DESIGN SPECIFICATION

3.1 GreenLoxx® Vegetated Slope Facing (VSF)

filtrexx® SUSTAINABLE TECHNOLOGIES

PURPOSE & DESCRIPTION

Filtrexx **GreenLoxx® Vegetated Slope Facing (VSF)** allows for the **protection 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 Filtrexx **GroSoxx®**, the GreenLoxx VSF system provides superior soil retention and erosion protection while providing an optimum environment for vegetation establishment. GroSoxx consists of Filtrexx® Durable mesh, filled with composted Filtrexx® GrowingMedia™. GreenLoxx VSF shall be designed as a plantable fascia providing two functions – surface protection from erosion, and plant growth. GreenLoxx VSF 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 VSF, 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. Encountering any of the following will require an engineer's review of the site and site-specific design prior to construction of a GreenLoxx VSF:

- GreenLoxx VSF 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 GreenLoxx VSF will be exerted on the GreenLoxx VSF.
- Mechanical stabilization devices will be incorporated into the GreenLoxx VSF system.

Constructing a GreenLoxx VSF involves stacking GroSoxx on top of one another in a recessed fashion on slopes. Geogrid is seamlessly incorporated into the system giving it added support and integrity to meet specific environmental and site requirements.

Although the central focus of the GreenLoxx VSF system is to protect 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 fascia of GroSoxx as well as the GrowingMedia™ that fills the GroSoxx.

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

- Steep Slopes
- Streambanks
- Pond banks
- Slip Repairs
- Culvert Headwalls
- Bridge Abutments
- Dikes/Berm
- Flood Protection

ADVANTAGES

- Lightweight components
- Highly efficient installation
- No footing or leveling pad required
- Seed injection into GroSoxx (optional)
- Filtrexx® GrowingMedia™
- Easily reinforced for severe applications (requires engineering stamp and soil analysis)
- Improved drainage/reduction of hydrostatic pressure
- Customizable vegetation with plants, plugs, live stakes or seed
- GreenLoxx VSF may assist in qualification for LEED® Green Building Rating and Certification credits under LEED Building Design & Construction (BD+C), New Construction v4. 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.*

MATERIAL CHARACTERISTICS

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

Definitions:

1. **GroSoxx:** Filtrexx Durable Multifilament Polypropylene mesh encapsulating Filtrexx GrowingMedia used for a soft vegetative fascia.
2. **Filtrexx Certified GrowingMedia:** Blended growth media, appropriate to the site and the plant list, placed in GroSoxx that meets the strict requirements of the Filtrexx program.
3. **Geosynthetic Reinforcement:** Geogrid fabric is used to provide stability and protection to the GroSoxx.
4. **Soil Anchor:** Soil Anchors are a cable tendon with a zinc aluminum anchor head, and a zinc alloy anchor. Each anchor is driven with a mechanical driver.
5. **Irrigation Components (optional):** Drip tape, and all connection accessories, used internally in the GreenLoxx VSF.

ADVANTAGES			
	LOW	MED	HIGH
Installation Difficulty		✓	
Soil Retention Ability			✓
Vegetation Establishment			✓
Aesthetic Quality			✓
Drainage			✓

References:

1. **GroSoxx Mesh:** Multifilament polypropylene: ASTMG-155
2. **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 ½ in (12.5mm) sieve in accordance with TMECC 02.02-B, "Sample Sieving for Aggregate Size Classification".
3. **Geosynthetic reinforcement:** ASTM D 6637, ASTM D 5262, ASTM D 5261, GRI GG-4 (b)
4. **Soil Anchors:** ASTM B-240-10, ASTM A-1023, ASTM B-240-10, ASTM B-240-10, MS51844

Filtrexx GroSoxx®

Filtrexx GroSoxx is comprised of Filtrexx® Durable 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. Standard GroSoxx units for a GreenLoxx VSF are manufactured in a diameter of 8 in and a length of 3 feet.

Filtrexx® GrowingMedia™ Characteristics

GreenLoxx VSF 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/longterm coverage of the completed slope protection 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 bio-assay, 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 VSF is installed using geogrid that is bi-axial in strength for constructibility 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 three courses of GroSoxx. Geogrid overwrap may be 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 Filtrexx FLW35 geogrid.

