are installed in continuous sections or segmented units, reducing the number of breaks in the system that might occur compared to other block structures. This allows the GroSoxx fascia to act as a solid, seamless beam across the slope, further distributing any acting pressures.

#### GrowingMedia™ Characteristics

GreenLoxx Non-MSE uses only Filtrexx® GrowingMedia™ which is a composted material that is specified to match the planting list for the region of use, in order to facilitate successful grow-out / long-term coverage of the completed wall or slope system. GrowingMedia can be third party tested and certified to meet minimum performance criteria defined by Filtrexx International. Performance parameters include: percent cover of vegetation, water holding capacity, pH, organic matter, soluble salts, moisture content, biological stability, maturity bioassay, percent inert material, bulk density and particle size distribution. For information on the physical, chemical, and biological properties of GrowingMedia refer to Specification 5.2 Filtrexx® GrowingMedia™.

#### Geogrid Reinforcement

Geogrid is a commonly used component for soil stabilization. GreenLoxx Non-MSE may be installed using a geogrid to meet the requirements of the project engineer. Filtrexx Geogrids are typically bi-axial in strength for constructability and with open apertures of 2” by 2” to facilitate insertion of live plant material without cutting. Geogrid is laid on the entire embankment and an over-wrap is recommended around every one or two courses of GroSoxx. Therefore, as geogrid spacing varies for application to application, GroSoxx fascia size (8 in dia or 200mm to 24 in dia or 600mm) is adjusted to meet the grid-spacing requirements as determined by the site engineer. Refer to Table 2.3 for technical data detailing the properties and strength of each variety of Filtrexx FLW geogrid.

For structural retaining walls, see Section 3.3 GreenLoxx MSE Living Retaining Wall. GreenLoxx Non-MSE is not intended to be used for structural applications.

#### Anchors

Earth Anchors are used to mechanically connect the fascia units and geogrid to the existing slope, they are



installed at the top of each geogrid wrap. The spacing is based on the site engineer as well as the strength and length of each anchor.

**Vegetation Choices**

- Turf/Forage Grasses
- Groundcovers
- Live Shrub Cuttings
- Native species
- Vines, etc.

**Methods for Establishing Vegetation**

- GrowingMedia incorporated with seed
- Live Staking
- Broadcast seeding
- Plugs

**Vegetation Selection**

When selecting vegetation for GreenLoxx Non-MSE the following should be considered:

- Degree of maintenance required. In general, low maintenance species are desirable
- Drought resistance
- Freeze tolerance
- Aesthetics
- Degree of Slope



*Note: If in doubt regarding vegetation, Filtrexx International should be consulted.*

**INSTALLATION**

1. GreenLoxx Non-MSE shall meet Filtrexx Specifications and use Filtrexx GrowingMedia.
2. Contractor is required to be a Filtrexx® Certified<sup>SM</sup> Installer as determined by Filtrexx International (877-542-7699). Certification shall be considered current if appropriate identification is shown during time of bid or at time of application. Look for the Filtrexx Certified Installer Seal.

**Required Tools & Materials**

- Safety Equipment
- Rappelling gear/rope tie offs
- Shovel(s)
- Laser level (or hand level)
- Tape Measure
- String Line
- Marking Paint
- Pneumatic blower unit
- Seed blending capability
- Filler cone for filling GroSoxx wall fascia (or prefilled GroSoxx on pallets)

**Materials:**

- Approved Filtrexx® Soxx™ mesh
- Approved Filtrexx® GrowingMedia™
- Tie-wraps (8 in or 200mm)
- Sod staples (8 in or 200mm)
- 2 in x 2 in x 24 in (50mm x 50mm x 600mm) wood stakes

**Site Preparation**

Prior to construction of GreenLoxx Non-MSE some preparation of the project area may be necessary. The project area must be clear of rock and debris that could prevent good ground contact or potentially damage the GroSoxx. During installation, care should be taken not to disturb excessive areas that will then need to be revegetated. In many cases, the GroSoxx may be installed around existing vegetation and land features which will increase the integrity of the system.

