To: SUPERSEDED BY EI 14-012 EFFECTIVE 1/8/2015		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 10-031

Title: **SECTION 554 – FILL TYPE RETAINING WALLS**

Distribution:
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Approved:
Anthony Torre 10-29-10
Anthony Torre, P.E., Date
Acting Deputy Chief Engineer (Research)

ADMINISTRATIVE INFORMATION:

- This Engineering Instruction (EI) is effective beginning with projects submitted for the letting of May 5, 2011.
- Superseded issuance(s): This EI supersedes EI 84-056, EI 96-018, EI 08-020 and EI 08-037.
- The information transmitted by this issuance will be incorporated into a future revision to the Standard Specifications.

PURPOSE: The purpose of this EI is to revise Standard Specifications Section 554 – Fill Type Retaining Walls.

TECHNICAL INFORMATION:

- EI 08-037 revised Section 554 *Internally Stabilized Fill Structures*, incorporating some special specifications into the standards. EI 08-020 revised Section 632 *Precast Modular Walls*, emulating the procedures defined in Section 554 for approving a wall system. Both sections refer to the Approved List for acceptable proprietary retaining wall systems and outline a submittal process for approving the Shop Drawings of a particular job specific wall system design.

  This revision to Section 554 takes the next logical step by combining the two sections into one. Section 554 *Fill Type Retaining Walls* is outlined to include Geosynthetically Reinforced Soil Systems (GRSS) and all proprietary fill type retaining walls (both internally stabilized fill structures and externally stabilized fill structures) which will be bid based on the height of wall.
- Section 632 *Precast Modular Walls* will be deleted.
- The Approved List will also identify designers of fill wall systems based on height of wall. Section 554 *Fill Type Retaining Walls* will still identify subcategories of walls (i.e. Mechanically Stabilized Earth System, Mechanically Stabilized Wall System, and Prefabricated Wall Systems) to provide requirements for the wall system selected by the Contractor.
- By combining all proprietary fill type retaining walls into one specification based on height ranges, a larger, more expansive Approved List was developed. This should aid designers by simplifying the detailing process and aid Contractors by providing approved systems based on the maximum height of the wall shown in the contract documents.

  The Approved List was revised to identify approved designers of Fill Type Retaining Walls. For designers who are interested in gaining acceptance onto the Approved List, submission instructions are available in the Department's Highway Design Manual, at: https://www.nysdot.gov/divisions/engineering/design/dqab/hdm/hdm-repository/chapt_09.pdf, in Appendix A of Chapter 9.
- The externally stabilized fill structures included in Section 554 *Fill Type Retaining Walls* incorporate both precast modular wall systems (open top face units) and segmental block wall systems (solid face

units). The specification combines the two types of wall systems into one generic category: Prefabricated Wall Systems.

- There are two main manufacturing processes used in the production of segmental precast concrete retaining wall blocks (solid face units); dry casting and wet casting. The dry cast process utilizes a stiff concrete mixture prepared with a minimal amount of water. The stiff concrete is placed into molds and consolidated through compression and vibration. Freeze thaw durability is obtained through the high density and low permeability of the concrete.

  The wet cast process utilizes a plastic concrete mixture prepared with a higher water content than the dry cast process. The plastic concrete is placed into molds and consolidated through vibration. Freeze thaw durability is obtained through the use of air entraining admixtures which create a system of entrained air voids in the concrete.

  To incorporate both wet cast and dry cast units into the prefabricated wall system category, the Department had to address the difference between masonry materials acceptance and precast concrete materials acceptance. Under current specifications, precast concrete materials are produced and accepted under a QC/QA program which allows approved manufacturers to produce, sample and test their products and then supply them to projects when specification requirements have been met. Under current specifications, masonry products are produced and accepted under a stock lot program which requires Department sampling and testing of products before they can be supplied to projects. The Materials Bureau has developed and is now implementing a QC/QA program for masonry materials which will operate much like the precast program allowing the two manufacturing processes to compete more competitively.
- The approved designers of proprietary fill type retaining wall systems used by the Department fall within three categories; mechanically stabilized earth systems (MSES), mechanically stabilized wall systems (MSWS), and prefabricated wall systems (PWS).

  The specification identifies a default treatment for the finished face of the chosen wall system. Aesthetic treatments applied to the face, either during or after the manufacture of the units, to modify the appearance of the units and of the wall as a whole may be identified in the contract documents and paid for under an additional, separate item.
- Over the years, the Reinforced Earth Company (RECo) has put several suppliers of MSES on notice to cease using "Reinforced Earth®" in their literature, drawings, web pages, and advertising as "Reinforced Earth®" is a registered trademark of RECo. Although the Department has been using Geosynthetic Reinforced Earth System (GRES) for years, RECo has requested an end to the acronym. Therefore, the terminology has been changed to Geosynthetically Reinforced Soil System (GRSS).
- Metric Standard Sheets M554-01 (Sheets 1 – 5) and M554-02 (Sheets 1 – 6) and US Customary Standard Sheets 554-01 (Sheets 1 – 5) and 554-02 (Sheets 1 – 6) are being issued concurrently via EB 10-041.
- Updates regarding *Fill Type Retaining Walls* to Chapter 9 of the Highway Design Manual are being issued concurrently via EB 10-042.

IMPLEMENTATION:

- The Main Office Design Quality Assurance Bureau will insert these standard specification revisions into contract proposals beginning with projects submitted for the letting of May 5, 2011.

- The following special specifications are disapproved:

Metric	Item 554.0401XX08:	Mechanically Stabilized Earth System (Modified) – No Color
Metric	Item 554.0402XX08:	Mechanically Stabilized Earth System (Modified) – Integral Color
Metric	Item 554.05----17:	Mechanically Stabilized Segmental Block Retaining Wall System (Extensible Reinforcement)
Metric	Item 554.9610--17:	Geosynthetic Reinforced Earth System (Permanent)
Metric	Item 554.9620--17:	Geosynthetic Reinforced Earth System (Temporary)
Metric	Item 554.96101010:	Mechanically Stabilized Earth System with Form Liner
Metric	Item 632.15----01:	Segmental Block Retaining Wall System – Install Only
Metric	Item 632.15----07:	Relocate Existing Ornamental or Decorative Segmental Block Wall (SBW)
US Cust	Item 632.15000007:	Relocate Existing Ornamental or Decorative Segmental Block Wall (SBW)
Metric	Item 632.15----17:	Segmental Block Retaining Wall System
US Cust	Item 632.15000017:	Segmental Block Retaining Wall System
Metric	Item 632.16----17:	Concrete Crib Type Retaining Wall "T-Wall"
Metric	Item 632.17----17:	Backfill for Concrete Crib Type Retaining Wall "T-Wall"
Metric	Item 632.20----17:	Precast Reinforced Concrete Cribwall (Evergreen Wall System)

- The following standard specifications are disapproved:

Metric & US Cust	Item 554.01XX:	Mechanically Stabilized Earth System, No Color
Metric & US Cust	Item 554.02XX:	Mechanically Stabilized Earth System, Integral Color
Metric & US Cust	Item 554.20:	Mechanically Stabilized Segmental Block Retaining Wall System
Metric & US Cust	Item 632.02:	Metal Bin-Type Retaining Wall
Metric & US Cust	Item 632.0501:	Excavation for Concrete Cribbing (Stretcher & Header Type)
Metric & US Cust	Item 632.0502:	Excavation for Concrete Cribbing (Precast Concrete Wall Unit Type)
Metric & US Cust	Item 632.0503:	Excavation for Metal Bin-Type Retaining Wall
Metric & US Cust	Item 632.0601:	Backfill for Concrete Cribbing (Stretcher & Header Type)
Metric & US Cust	Item 632.0602:	Backfill for Concrete Cribbing (Precast Concrete Wall Unit Type)
Metric & US Cust	Item 632.0603:	Backfill for Metal Bin-Type Retaining Wall
Metric & US Cust	Item 632.1001:	Precast Modular Wall, No Color, Plain Concrete Surface
Metric & US Cust	Item 632.1002:	Precast Modular Wall, No Color, Textured Surface (Hand Tooled, Raked, etc.)
Metric & US Cust	Item 632.1003:	Precast Modular Wall, No Color, Exposed Aggregate Surface
Metric & US Cust	Item 632.1004:	Precast Modular Wall, No Color, Architectural Pattern (Form Liner or Stamped)