For structural retaining walls, see Section 3.2 GreenLoxx MSE Living Retaining Wall. GreenLoxx VSF is not intended to be used for structural applications.

Anchors

Soil Anchors are used to mechanically connect the GroSoxx 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 VSF the following should be considered:

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

INSTALLATION

Required Tools & Materials

- PPE/Safety Equipment
- Shovel(s)
- Laser level (or hand level)
- Tape Measure
- String Line
- Marking Paint
- Anchor driving and setting equipment

Materials

- Filtrexx GroSoxx
- Filtrexx FLW35 Geogrid
- Soil anchors
- Seed and planting material
- Irrigation (optional)
- Additional materials may be required as determined by the engineer.

Site Preparation

Prior to construction of GreenLoxx VSF 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 VSF is typically not required. GroSoxx are highly permeable, greatly reducing hydrostatic pressure and facilitating hydration of the GrowingMedia and 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. 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 GreenLoxx VSF may begin. Begin by laying the geogrid from the top of slope to the bottom of slope on contour where the first course of the GroSoxx is to be installed. Place the geogrid so that the remainder of the roll is at the toe of the slope. The first layer of GroSoxx can then be placed, wrapped with geogrid, and then anchored at the pinch point between the geogrid and GroSoxx. The anchors are mechanically driven with a gas powered driver directly into the substrate through the open grid apertures, typically driven in a minimum depth of 3 feet 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 3 feet on center or according engineer's specifications.

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
Capping is done at the top of the GreenLoxx VSF to ensure that the GreenLoxx VSF is not undermined. 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 GreenLoxx VSF and backfilled with topsoil or GrowingMedia to connect the system with existing vegetation and help to reduce run-on/runoff volume and velocity flowing to the GreenLoxx VSF system.

Planting
GroSoxx are designed 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. If planting live plants instead of seed, planting must start from the top course and continue down the face of the GreenLoxx VSF. 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, and will depend on the availability of a water source at the site. The inclusion of efficient drip irrigation can 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 GroSoxx mesh and threading tubing laterally under the mesh, inside the GroSoxx 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 GreenLoxx VSF.

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

MAINTENANCE
Maintenance and care of the vegetated portions of the GreenLoxx VSF 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.

METHOD OF MEASUREMENT
GreenLoxx VSF shall be itemized as 'Supply and Installation of 'Filtrexx GreenLoxx VSF/GroSoxx'. Bid prices shall be based on a per ft^2 or m^2 of fascia and shall include the supply and installation of the following:

- Filtrexx GroSoxx (Filtrexx Durable mesh filled with Filtrexx GrowingMedia and seed [optional] or plantings)
- Filtrexx FLW35 Geogrid
- Soil anchors
- GrowingMedia/aggregate/soil backfill as needed

1. **Shop Drawings (if required):** Design calculations, including global stability analysis and drawings may be required. If so, they are to be stamped by a registered Professional Engineer licensed in the state of the project.
2. **Product Data:** Material description for all components listed in 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
Contractor shall check the materials upon delivery to assure the proper materials have been received.

GroSoxx are to match specified length and diameter per engineered drawings, while also being free of any rips or tears in mesh material.

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 filtrexx.com

Filtrexx International, Technical Support
877-542-7699 | www.filtrexx.com | info@filtrexx.com
Call for complete list of international installers and distributors.

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FIELD APPLICATION PHOTO REFERENCES

Project site, GreenLoxx VSF Installation

GreenLoxx VSF, after

Table 1.1. Filtrexx GroSoxx® Mesh Material Specifications.

Material Type	DURABLE (Multi-Filament Polypropylene MFPP)
Material Characteristic	Photodegradable
Design Diameters	8 in (200mm)
Mesh Opening	1/8 in (3mm)
Tensile Strength (ASTM D4595)[1]	MD: 545 lbs TD: 226 lbs
% Original Strength from Ultraviolet Exposure (ASTM G-155)	100% at 1000 hr
Functional Longevity/ Project Duration[2]	up to 5 yr

[1] Tensile Strength is based on 12″ diameter using ATSM D4595. See Filtrexx TechLink #3342 for full tensile strength testing.
[2]Functional longevity ranges are estimates only. Site specific environmental conditions may result in significantly shorter or longer time periods.