**Drainage**

Unlike impermeable, hard-faced walls, a drainage zone behind the face of the GreenLoxx Non-MSE may not be required. This is because the GroSoxx fascia is highly permeable. This permeability greatly reduces hydrostatic pressure and facilitates hydration of the GrowingMedia and fascia vegetation. Where increased drainage is desired or in high-flow areas, stone may be added in addition to the GrowingMedia in the first and/or second GroSoxx course to enhance the movement of interflow, subsurface flow and/or runoff. Additional drainage systems may be installed behind the wall. It is recommended that drainage requirements be addressed by a geotechnical engineer and/or hydrologist on a site-by-site basis.

**Installation of Base Course**

After initial site preparation, construction of the wall may begin. Begin by laying the geogrid from the top of wall to the bottom of wall on contour where the first course of the GroSoxx is to be installed. Place the geogrid so that the remainder of the rolls is at the toe of the wall. After a work plan is reached between the blower truck operator and wall installation team, the base course may be installed. The desired seed mix and/or additives should also be installed in the Seed Injection Unit(s) or otherwise premixed with the GrowingMedia inside the GroSoxx. The first layer of GroSoxx can then be placed or blown in place, wrapped with geogrid, and then anchored at the pinch point between the geogrid and GroSoxx.



### **Anchoring System**

After the GroSoxx Fascia Units have been wrapped with Geogrid Reinforcement, the anchoring system is then put in place. The Anchors are installed at the pinch point where the Geogrid that is wrapping the face meets the Geogrid behind the GroSoxx Fascia Unit. The Anchor is mechanically driven with a gas powered driver directly into the substrate through the open grid apertures, typically driven in 2.5 ft depth or to the engineer's specification. The anchor is then mechanically load locked which sets the anchor in the existing substrate, this process is continued typically at 4' on center or according to specified engineer's drawings.

### **Installation of Successive Courses**

Successive courses will be set upon previous courses in a batter prescribed by the site engineer. Continue placing GroSoxx; the weight of successive layers will slightly compact the GroSoxx. Walking along the courses of GroSoxx or tamping them will ensure consistent settlement as well.

### **Capping**

A number of options exist for capping GreenLoxx Non-MSE Walls. In any case, it is important that the geogrid is sufficiently buried below finished grade. In most cases a single GroSoxx can be placed at the top of the wall and backfilled with topsoil or GrowingMedia. An application of a Filtrexx storm water blanket (Specification 2.1) will connect the system with existing vegetation and help to reduce run-on/runoff volume and velocity flowing to the GreenLoxx Non-MSE system.

### **Planting**

GroSoxx were designed from their inception to be planted and grown over. The system is intended to be a reliable means for creating strong, economical structures that quickly disappear into the natural landscape. The system design shall facilitate the structural facing being completely covered with selected plantings once established to yield an end-product that blends into the surrounding landscape as opposed to separating it. If planting live plants instead of from seed, planting must start from the top course and continue down the face of the wall. Always consult with the owner and/or their representatives early in the project to determine all responsible parties with regard to plants, quantity, design, maintenance and feeding.

### **Irrigation (if needed)**

The system may accommodate internal irrigation and it can be installed during the building process. Irrigation is not always necessary depending upon the specific site and if water is present. The inclusion of efficient drip irrigation will ensure fast establishment of intended species regardless of climatic conditions such as untimely heat and drought. The insertion of drip tubing is executed by cutting small slits in the Soxx mesh and threading tubing laterally under the mesh, inside the soxx from station to station. Depending on slope configuration and project intentions, it may be necessary to irrigate each row of GroSoxx.

### **INSPECTION**

Field reviews to ensure seed and/or plant establishment should occur at regular intervals after seeding or planting to assure germination and/or coverage of the wall system.

At six months if complete coverage has not occurred it is recommended that reseeding or remedial planting be preformed.