Metric & US Cust	Item 632.1005:	Precast Modular Wall, No Color, As Shown in the Plans
Metric & US Cust	Item 632.1101:	Precast Modular Wall, Integral Color, Plain Concrete Surface
Metric & US Cust	Item 632.1102:	Precast Modular Wall, Integral Color, Textured Surface (Hand Tooled, Raked, etc.)
Metric & US Cust	Item 632.1103:	Precast Modular Wall, Integral Color, Exposed Aggregate Surface
Metric & US Cust	Item 632.1104:	Precast Modular Wall, Integral Color, Architectural Pattern (Form Liner or Stamped)
Metric & US Cust	Item 632.1105:	Precast Modular Wall, Integral Color, As Shown in the Plans

- The following standard specifications are approved:

Metric & US Cust	Item 554.30XX:	Geosynthetically Reinforced Soil System Wall
Metric & US Cust	Item 554.31:	Geosynthetically Reinforced Soil System Slope
Metric	Item 554.40:	Fill Type Retaining Wall (0 – 1.8 m)
US Cust	Item 554.40:	Fill Type Retaining Wall (0 – 6 ft.)
Metric	Item 554.41:	Fill Type Retaining Wall (Greater than 1.8 m – 3.7 m)
US Cust	Item 554.41:	Fill Type Retaining Wall (Greater than 6 ft. – 12 ft.)
Metric	Item 554.42:	Fill Type Retaining Wall (Greater than 3.7 m – 5.5 m)
US Cust	Item 554.42:	Fill Type Retaining Wall (Greater than 12 ft. – 18 ft.)
Metric	Item 554.43:	Fill Type Retaining Wall (Greater than 5.5 m – 7.3 m)
US Cust	Item 554.43:	Fill Type Retaining Wall (Greater than 18 ft. – 24 ft.)
Metric	Item 554.44:	Fill Type Retaining Wall (Greater than 7.3 m – 9.1 m)
US Cust	Item 554.44:	Fill Type Retaining Wall (Greater than 24 ft. – 30 ft.)
Metric	Item 554.45:	Fill Type Retaining Wall (Greater than 9.1 m)
US Cust	Item 554.45:	Fill Type Retaining Wall (Greater than 30 ft.)
Metric & US Cust	Item 554.5001:	Fill Type Retaining Wall Aesthetic Treatment – Textured Surface (Hand Tooled, Raked, etc.), No Color
Metric & US Cust	Item 554.5002:	Fill Type Retaining Wall Aesthetic Treatment – Textured Surface (Hand Tooled, Raked, etc.), Integral Color
Metric & US Cust	Item 554.5101:	Fill Type Retaining Wall Aesthetic Treatment – Exposed Aggregate Finish, No Color
Metric & US Cust	Item 554.5102:	Fill Type Retaining Wall Aesthetic Treatment – Exposed Aggregate Finish, Integral Color
Metric & US Cust	Item 554.5201:	Fill Type Retaining Wall Aesthetic Treatment – Architectural Pattern, No Color
Metric & US Cust	Item 554.5202:	Fill Type Retaining Wall Aesthetic Treatment – Architectural Pattern, Integral Color
Metric & US Cust	Item 554.53:	Fill Type Retaining Wall Aesthetic Treatment – Other; As Shown in the Contract Documents

TRANSMITTED MATERIALS:

- Revisions to Standard Specification Section 554 *Fill Type Retaining Walls.* Both metric and US Customary revisions are attached.

BACKGROUND: EI 08-020 revised Section 632 *Precast Modular Walls*, emulating the procedures defined previously in Section 554 for approving a wall system. By adding the Segmental Block Wall Systems to the Precast Modular Wall specification, the list of available externally stabilized fill structures was expanded. EI 08-037 revised Section 554 *Internally Stabilized Fill Structures*, incorporating retaining wall systems consisting of reinforced fill with a facing.

This current issuance for the revision to Section 554 *Fill Type Retaining Walls*, combines like elements (externally and internally fill structures) and establishes a broader Approved List for proprietary fill type retaining wall systems based on wall height.

CONTACT: Questions or comments regarding this issuance should be directed to Randall J. Romer, P.E., of the Geotechnical Engineering Bureau at (518) 457-4714, rromer@dot.state.ny.us.

Make the following changes to the Standard Specifications dated May 4, 2006:

Pages 328 through 334, **Delete** SECTION 554 in its entirety and **Replace** it with the following:

SECTION 554 – FILL TYPE RETAINING WALLS

554-1 DESCRIPTION. This work shall consist of furnishing and installing a fill type retaining wall at the location(s) and to the elevation(s) shown in the contract documents.

554-1.01. General. The fill type classification refers to the construction method used for the installation of the wall. Fill type retaining walls are retaining structures constructed from the base of the wall to the top (i.e. "bottom-up" construction).

The fill type retaining walls are further classified according to the basic mechanism of lateral load support. These classifications include internally stabilized fill structures and externally stabilized fill structures.

The specification is supplemented with an Approved List which provides a listing of available designers and their corresponding fill type retaining walls. Fill type retaining walls are further defined in the pertinent subsequent section. For proprietary fill type retaining wall systems, approved designers, wall systems, and the components of each wall system appear on the Approved List, available on the Department's web site. Designers wishing to have their wall systems reviewed for placement on the Approved List shall follow the procedural directives of the Geotechnical Engineering Bureau as contained in Highway Design Manual Appendix 9A.

554-1.02 Definitions. Internally stabilized fill structures are structures which rely on friction developed between closely-spaced reinforcing elements and the backfill to resist lateral soil pressure and are subcategorized in the retaining wall subsections of this specification. Externally stabilized fill structures are structures which utilize the weight of the wall system elements and the weight of the infill to resist lateral soil pressure.

A. Wall System. A wall system is either a series of open top face units assembled to form bins which are connected in unbroken sequence or a combination of specific solid face units with a characteristic alignment and connection method, which utilize the weight of the wall system elements and the weight of the infill to resist lateral soil pressure. As indicated, the bin volume is infilled with backfill material to supplement the face unit geometry, adding to the stability of the system.

B. Internally Stabilized Wall System. A wall system which, when constructed beyond wall heights exceeding the maximum allowable unreinforced height per the Approved List, relies on reinforcing elements within the backfill to provide stability.

C. Internally Stabilized Earth System. A series of tensile reinforcing elements which, when placed in multiple layers within the backfill volume, improves the strength such that the vertical face of the stabilized earth volume is essentially self supporting.