Table 1.2. Filtrexx 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, steepened slopes, embankments, sub-grade stabilization, embankments over soft soils and waste containment applications.

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_{al} = 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

Figure 1.1. Engineering Design Drawing for Filtrexx GreenLoxx® VSF

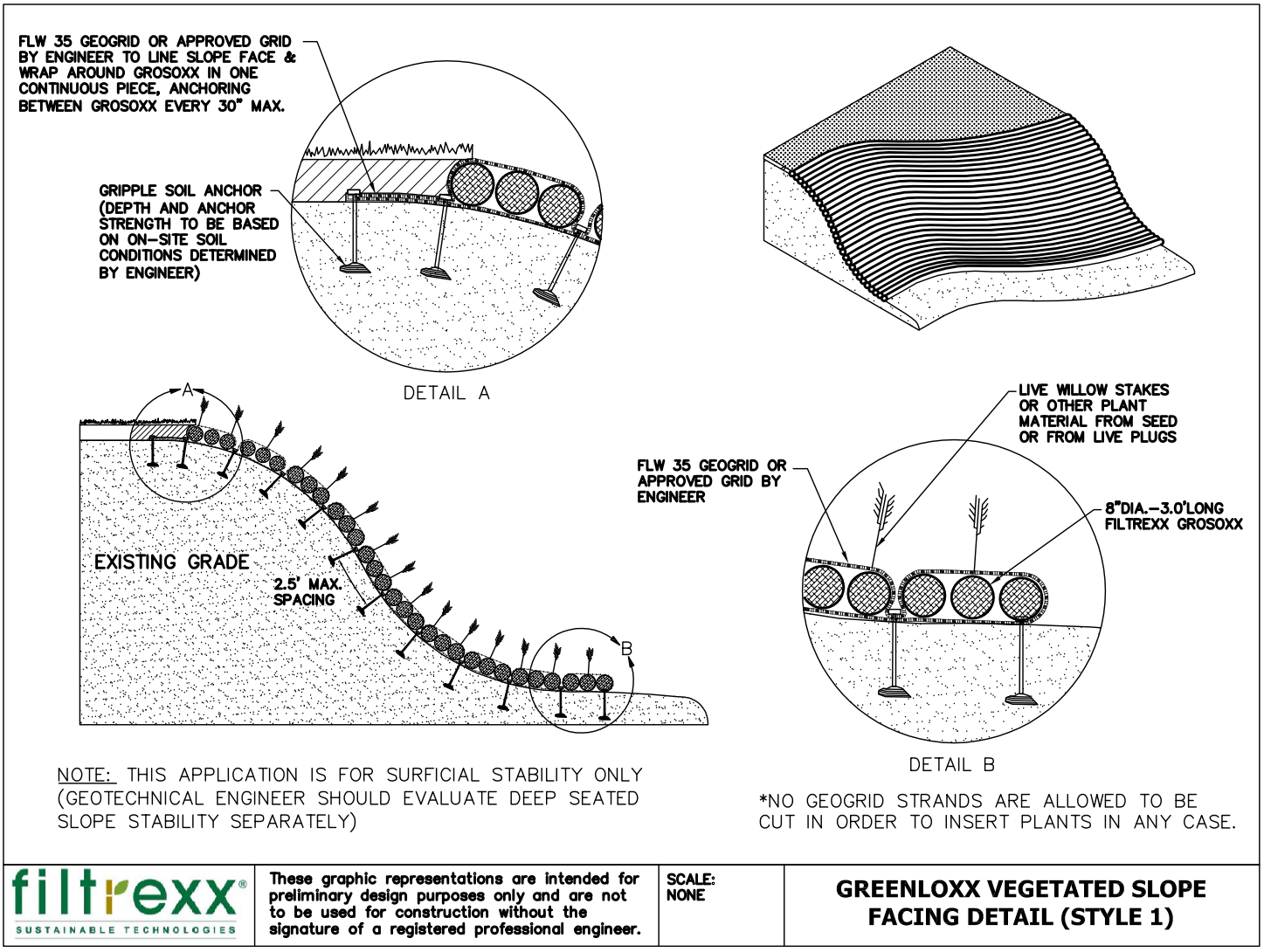

Figure 1.2. Engineering Design Drawings for Filtrexx GreenLoxx® VSF - Alternate Drawing