### **MAINTENANCE**

Maintenance and care of the vegetated portions of the wall system is required at least until the vegetation is established (grown in). The initial and continuing maintenance required will depend on the plantable unit infill, type of vegetation, local weather conditions and exposure. Filtrexx International may, at its discretion, provide maintenance review visits for the purpose of documenting the progress and condition of the completed system. At such regular visits within the first 12-24 months from completion, reports will be generated and shared with stakeholders as a tool to facilitate successful grow-out. Plant maintenance can be offered as a line item in the material package and carried out by Filtrexx International or it can be designated for the Site Contractor. Any provisions, by and for, the project owner in addition to those listed above, such as % plant coverage by calendar date, shall be placed in a separate document and included with the plans and specifications of the project prior to bidding and selection of installer.

### **METHOD OF MEASUREMENT**

GreenLoxx Non-MSE shall be itemized as 'Supply and Installation of 'Filtrexx GreenLoxx Non-MSE/ GroSoxx'. Bid prices shall be based on a per ft<sup>2</sup> or m<sup>2</sup> of fascia and shall include the supply and installation of the following:



- Filtrexx Soxx mesh filled with Filtrexx GrowingMedia and vegetated with site specific seed or plantings (Filtrexx GroSoxx).
- Filtrexx FLW Geogrid
- GrowingMedia/aggregate/soil backfill as needed.
- Filtrexx compost storm water blanket around extremities of system.

Engineer shall notify Filtrexx of location, description, and details of project prior to the bidding process so that Filtrexx can provide design aid and technical support.

**Submittals**

- 1. Shop Drawings:** Retaining wall design calculations, including global stability analysis and drawings are to be stamped by a registered Professional Engineer licensed in the state of the project. Filtrexx International can provide design services, pertaining to Filtrexx LivingWalls
- 2. Product Data:** Material description for all components listed in section 1.02 of this document to include, composition, MSDS sheets, manufacturer certifications and installation information for each product specified as part of the system.
- 3. Planting and Irrigation Plan:** Plant list with elevation views, approved suppliers, seasonal requirements for planting, fertilization, plant coverage targets, methods of measurement, erosion control plans addressing site runoff during and after construction, maintenance agreements

**Delivery, Storage & Handling**

1. Contractor shall check the materials upon delivery to assure the proper materials have been received.
2. GroSoxx are to match specified length and diameter per engineered drawings, while also being free of any rips or tears in mesh material.
3. Contractor shall protect the materials from damage, as damaged materials shall not be used in the project.

**ADDITIONAL INFORMATION**

For other references on this topic, including additional research reports and trade magazine and press coverage, visit the Filtrexx website at [www.filtrexx.com](http://www.filtrexx.com)

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 Call for complete list of international installers.

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## TABLES & FIGURES:

**Table 1.1.** Filtrexx® FilterSoxx™ Material Specifications.

| Material Type  | Multi-Filament Polypropylene (HDPP)  | Multi-Filament Polypropylene SafteySoxx™          | Multi-Filament Polypropylene DuraSoxx®   |
|--|--|---|--|
| Material Characteristic                                    | Photodegradable  | Photodegradable                                   | Photodegradable  |
| Design Diameters   | 8 in (200mm),<br>12 in (300mm),<br>18 in (400mm),<br>24 in (600mm),<br>32 in (800mm) | 8 in (200mm),<br>12 in (300mm),<br>18 in (400mm), | 8 in (200mm),<br>12 in (300mm),<br>18 in (400mm),<br>24 in (600mm),<br>32 in (800mm) |
| Mesh Opening   | 3/8 in (10mm)  | 1/8 in (3mm)                                      | 1/8 in (3mm)   |
| Tensile Strength   | 44 psi (3.09 kg/cm2)   | 202 psi (14.2 kg/cm2)*                            | 202 psi (14.2 kg/cm2)  |
| % Original Strength from Ultraviolet Exposure (ASTM G-155) | 100% at 1000 hr  | 100% at 1000 hr                                   | 100% at 1000 hr  |
| Functional Longevity/ Project Duration**                   | 1-4 yr   | 2-5 yr  | 2-5 yr   |

\* Tested at Texas Transportation Institute/Texas A&M University (ASTM 5035-95).