D. Internally Stabilized Fill Structures.

1. Fill Structure. A fill type retaining wall as described in §554-1.01 *Fill Type Retaining Walls* which consists of either an internally stabilized wall system or an internally stabilized earth system.

i. Mechanically Stabilized Earth System (MSES). An MSES is an internally stabilized fill structure comprised of an unreinforced concrete leveling pad, precast concrete face panel units and coping units, earth backfill, subsurface drainage system, and reinforcing elements used to stabilize the backfill. Only MSES designers appearing on the Approved List

will be acceptable for use. All necessary materials, except backfill, leveling pad, and subsurface drainage system, are obtained from the approved wall system designer.

ii. Mechanically Stabilized Wall System (MSWS). An MSWS is an internally stabilized fill structure comprised of an unreinforced concrete or compacted granular fill leveling pad, face units (solid or open top) and coping units, earth backfill, subsurface drainage system, and reinforcing elements used to stabilize the backfill. Only MSWS designers with face units appearing on the Approved List will be acceptable for use. All necessary materials, except backfill, face unit infill, leveling pad material, backfill drainage materials, and cast-in-place concrete, are obtained from the designer.

iii. Geosynthetically Reinforced Soil System (GRSS). A GRSS is an internally stabilized fill structure comprised of earth backfill, geosynthetic reinforcing elements used for internal stabilization and surface protection to resist erosion.

a. GRSS Wall. For wall applications, the surface protection is the permanent facing elements (excluding precast units) or a geotextile face wrap which typically includes welded wire forms remaining from the installation operation.

b. GRSS Slope. For slope applications, the surface protection consists of a secondary reinforcing element to aid in stability of the slope face between primary reinforcing layers. To protect against erosion, the GRSS slope is covered by either a non-degradable erosion control mat or a granular fill slope protection blanket.

Although GRSS is a fill type retaining wall, it is not a part of the selection process outlined in §554-3.01A. *Fill Type Retaining Wall Selection* or supplemented by the Approved List for Fill Type Retaining Walls, as it is not a proprietary system. A GRSS will be designed and detailed in the contract documents by the Department or its representatives.

2. Leveling Pad. A compact surface which serves as a flat, level area for placing the initial course of face units.

i. Concrete. An unreinforced concrete slab.

ii. Granular. A compacted granular fill pad.

3. Face Unit. A structural unit incorporating a means for attaching the backfill reinforcing element, which restrains the alignment of the wall system during installation compaction operations and provides support for the front edge of the backfill for the life of the wall system.

i. Panel Unit. A precast concrete panel incorporating a means for attaching the backfill reinforcing element, forming part of the face area of the MSES.

ii. Solid Unit. A face unit which has a solid mass and incorporates a means for attaching the backfill reinforcing element, forming part of the face area of the MSWS.

iii. Open Top Unit. A face unit which has an open structure, to allow placement of infill material, and incorporates a means for attaching the backfill reinforcing element, forming part of the face area of the MSWS.

iv. Corner Unit. A corner unit is a face unit having two faces.

v. Geotextile Face Wrap. A layer of geotextile used to prevent loss of backfill, typically employed in a temporary wall application in conjunction with welded wire forms. In applications where a geotextile is used as the primary reinforcing element, it may be designed to also function as the face wrap.

a. Welded Wire Forms. A non-structural system used in temporary walls to aid in compaction near the face of the wall.

vi. Geocells. A three-dimensional, permeable polymeric honeycomb or web structure expandable panels used to confine fill materials to create structural stability.

vii. Timbers. A dressed piece of wood used as a building material.

viii.Gabions. A partitioned, wire fabric container filled with stone to form a flexible and permeable structure.

4. Alignment and Connection Device. Any device that is either built into or specially manufactured for the face units, such as shear keys, leading/trailing lips, or pins. The device is

used to provide alignment and maintain positive location for a face unit and also provide a means for connecting the reinforcing elements.

5. Fastener. Hardware used to connect the reinforcing element to the attaching device.

6. Coping. A precast or cast-in-place element placed on and attached to the top of the finished wall system to form a protective cap against the weather.

7. Joint Filler. Material used to fill the joints between face units.

8. Slip Joint. A vertical joint specific to the wall system used as a stress relief at wall step locations.

9. Geotextile. A permeable, planar polymeric textile material used to promote drainage, prevent infill and/or backfill material from releasing through the joints, or separating dissimilar granular materials.

10. Reinforcing Element. An inclusion connected to the face unit and extending into the backfill for the purpose of backfill stabilization.

i. Inextensible Reinforcement. A metal strip typically incorporating ribs on the top and bottom, or metal grids with design specific mesh openings.

ii. Extensible Reinforcement. Geogrid or geotextile sheets typically made from high density polyethylene/ polypropylene geogrids or high tenacity polyester geogrids, or high strength geotextiles.

11. Unit Infill. Granular material placed within the open structure of an open top face unit or contiguous to the bevel sides of a solid face unit.

12. Backfill. Granular material placed and compacted in conjunction with the reinforcing elements and face units.

13. Subsurface Drainage System. A system for removing water from behind the wall and channeling it to a point of positive drainage.

14. Identification Markers. Signs and marking tape, buried near the finished grade, to identify and prohibit excavation of the reinforced backfill.

E. Externally Stabilized Fill Structures.

1. Fill Structure. A fill type retaining wall as described in §554-1.01 *Fill Type Retaining Walls* which consists of a prefabricated face unit.

i. Prefabricated Wall System (PWS). A PWS is an externally stabilized fill structure comprised of prefabricated face units & coping units, including leveling pads, unit infill, earth backfill, joint filler material and geotextile, and a subsurface drainage system to reduce hydrostatic pressure on the wall system. Only PWS designers appearing on the Approved List will be acceptable for use. All necessary materials, except backfill, unit infill, backfill drainage materials, and cast-in-place concrete, are obtained from the designer.

When reinforcement is introduced to a PWS, they shall be reclassified as Mechanically Stabilized Wall Systems and the pertinent sections of the specification shall apply.

2. Leveling Pad. A compact surface which serves as a flat, level area for placing the initial course of face units.

i. Concrete. An unreinforced concrete slab.

ii. Granular. A compacted granular fill pad.

3. Face Unit. A prefabricated concrete element, incorporating alignment and connection devices, that is able to be arranged, stacked, placed, combined, or interchanged easily into an assembled wall system.

i. Solid Unit. A face unit which has a solid mass, utilizing the weight of the wall system elements to resist lateral soil pressure. A solid unit may require some infill material depending on the geometric bevel of the units.

ii. Open Top Unit. A face unit which has an open structure to allow placement of infill material, utilizing the weight of the wall system elements and the weight of the infill to resist lateral soil pressure.

4. Bin. Any volumetric space which is designated to be infilled, as defined in this section, and is encompassed within the dimensions of the open top unit.

5. Alignment and Connection Device. Any device that is either built into or specially manufactured for the face units, such as shear keys, leading/trailing lips, or pins. The device is used to provide alignment and maintain a positive location.

6. Coping. A precast or cast-in-place element placed on and attached to the top of the finished wall system to form a protective cap against the weather.

7. Joint Filler. Material used to fill the joints between face units.

8. Slip Joint. A vertical joint specific to the wall system used as a stress relief at wall step locations.

9. Geotextile. A permeable, planar polymeric textile material used to promote drainage, prevent infill and/or backfill material from releasing through the joints, or separating dissimilar granular materials.

10. Unit Infill. Granular material placed within the bin, such as the open structure of an open top face unit or contiguous to the bevel sides of a solid face unit.

11. Backfill. Granular material placed directly behind and/or above the bins in conjunction with the wall assembly.

12. Subsurface Drainage System. A system for removing water from behind the wall and channeling it to a point of positive drainage.

F. Aesthetic Treatment. A treatment applied to the face either during or after the manufacture of the face units to modify the appearance of the units and of the wall as a whole. Aesthetic treatment can include modifications to color, texture, architectural pattern, the addition of exposed surface aggregate (real or artificial), the addition of simulated joints or cracks, or any other treatment or material that modifies the appearance, provided that the structural integrity, function, or life span of the wall is not negatively impacted.