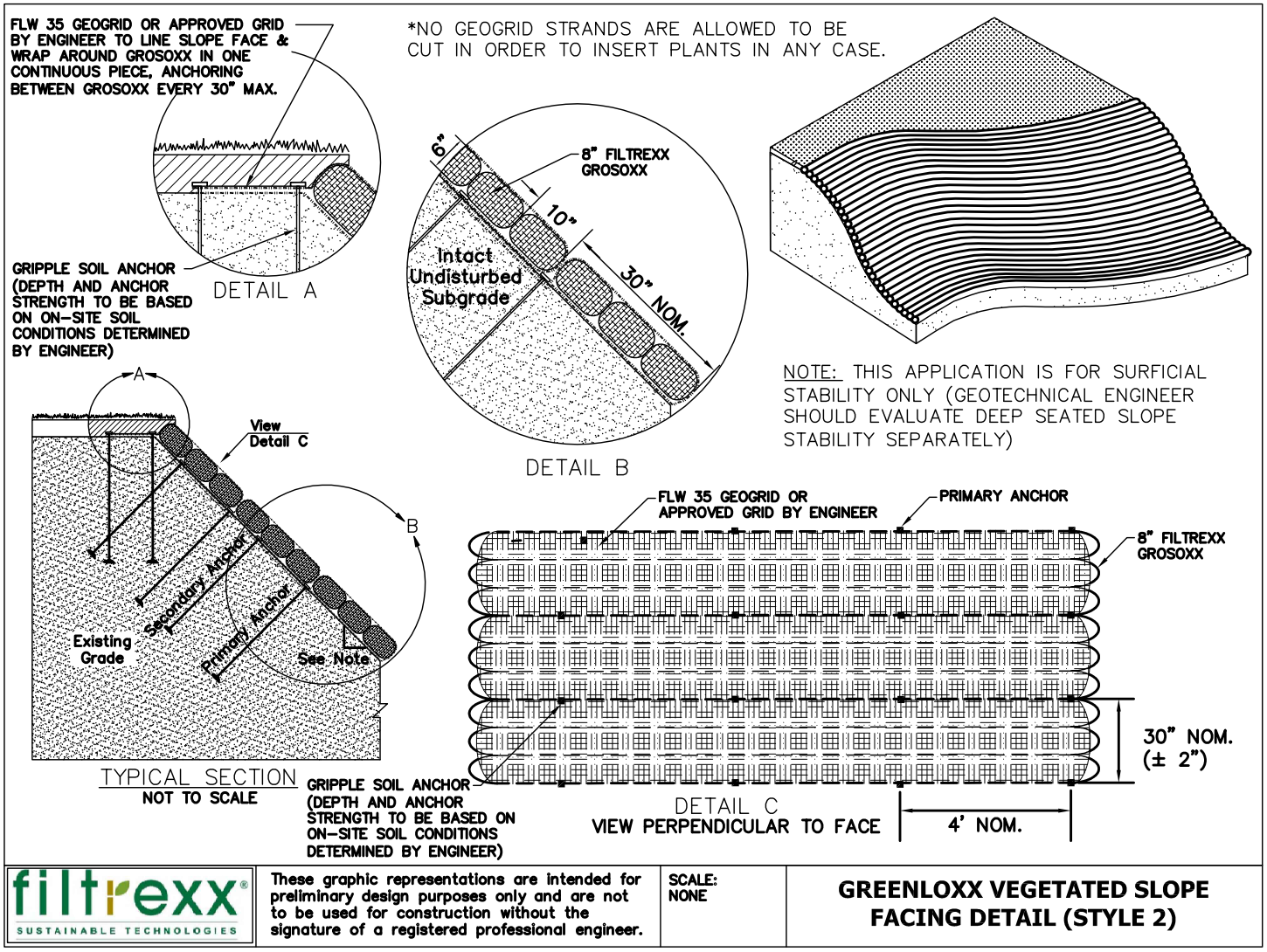

Figure 1.3. Filtrexx GreenLoxx® 8″ GroSoxx® Module Dimensions Detail