\*\* Functional Longevity based on continual UV exposure without vegetation. Once vegetation is established longevity of the system is greatly increased. Functional longevity ranges are estimates only. Site specific environmental conditions may result in significantly shorter or longer time periods.

**Table 1.2.** Vegetated Retaining Wall GroSoxx® Wall Fascia Sizing.

| Prescribed vertical geogrid spacing as per Engineer |     | GroSoxx® wall fascia diameter |     |
|---|-----|-------------------------------|-----|
| inches  | mm  | inches                        | mm  |
| 8   | 200 | 12                            | 300 |
| 12  | 300 | 18                            | 450 |
| 18  | 450 | 24                            | 600 |
| 24  | 600 | 30                            | 750 |





**Table 1.3. Filtrex FLW Geogrid Details**

FLW Geogrids are composed of high molecular weight, high tenacity multifilament polyester yarns that are bidirectional and woven into a stable network placed under tension. The high strength polyester yarns are coated with a PVC material. FLW Geogrids are inert to biological degradation and are resistant to naturally encountered chemicals, alkalis and acids. FLW Geogrids are typically used for soil reinforcement applications such as retaining walls, steep-ened slopes, embankments, sub-grade stabilization, embankments over soft soils and waste containment applications.

| FLW 20 Tensile Properties                                     | Test Method | MARV Values (lbs/ft) MD/CMD |
|---|-------------|-----------------------------|
| Ultimate Strength Machine Direction                           | ASTM D 6637 | 2,075                       |
| Creep Limited Strength Machine Direction                      | ASTM D 5262 | 1,313                       |
| T <sub>al</sub> = Long Term Design Strength Machine Direction | NCMA 97     | 1,085                       |
| Aperture Size - 2.00 x 2.00 (inches)                          | Measured    | N/A                         |

RF Creep - 1.58 RF Durability - 1.10 RF Installation Damage (Soil Type 3) - 1.10

| FLW 35 Tensile Properties                   | Test Method | MARV Values (lbs/ft) MD/CMD |
|---|-------------|-----------------------------|
| Ultimate Strength                           | ASTM D 6637 | 3,600                       |
| Creep Limited Strength                      | ASTM D 5262 | 2,278                       |
| T <sub>al</sub> = Long Term Design Strength | NCMA 97     | 1,918                       |
| Aperture Size - 2.00 x 2.00 (inches)        | Measured    | N/A                         |