554-2 MATERIALS.

554-2.01. Fill Type Retaining Walls. Provide materials for the selected fill type retaining wall as outlined in the pertinent subsequent section.

554-2.02. Mechanically Stabilized Earth System. Not all materials listed below are required for each MSES. Ensure that the proper materials are supplied for the chosen system design. Provide materials meeting the following requirements:

A. MSES Leveling Pad. Provide leveling pad material meeting the requirements of Section 501 *Portland Cement Concrete - General*, Class A concrete.

1. Leveling Pad Placement. For precast leveling pad installations, a substitution of cushion sand, meeting the requirements of §703-06 *Cushion Sand,* in lieu of MSES backfill material directly beneath the leveling pad may be made to facilitate placement of the pad.

B. MSES Facing Panel Units. Fabricate precast concrete face panel units and incidental precast units in accordance with the requirements of §704-14 *Precast Concrete Panel Units*. The default aesthetic treatment for an MSES facing panel is a plain, smooth concrete finish of natural concrete (gray) color.

1. Coping Unit. Fabricate precast concrete coping units, and incidental precast units in accordance with the requirements of §704-14 *Precast Concrete Panel Units*.

C. MSES Fasteners and Attaching Devices. The fasteners and attaching devices are specific to each wall system and provided by the wall system manufacturer. The fasteners and attaching devices associated with each approved wall system appear on the Approved List under wall system components.

D. MSES Joint Fillers. Fill joints with material approved by DCES and approved by the wall system designer.

E. MSES Geotextile. Provide a geotextile meeting the requirements of §737-01B *Geotextile Separation.*

F. MSES Slip Joints. The type of slip joints are specific to each wall system and are designed and supplied by the wall system manufacturer.

G. MSES Metal Reinforcing Strips. Provide reinforcing strips of ASTM Designated metal grades and galvanize in accordance with the requirements of §719-01 *Galvanized Coatings and Repair Methods, Type I.* The reinforcing strips associated with each approved wall system appear on the Department's Approved List under wall system components.

H. MSES Metal Reinforcing Mesh. Fabricate the reinforcing mesh from cold drawn steel wire conforming to the requirements of §709-09 *Cold Drawn Wire for Concrete Reinforcement,* and weld into the finished mesh fabric in accordance with the requirements of §709-02 *Wire Fabric for Concrete Reinforcement.* Galvanize in accordance with §719-01 *Galvanized Coatings and Repair Methods, Type I.* The reinforcing mesh associated with each approved wall system appears on the Department's Approved List under wall system components.

I. MSES Geogrid Reinforcing Element. Provide geogrid reinforcing elements meeting the requirements of §737-07 *Geogrids.* The grid(s) associated with each approved wall system appear on the Approved List under wall system components.

J. MSES Backfill. Provide backfill material meeting the requirements of §733-02 *Mechanically Stabilized Earth System Backfill Material.*

K. MSES Subsurface Drainage System. Provide underdrain and geotextile material for a backfill drainage system as shown in the contract documents or conforming to the designers Installation Manual:

1. Underdrain Pipe. Provide optional underdrain pipe conforming to Section 605 *Underdrains.*

2. Geotextile Drainage. Provide geotextile conforming to the requirements of §737-01 *Geotextiles,* Geotextile Drainage, Strength Class 2, Drainage Class B.

L. MSES Identification Markers

1. Signs. These will be 180 mm x 250 mm (minimum) fiberglass. Include warning information as follows:

WARNING
Internally Stabilized Fill Structure
DO NOT EXCAVATE
Call Regional Office of NYS DOT

For signs installed on concrete units, provide 6 mm diameter by 38 mm long stainless steel nail drive expansion anchors meeting GSA Specifications FF-S-325.

For signs installed on timbers, provide 6 mm diameter by 38 mm long stainless steel wood screws.

2. Marking Tape. This will be polyethylene material 75 mm wide, 100 µm thick. Include warning markings.

554-2.03. Mechanically Stabilized Wall System. Not all materials listed below are required for each MSWS. Ensure that the proper materials are supplied for the chosen system design. Provide materials meeting the following requirements:

A. MSWS Leveling Pad. MSWS height is measured from the top of the leveling pad to the top of the face coping unit.

1. Wall Heights Taller Than or Equal to 4.6 m. For MSWS taller than or equal to 4.6 m in total height, provide a leveling pad of unreinforced Class A concrete - Section 501 *Portland Cement Concrete – General.*

2. Wall Heights Shorter Than 4.6 m. For MSWS shorter than 4.6 m in total height, provide a leveling pad conforming to one of the following:

i. Concrete. Unreinforced Class A concrete - Section 501 *Portland Cement Concrete – General*, or

ii. Granular. Select Granular Fill - §733-11 *Select Granular Fill*, or Crushed Stone - §501-2.02, B.1.b. *Coarse Aggregate Type CA-2* in Table 501-2 Coarse Aggregate Gradations.

3. Leveling Pad Placement. For precast leveling pad installations, a substitution of cushion sand, meeting the requirements of §703-06 *Cushion Sand,* in lieu of MSWS backfill material directly beneath the leveling pad may be made to facilitate placement of the pad.

B. MSWS Facing System. Provide a facing system in accordance with the requirements below.

1. Solid Face Units. Provide face units fabricated and conforming to §704-07 *Dry Cast Concrete Wall Units* or §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.* The default treatment for a MSWS face unit is a split face finish of natural concrete (gray) color.

i. Coping Unit. Provide coping units fabricated and conforming to §704-07 *Dry Cast Concrete Wall Units* or §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.*

2. Open Top Face Unit. Provide face units meeting the requirements of §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.* The default treatment for a MSWS face unit is a plain, smooth concrete finish of natural concrete (gray) color.

i. Coping Unit. Provide coping units meeting the requirements of §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.*

C. MSWS Alignment and Connection Devices. Provide devices conforming to the designers Installation Manual.

D. MSWS Joint Fillers. Fill joints with material meeting the requirements of §705-07 *Premoulded Resilient Joint Filler* and approved by the wall system designer.

E. MSWS Geotextile. Provide a geotextile meeting the requirements of §737-01B *Geotextile Separation.*

F. MSWS Slip Joints. The type of slip joints are specific to each wall system and are designed and supplied by the wall system manufacturer.

G. MSWS Reinforcing Element. Provide geogrid or geotextile reinforcing elements meeting the requirements of §737-07 *Geogrids.*

H. MSWS Unit Infill. Provide infill material meeting the requirements of §733-02 *Mechanically Stabilized Earth System Backfill Material.*

I. MSWS Backfill. Provide backfill material meeting the requirements of §733-02 *Mechanically Stabilized Earth System Backfill Material.*

J. MSWS Drainage System. Provide underdrain, geotextile material, and prefabricated structural drain for a backfill drainage system as shown in the contract documents or conforming to the designers Installation Manual:

1. Underdrain Pipe. Provide optional underdrain pipe conforming to Section 605 *Underdrains.*

2. Geotextile Drainage. Provide geotextile conforming to the requirements of §737-01 *Geotextiles*, Geotextile Drainage, Strength Class 2, Drainage Class B.

3. Prefabricated Composite Structural Drain. Provide structural drain conforming to the requirements of §737-04 *Prefabricated Composite Structural Drain.*

K. MSWS Identification Markers. Provide identification markers conforming to §554-2.02 L. *MSES Identification Markers.*

554-2.04. Geosynthetically Reinforced Soil System. Not all materials listed below are required for each GRSS. Ensure that the proper materials are supplied for the chosen system design. Provide materials meeting the following requirements:

A. GRSS Geosynthetic Reinforcing Element. Provide a geogrid or geotextile primary and secondary reinforcing elements meeting the requirements of §737-07 *Geogrids.*

B. GRSS Backfill. Provide backfill material conforming to the following:

1. Walls. Provide backfill material meeting the requirements of §733-14 *Select Structural Fill* with the exception that the pH requirements are waived.