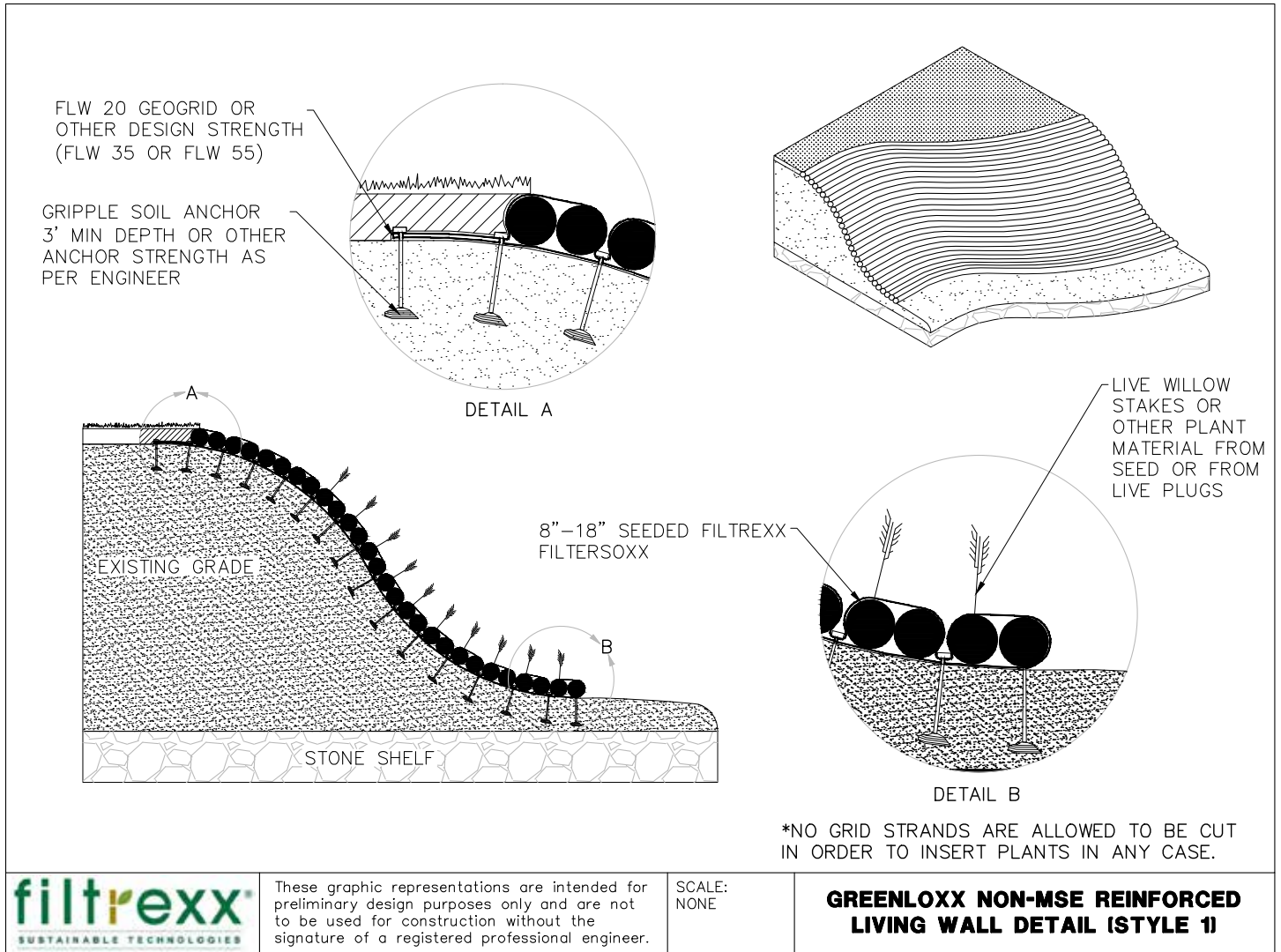
RF Creep - 1.58 RF Durability - 1.10 RF Installation Damage (Soil Type 3) - 1.08

| FLW 55 Tensile Properties                   | Test Method | MARV Values (lbs/ft) MD/CMD |
|---|-------------|-----------------------------|
| Ultimate Strength                           | ASTM D 6637 | 5,000                       |
| Creep Limited Strength                      | ASTM D 5262 | 3,165                       |
| Tensile Strength @ 5% Strain                | ASTM D 6637 | 1,500                       |
| T <sub>al</sub> = Long Term Design Strength | NCMA 97     | 2,740                       |
| Aperture Size - 2.00 x 2.00 (inches)        | Measured    | N/A                         |