2. Slopes. Provide backfill material meeting the requirements of §733-03 *Geosynthetically Reinforced Soil System Slope Backfill Material.*

C. GRSS Wall Facing Foundation. Provide a pad of material meeting the requirements of §703-02 *Crushed Stone, Size Designation 2.*

D. GRSS Facing System. Provide a facing system shown in the contract documents and in accordance with the requirements below.

1. Welded Wire Forms. Provide welded wire forms and wire struts as shown in the contract documents, conforming to the material requirements of §709-02 *Wire Fabric for Concrete Reinforcement.* For applications other than staging walls, provide galvanization to the forms in accordance with the requirements of ASTM A 641 Class 3 for zinc coating (including the zinc coating on the Style 2 fabric), ASTM A 856M Class 3 for Zn-5Al-MM coating, or ASTM A 809 for aluminum coating.

Provide geotextile face wrap material meeting the requirements of §737-01B *Geotextile Separation* and as shown in the contract documents.

Proposed alternate, non-structural facing systems used to aid in compaction near the face of the wall shall be included in the submittal outlined in §554-3.03 A. *GRSS Submittal.*

2. Geocells. Provide geocells, anchoring devices, and staples as shown in the contract documents, conforming to the material requirements of §737-08 *Geocells.*

Provide infill material conforming to §733-14 *Select Structural Fill,* with the added stipulation that the maximum particle size is 50 mm. Where a vegetated face is called for, the outermost cells are to be filled with topsoil meeting the material requirements of §713-01 *Topsoil.*

3. Timbers. Provide timbers as shown in the contract documents, graded for an extreme fiber stress of at least 6900 kPa conforming to the material requirements of §712-14 *Stress Graded Timber and Lumber.* Treat timbers in accordance with §708-31 *Wood Preservative - Waterborne* and applied in conformance with American Wood Preservers Association (AWPA) Use Category Designation UC4B.

4. As Shown in the Contract Documents. Provide materials in accordance with the contract documents. Precast units are excluded as a design-specific GRSS facing system,

E. GRSS Surface Protection. Provide erosion resistant covering of the finished GRSS slope surface meeting the requirements of §713-07 *Rolled Erosion Control Products and Soil Stabilizers* Class III Type C.

F. GRSS Drainage System. Provide underdrain and geotextile material for a backfill drainage system conforming to §554-2.02 K. *MSES Drainage System.*

G. GRSS Identification Markers. Provide identification markers conforming to §554-2.02 L. *MSES Identification Markers.*

554-2.05. Prefabricated Wall System. Not all materials listed below are required for each PWS. Ensure that the proper materials are supplied for the chosen system design. Provide materials meeting the following requirements:

A. PWS Leveling Pad. Provide a leveling pad conforming to the following:

1. Open Top Face Units. For PWS utilizing open top face units, provide a leveling pad of unreinforced Class A concrete - Section 501 *Portland Cement Concrete – General.*

For precast leveling pad installations, a substitution of cushion sand, meeting the requirements of §703-06 *Cushion Sand,* in lieu of PWS backfill material directly beneath the leveling pad may be made to facilitate placement of the pad.

2. Solid Face Units. For PWS utilizing solid face units, provide a leveling pad conforming to the requirements of §733-11 *Select Granular Fill* or §501-2.02, B.1.b. *Coarse Aggregate Type CA-2* in Table 501-2 Coarse Aggregate Gradations.

B. PWS Face Unit. Provide face units meeting the following:

1. Open Top Face Units. For PWS utilizing open top face units, provide units meeting the requirements of §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.* The default treatment for a PWS open top face unit is a plain, smooth concrete finish of natural concrete (gray) color.

i. Coping Unit. Provide coping units meeting the requirements of §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.*

2. Solid Face Units. For PWS utilizing solid face units, provide units meeting the requirements of §704-07 *Dry Cast Concrete Wall Units* or §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.* The default treatment for a PWS solid face unit is a split face finish of natural concrete (gray) color.

i. Coping Unit. Provide coping units fabricated and conforming to §704-07 *Dry Cast Concrete Wall Units* or §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.*

C. PWS Joint Fillers. Fill joints with material meeting the requirements of §705-07 *Premoulded Resilient Joint Filler* and approved by the wall system designer.

D. PWS Geotextile. Provide a geotextile meeting the requirements of §737-01B *Geotextile Separation.*

E. PWS Slip Joints. The type of slip joints are specific to each wall system and are designed and supplied by the wall system manufacturer.

F. PWS Backfill. Provide backfill material meeting the requirements of §733-14 *Select Structural Fill.*

G. PWS Unit Infill. Provide unit infill material meeting the requirements of §733-14 *Select Structural Fill.*

For systems which allow plantings to integrate the structure into the surrounding environment, the front pocket of the unit shall be filled with a minimum of 200 mm of topsoil conforming to the material requirements as specified in §713-01 *Topsoil.*

H. PWS Drainage System. Provide underdrain, geotextile material, and prefabricated structural drain for a backfill drainage system as shown in the contract documents or conforming to the designers Installation Manual:

1. Underdrain Pipe. Provide optional underdrain pipe conforming to Section 605 *Underdrains.*

2. Geotextile Drainage. Provide geotextile conforming to the requirements of §737-01 *Geotextiles*, Geotextile Drainage, Strength Class 2, Drainage Class B.

3. Prefabricated Composite Structural Drain. Provide structural drain conforming to the requirements of §737-04 *Prefabricated Composite Structural Drain.*

554-2.06 Fill Type Retaining Wall Aesthetic Treatment. The requirements for color, texture and pattern will be described in the contract documents using industry-standard descriptions and terminology. Other requirements will be vividly described in the contract documents using special notes and sketches, as needed.

554-3 CONSTRUCTION DETAILS

554-3.01. General.

A. Fill Type Retaining Wall Selection. Approved designers of proprietary Fill Type Retaining Walls, wall systems, and the components of each wall system appear on the Approved List, available on the Department's web site. Proprietary Fill Type Retaining Walls include Mechanically Stabilized Earth Systems, Mechanically Stabilized Wall Systems, and Prefabricated Wall Systems.

Select a designer appearing on the Approved List for Fill Type Retaining Walls. The selection shall be based on the maximum wall height shown in the contract documents.

B. Fill Type Retaining Wall Submittal. Obtain from the chosen designer a Fill Type Retaining Wall design stamped by a Professional Engineer. Submit the design package, including working drawings of the wall design, design calculations, and the designers Installation Manual at least 30 work days before starting work to the following:

1. Mechanically Stabilized Earth System. Submit the design package to the Deputy Chief Engineer Technical Services (DCETS) Attn: Materials Bureau in accordance with the requirements for Drawing in §704-03 *Precast Concrete – General*. The design shall be consistent with the design methods employed in obtaining acceptance to appear on the Department's Approved List. The design package shall also include identification of backfill material gradation type(s) (outlined in §733-02B *Gradation*) suitable for the construction of the wall system, fabrication drawings for precast panels and coping and, for treatments applied to the face panel units other than the default treatment, a face panel unit sample for color and texture approval by the Regional Landscape Architect.

2. Mechanically Stabilized Wall System. Submit the design package to the Deputy Chief Engineer Technical Services (DCETS) Attn: Geotechnical Engineering Bureau. The design shall be consistent with the design methods employed in obtaining acceptance to appear on the Department's Approved List. The design package shall also include identification of backfill material gradation type(s) (outlined in §733-02B *Gradation*) suitable for the construction of the wall system and, for treatments applied to the face units other than the default treatment, a face unit sample for color and texture approval by the Regional Landscape Architect.

3. Prefabricated Wall System.

i. Open Top Face Units. For PWS utilizing open top face units, submit the design package to the Deputy Chief Engineer Technical Services (DCETS) Attn: Materials Bureau in accordance with the requirements for Drawing in §704-03 *Precast Concrete – General*. The

design shall be consistent with the design methods employed in obtaining acceptance to appear on the Department's Approved List. The design package shall also include fabrication drawings for the face units and, for treatments applied to the face units other than the default treatment, a face unit sample for color and texture approval by the Regional Landscape Architect.

ii. Solid Face Units. For PWS utilizing solid face units, submit the design package to the Engineer for approval. For solid face units consisting of units manufactured via the wet-casting process, submit the design package in accordance with the requirements for Drawing in §704-03 *Precast Concrete – General.* The design shall be consistent with the design methods employed in obtaining acceptance to appear on the Department's Approved List. For treatments applied to the face units other than the default treatment, the design package submittal shall also include a face unit sample for color and texture approval by the Regional Landscape Architect.

After receipt of all pertinent information, the Department requires 10 work days or 2 work days per drawing sheet, whichever is greater, to review the submission.

554-3.02. Mechanically Stabilized Earth System.

A. Pre-Operation Meeting. A Pre-Operation Meeting will be held between the Engineer, Contractor, Regional Geotechnical Engineer, Geotechnical Engineering Bureau and other appropriate Department representatives to discuss the Contractors proposed construction methods. Begin work only after receiving the DCES written approval and holding the Pre-Operation Meeting.

Supply on-site technical assistance from a representative of the designated designer during the beginning of the installation until such time as outside consultation is no longer required.

B. MSES Excavation and Disposal. Excavation shall be conducted in accordance with the applicable requirements of Section 206 *Trench, Culvert and Structure Excavation* and the details specified in the contract documents.

C. MSES Foundation. Prior to erection of the wall system, the foundation shall be inspected and approved by the Engineer.

1. Placement Area. Grade the area under the MSES, level for a width equal to, or in excess of, the reinforcing element length. Prior to wall system construction, compact this area to a minimum of 90% of Standard Proctor Maximum Density. Treat all soils found to be unsuitable, or incapable of being satisfactorily compacted because of moisture content, in a manner directed by the Engineer, in conjunction with the recommendations of the Regional Geotechnical Engineer.

D. MSES Subsurface Drainage System. Install the subsurface drainage system simultaneously with the erection and backfill of the MSES to ensure a continuous, uninterrupted system to prevent the accumulation of destabilizing water pressure on the wall. In all cases, the subsurface drainage system will be installed to drain all intercepted water to a point of positive drainage.

E. MSES Facing Panel Unit Inspection, Storage, and Handling

1. Face Panel Units. An inspection will be made prior to installation to determine if any damage has occurred to the panel unit(s). Handle and store the panel units with care to prevent damage.

2. Damaged Panel Units. Repair damaged panel units in a manner approved by the Engineer. Replace panel units that are not repairable at no additional cost to the State.

F. MSES Leveling Pad. Provide an unreinforced concrete leveling pad as required by the contract documents. Cast the concrete, in accordance with the requirements Section 555 Structural Concrete, or place the precast leveling pad for the foundation of the MSES to ensure a flat surface for placing the initial course of precast facing panel units. Step the leveling pad to conform to grade changes as shown in the contract documents or approved Shop Drawings.

G. MSES Erection

1. Methods and Equipment. Install panel units in accordance with the designers approved shop drawings and Installation Manual, unless otherwise modified by the contract documents. Prior to installation of the panel units, furnish the Engineer with detailed information concerning the proposed construction method, as well as the equipment planned for use.

2. Panel Unit Installation

i. Place panel units such that, after completion of compaction, the tolerances of Table 554-1 *MSES Facing Panel Unit Alignment and Joint Offset Tolerances* are not exceeded. After placement, maintain each panel unit in position. If wedges are used, do not allow them to remain in place below three panel unit heights during installation, and compaction. Remove all wedges remaining in the top three panel unit heights upon completion of the MSES. External braces may be required for initial placements. Install joint fillers in the manner indicated by the Installation Manual.

ii. Correct all misalignments of installed panel units in excess of the tolerances allowed by Table 554-1 *MSES Facing Panel Unit Alignment and Joint Offset Tolerances*, at no additional cost to the State.

TABLE 554-1 MSES FACING PANEL UNIT ALIGNMENT AND JOINT OFFSET TOLERANCES	
Horizontal Alignment	± 7 mm/m
Joint Offset per Panel Unit	± 19 mm
Overall Vertical Plumbness (Top to Bottom of Wall System)	± 4 mm/m

H. MSES Backfill. Do not mix backfill material from different sources behind any wall without the written permission of the Director, Geotechnical Engineering Bureau.

1. Moisture Content. Place backfill materials, other than Type B and Type D, at or within 2% dry of the Optimum Moisture Content. Rework or replace all backfill material which is at a moisture content in excess of the Optimum Moisture content. Determine the Optimum Moisture Content in conformance with the latest Geotechnical Test Methods for compaction that incorporate moisture content determination. Rework or replace backfill material at no additional cost to the State.

2. Backfill Placement. Prior to placement of the reinforcing element, backfill and compact the area within 1 m of the panel units horizontally to 50 mm above the required reinforcing element elevation. Roughly grade the backfill beyond the 1 m line to the reinforcing element elevation.

i. Place granular backfill material in uniform layers not exceeding 300 mm loose lift thickness per layer. Compact each layer to a minimum of 95% of Standard Proctor Maximum Density.

ii. Place Type B and Type D backfill in uniform layers not exceeding 400 mm loose lift thickness. Compact in accordance with requirements determined by the Engineer.

3. Surface Drainage Control. Provide positive control and discharge of all surface drainage that will affect the installation of the MSES throughout the construction of the wall. Maintain all vertical drains, weeps, ditches, pipes, or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.

4. QA Program. The Department will sample and test backfill from the grade in accordance with the Quality Assurance Program outlined in §733-02 *Mechanically Stabilized Earth System Backfill Material.* If the material is determined to not meet the specification requirements, the material will be rejected.

I. MSES Reinforcing Elements. Place reinforcing elements in accordance with the designer's recommendations or as described in the designers Installation Manual. Before attaching the reinforcing elements to the panel units, repair all damage to the zinc coating in accordance with the requirements of §719-01 *Galvanized Coatings and Repair Methods, Type I.*

1. Placement. Place reinforcing elements normal to the panel units unless indicated otherwise by the contract documents or approved shop drawings. Take care to avoid breaking, distorting, or disturbing the reinforcing elements. Replace reinforcing elements which are broken or distorted.

2. Connections. Prior to the attachment of the reinforcing elements, as required, fill all openings, or attachment locations, with grease, or other protective material. Obtain the grease or other protective materials from the chosen designer. Connect reinforcing elements to the face panel unit before placement of subsequent face panel units, or as directed by the approved shop drawings.

J. MSES Identification Markers. Install MSES identification markers.

Place the marking tape at the highest possible elevation that will not damage the tape. For walls supporting a pavement section, install the tape 150 mm below top of subbase elevation. For walls supporting earth, install the tape 150 mm below finished grade. Install the marking tape on top of the reinforced backfill area, parallel to the wall face in rows at 1.5 m intervals until the back edge of the reinforced backfill area is reached.