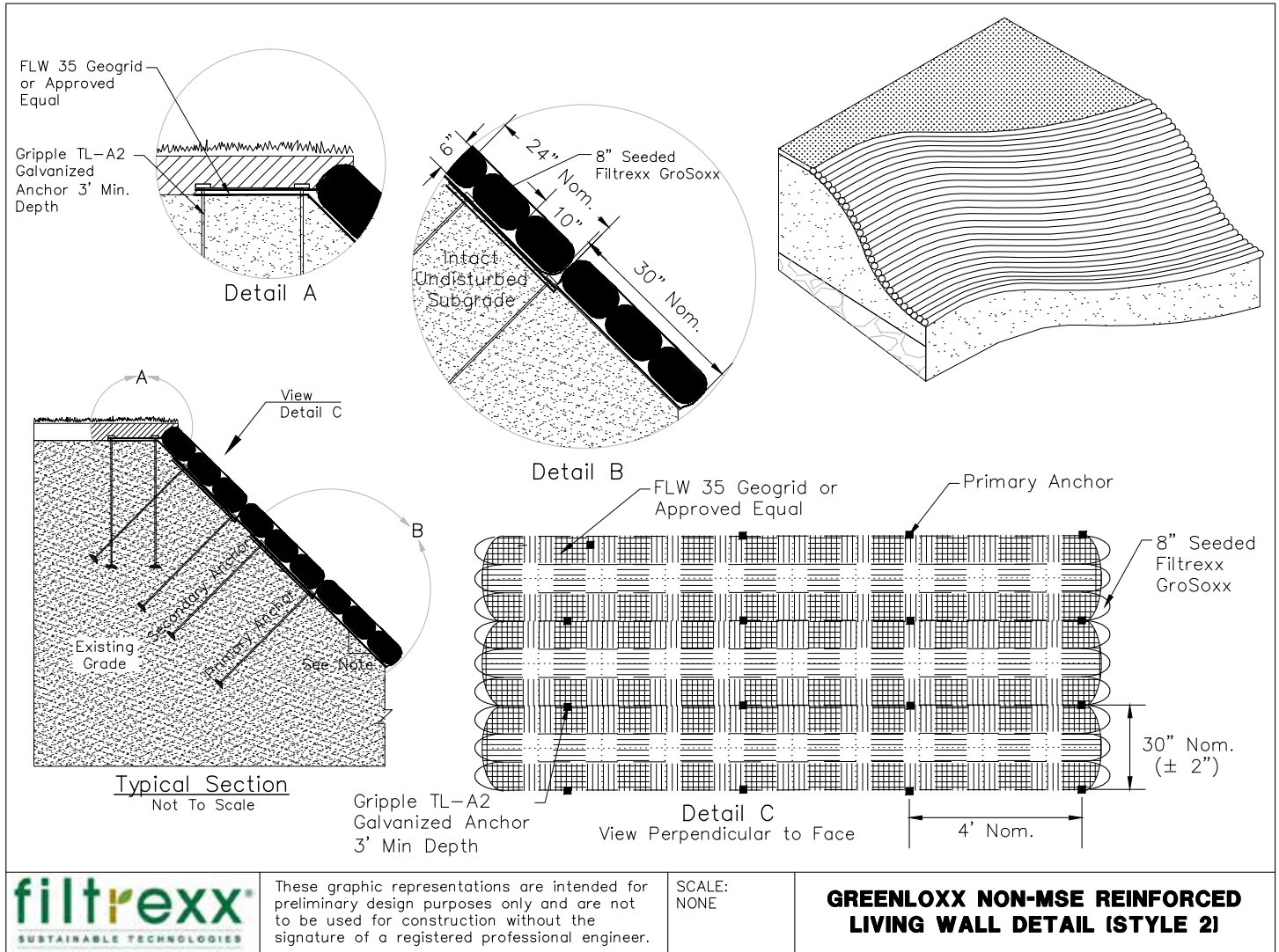
RF Creep - 1.58 RF Durability - 1.10 RF Installation Damage (Soil Type 3) - 1.05