Drill two, 8 mm diameter, holes for mounting, located 13 mm from the ends of the sign and 90 mm from the top of the sign. Secure the sign using anchorage appropriate for the supporting material.

K. Equipment Movement. Movement of construction equipment and all other vehicles and loads over and adjacent to MSES shall be done at the Contractor's risk. Govern the operations and procedures to prevent misalignment of the installed panel units. Precautionary measures include, but are not limited to, keeping vehicular equipment a minimum of 1.0 m from the panel units. Within 1.0 m of the panel units use compaction equipment meeting the requirements of *Compaction Equipment for Confined Areas* in Section 203 Excavation and Embankment. Operate rubber tired equipment on top of reinforcing elements only at low speeds (less than 8 kph) and without making sharp turns or braking sharply. Do not operate tracked equipment directly on reinforcing elements. Cover reinforcing elements with a minimum 150 mm thick soil layer prior to operating tracked equipment over reinforced areas. Repair or replace damaged reinforcing elements in strict accordance with the

designers written instructions at no additional cost to the State.

554-3.03. Mechanically Stabilized Wall System.

A. Pre-Operation Meeting. A Pre-Operation Meeting will be held between the Engineer, Contractor, Regional Geotechnical Engineer, Geotechnical Engineering Bureau and other appropriate Department representatives to discuss the Contractors proposed construction methods. Begin work only after receiving the DCETS written approval and holding the Pre-Operation Meeting.

Supply on-site technical assistance from a representative of the designated designer during the beginning of the installation until such time as outside consultation is no longer required.

B. MSWS Excavation and Disposal. Excavation shall be conducted in accordance with the applicable requirements of Section 206 *Trench, Culvert and Structure Excavation* and the details specified in the contract documents.

C. MSWS Foundation. Prepare the foundation in accordance with the requirements of §554-3.02 C. *MSES Foundation.*

D. MSWS Subsurface Drainage System. Install the subsurface drainage system simultaneously with the erection and infill/backfill of the MSWS to ensure a continuous, uninterrupted system to prevent the accumulation of destabilizing water pressure on the wall. In all cases, the subsurface drainage system will be installed to drain all intercepted water to a point of positive drainage.

E. MSWS Leveling Pad. Provide an unreinforced concrete leveling pad or compacted granular fill leveling pad as shown in the contract documents to ensure a flat surface for placing the initial course of face units. Step the leveling pad to conform to grade changes as shown in the contract documents or approved Shop Drawings.

1. Concrete. Cast the concrete leveling pad, in accordance with the requirements of Section 555 Structural Concrete, or place the precast leveling pad, for the foundation of the MSWS.

2. Granular. Place and compact granular fill in conformance with Section 203 Excavation and Embankment.

F. MSWS Facing Unit Erection

1. Solid Face Unit Erection

i. Methods and Equipment. Install face units in accordance with the designers approved shop drawings and Installation Manual, unless otherwise modified by the contract documents. Prior to installation of the face units, furnish the Engineer with detailed information concerning the proposed construction method, as well as the equipment planned for use.

ii. Face Unit Installation.

a. Install by placing, positioning, and aligning face units in conformance with the designers Installation Manual and within the tolerances in Table 554-2 *MSWS Solid Face Unit Alignment Tolerances.*

b. Correct all misalignments of installed face units that exceed the tolerances allowed in Table 554-2 *MSWS Solid Facing Unit Alignment Tolerances.*

TABLE 554-2 MSWS SOLID FACE UNIT ALIGNMENT TOLERANCES	
Vertical Control	± 7 mm over a distance of 3 m
Horizontal Control	± 13 mm over a distance of 3 m
Rotation from established plan wall batter	± 13 mm over a distance of 3 m

2. Open Top Face Unit Erection. During erection, any face unit damaged beyond repair shall be removed and replaced by the Contractor with approved face units at no additional cost to the State.

i. All face units shall be assembled and handled in accordance with the designer's instructions and the contract documents. Erect the face units conforming to the lines, grades, and typical sections shown on the contract documents and in accordance with the designated manufacturer's installation manual.

ii. Place the face units side by side and in full contact with the installed leveling pad.

iii. Maintain the minimum face unit tolerances shown in Table 554-3 *MSWS Open Top Face Unit Tolerances.* Correct all misalignments of installed face units that exceed the tolerances allowed in a manner satisfying the Engineer:

TABLE 554-3 MSWS OPEN TOP FACE UNIT ALIGNMENT TOLERANCES	
Vertical control (plumbness)	± 19 mm over a distance of 3 m
Horizontal location control (alignment)	± 19 mm over a distance of 3 m
Vertically overall (plumbness from top to bottom)	± 13 mm over a height of 3 m

iv. Adjust face unit spacing for curved sections according to the manufacturer's installation recommendations.

G. MSWS Facing Unit Bin Infill

1. Solid Face Unit Bin Infill

i. Placement. Place unit infill to the limits indicated in the contract documents. Before installing the next course of face units, compact the unit infill and brush the tops of the face units clean to ensure an even placement area.

ii. Protection. Protect unit infill from contamination during construction.

2. Open Top Face Unit Bin Infill.

i. Placement. Place and compact backfill and face unit infill simultaneously with the erection of the PWS and in accordance with *Compaction* in Section 203 Excavation and Embankment. Placement of infill in the wall and backfill behind the wall shall closely follow the erection of successive courses of face units.

ii. Protection. Protect unit infill from contamination during construction.

H. MSWS Backfill. Do not mix backfill material from different sources behind any wall without the written permission of the Director, Geotechnical Engineering Bureau.

1. Moisture Content. Place backfill materials (other than Types B and D) at or within 2% dry of the Optimum Moisture Content. Rework or replace all material which is at a moisture content exceeding the Optimum Moisture Content. Determine Optimum Moisture Content in conformance with Geotechnical Test Methods (excluding GTM-6) for compaction that incorporates moisture content determination. Rework or replace backfill material at no additional cost to the State.

2. Backfill Placement. Prior to placement of the reinforcing element, backfill and compact the area within 1 m of the face units horizontally to 50 mm above the required reinforcing element elevation. Roughly grade the backfill beyond the 1 m line to the reinforcing element elevation.

i. Place granular backfill material in uniform layers so that the compacted thickness of each layer does not exceed 250 mm or one unit height, whichever is less. Compact each layer to a minimum of 95% of Standard Proctor Maximum Density.

ii. Place Types B and D backfill in uniform layers so that the compacted thickness of each layer does not exceed 250 mm or one unit height, whichever is less. Compact each layer in conformance with *Compaction* in Section 203 Excavation and Embankment.

3. Separation Geotextile. Place the geotextile separation, if required, loosely but in intimate contact with the soil so that placement of the overlying material will not stretch or tear the geotextile.

4. Surface Drainage Control. Provide positive control and discharge of all surface drainage that will affect the installation of the MSWS throughout the construction of the wall. Maintain all vertical drains, weeps, ditches, pipes, or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.

5. QA Program. The Department will sample and test backfill from the grade in accordance with the Quality Assurance Program outlined in §733-02 *Mechanically Stabilized Earth System Backfill Material.* If the material is determined to not meet the specification requirements, the material will be rejected

I. MSWS Reinforcing Element

1. Reinforcing Element Placement. Place the reinforcing element normal to face units unless otherwise indicated in the contract documents. Replace all broken, damaged or distorted reinforcing elements at no additional cost to the State.

2. Reinforcing Element Connection. Install the reinforcing element within/between courses of face units conforming to the designers Installation Manual. Pull taut and secure the reinforcing element before placing the backfill.