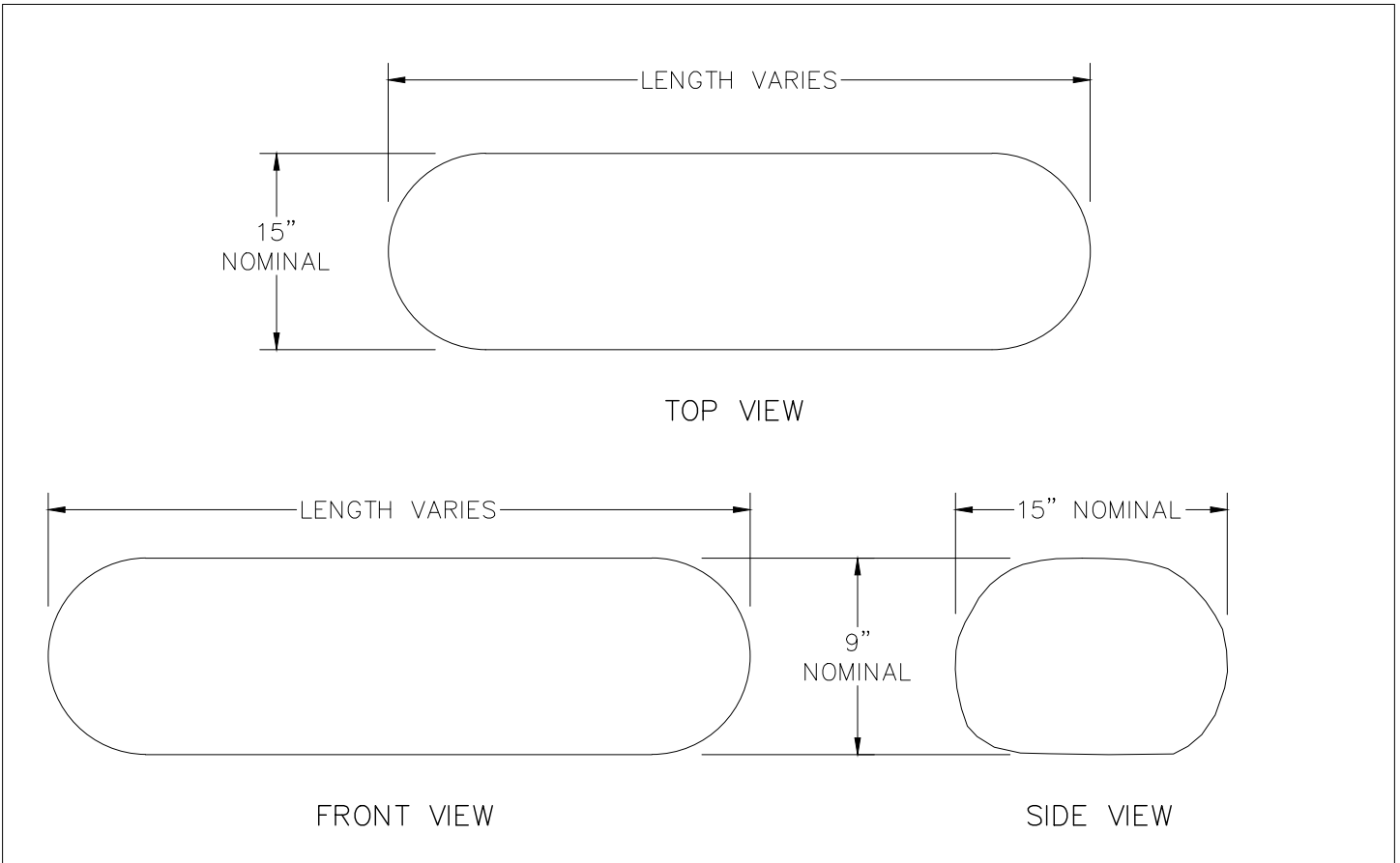
**Figure 1.1.** Engineering Design for Filtrexx® GreenLoxx® Non-MSE Living Wall



**Figure 1.2. Engineering Design for Filtrex® GreenLoxx® Non-MSE Living Wall - Alternate Drawing**



**Figure 1.3.** Filtrexx® GreenLoxx® 12" GroSoxx® Module Dimensions Detail



**NOTES:** GROSOXX ARE 12-INCH DIAMETER TUBES THAT DEFORM TO NOMINALLY 9-INCHES TALL AND 15-INCHES WIDE.

|  |   |                        |   |
|--|---|------------------------|---|
|  | <p>These graphic representations are intended for preliminary design purposes only and are not to be used for construction without the signature of a registered professional engineer.</p> | <p>SCALE:<br/>NONE</p> | <p><b>GREENLOXX 12' DIA. GROSOXX<br/>MODULE DIMENSIONS DETAIL</b></p> |
|--|---|------------------------|---|