J. MSWS Identification Markers. Install MSWS identification markers in accordance with the requirements of §554-3.02 J. *MSES Identification Markers.*

K. Equipment Movement. Movement of construction equipment and all other vehicles and loads over and adjacent to MSWS shall be done at the Contractor's risk. Control all operations and procedures to prevent misalignment of the face units. Precautionary measures include, but are not

limited to, keeping vehicular equipment at least 1 m behind the back of the face units. Compaction equipment used within 1.0 m of the back of the face units must conform to *Compaction Equipment for Confined Areas* in Section 203 Excavation and Embankment. Operate rubber tired equipment on top of reinforcing elements only at low speeds (less than 8 kph) and without making sharp turns or braking sharply. Do not operate tracked equipment directly on reinforcing elements. Cover reinforcing elements with a minimum 150 mm thick soil layer prior to operating tracked equipment over reinforced areas. Repair or replace damaged reinforcing elements in strict accordance with the designers written instructions at no additional cost to the State.

554-3.04. Geosynthetically Reinforced Soil System.

A. GRSS Submittal. Submit the geogrid or geotextile reinforcing element certifications, verifying that the material meets the requirements of §737-07 *Geogrids* for the specified long term design tensile strength shown in the contract documents, to the Engineer prior to start of work. Begin work only after receiving the Engineer's approval.

Supply on-site technical assistance from a representative of the geosynthetic reinforcing element manufacturer until such time as outside consultation is no longer required.

B. GRSS Storage of Geosynthetic. Store and protect geosynthetic materials in accordance with the manufacturer's recommendations prior to installation.

C. GRSS Excavation and Disposal. Excavation shall be conducted in accordance with the applicable requirements of Section 206 *Trench, Culvert and Structure Excavation* and the details specified in the contract documents.

D. GRSS Foundation. Prior to erection of the GRSS system, the foundation shall be inspected and approved by the Engineer.

Grade the area under the GRSS level for the width shown in the contract documents. A minimum of 90% of Standard Proctor Maximum Density will be required.

For GRSS wall systems, a pad of crushed stone shall be incorporated into the foundation directly below the wall facing.

E. GRSS Subsurface Drainage System. Install the subsurface drainage system simultaneously with the erection and backfill of the GRSS to ensure a continuous, uninterrupted system to prevent the accumulation of destabilizing water pressure on the wall. In all cases, the subsurface drainage system will be installed to drain all intercepted water to a point of positive drainage.

F. GRSS Placement of Materials.

1. Geosynthetic Reinforcing Element. Place and secure the primary and secondary reinforcing element in accordance with the manufacturer's recommendations, in continuous strips without joints, seams or connections throughout the embedment length, to the line, grade and orientation shown in the contract documents. Place reinforcing elements to lay flat with no creases and pull taut to remove any slack prior to placement of backfill.

2. Welded Wire Forms. Place welded wire forms where required, as shown in the contract documents. Position and connect the welded wire forms to overlap 50 mm with adjacent forms and connect with wire ties. Install wire struts as shown in the contract documents and as required to stiffen the welded wire forms.

3. Geotextile Face Wrap. Place geotextile face wrap as shown in the contract documents. If used in conjunction with welded wire forms, place the geotextile face wrap so as to conform closely to the welded wire forms.

4. Backfill. Replace any damaged geosynthetic prior to placement of any overlying material at no cost to the State. Place the backfill onto the geosynthetic reinforcing elements in such a manner that no damage occurs. Progress placement of backfill materials so as to minimize the development of slack in the reinforcing element. The thickness of a compacted lift of backfill is not to exceed 300 mm or the measured vertical distance between geosynthetic layers, whichever is less. Compact the backfill to a minimum of 95% of Standard Proctor Maximum Density in accordance with the requirements contained in *Compaction* in Section 203 Excavation and Embankment. Only hand operated equipment is allowed within 1.0 m of the face. Lift thickness may have to be reduced to achieve required compaction.

5. Surface Protection. Place and secure erosion control material in accordance with Section 209 *Soil Erosion and Sediment Control* and as shown in the contract documents.

6. Permanent Facing. Place and connect permanent facing as shown in the contract documents.

7. Surface Drainage Control. Provide positive control and discharge of all surface drainage that will affect the installation of the GRSS throughout the construction of the wall. Maintain all vertical drains, weeps, ditches, pipes, or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.

G. GRSS Construction Monitoring. Monitor the system face during fill placement and compaction. If verticality or the required batter of a system is not being maintained, stop work until compaction equipment and/or operational procedures are modified.

H. GRSS Identification Markers. For applications other than staging walls, install GRSS identification markers in accordance with the requirements of §554-3.02 J. *MSES Identification Markers.*

I. Equipment Movement. Movement of construction equipment and all other vehicles and loads over and adjacent to GRSS shall be done at the Contractor's risk. Operate rubber tired equipment on top of reinforcing elements only at low speeds (less than 8 kph) and without making sharp turns or braking sharply. Do not operate tracked equipment directly on reinforcing elements. Cover reinforcing elements with a minimum 150 mm thick soil layer prior to operating tracked equipment over reinforced areas. Repair or replace damaged reinforcing elements in accordance with the manufacturer's written instructions at no additional cost to the State.

554-3.05. Prefabricated Wall System.

A. PWS Excavation and Disposal. Excavation shall be conducted in accordance with the applicable requirements of Section 206 *Trench, Culvert and Structure Excavation* and the contract documents.

B. PWS Foundation. Prior to erection of the wall system, the foundation shall be inspected and approved by the Engineer.

Grade the area under the PMWS level for the width shown in the contract documents. A minimum of 90% of Standard Proctor Maximum Density will be required.

Construct the wall system to meet the line and grade shown in the contract documents.

C. PWS Subsurface Drainage System. Install the subsurface drainage system simultaneously with the erection and infill/backfill of the PWS to ensure a continuous, uninterrupted system to prevent the accumulation of destabilizing water pressure on the wall. In all cases, install the subsurface drainage system to drain all intercepted water to a point of positive drainage.

D. PWS Leveling Pad. Provide an unreinforced concrete leveling pad or compacted granular fill leveling pad as shown in the contract documents to ensure a flat surface for placing the initial course of face units. Step the leveling pad to conform to grade changes as shown in the contract documents or approved Shop Drawings.

1. Concrete. Cast the concrete leveling pad, in accordance with the requirements of Section 555 Structural Concrete, or place the precast leveling pad, for the foundation of the PWS.

2. Granular. Place and compact granular fill in conformance with Section 203 Excavation and Embankment.

E. PWS Erection. During erection, remove and replace any face units damaged beyond repair with approved face units at no additional cost to the State.

1. Assembly. All PWS shall be assembled and handled in accordance with the designer's instructions and the contract documents. Erect the PWS conforming to the lines, grades, and typical sections shown on the contract documents and in accordance with the designated manufacturer's installation manual.

2. Placement. Place the PWS side by side and in full contact with the installed leveling pad.

3. Tolerances. Maintain the minimum PWS tolerances shown in Table 554-2 *MSWS Solid Face Unit Alignment Tolerances* or Table 554-3 *MSWS Open Top Face Unit Alignment Tolerances* as appropriate. Correct all misalignments of installed face units that exceed the tolerances allowed in a manner satisfying the Engineer:

4. Adjustments. Adjust PWS spacing for curved sections according to the manufacturer's installation recommendations.

5. Coping. Apply the coping unit to the top of the wall using mastic adhesive, in accordance with, and conforming to the unit manufacturer's installation recommendations.

F. PWS Infill and Backfill. Immediately prior to backfilling, the Engineer will inspect the face units for damage. Face units which are damaged beyond repair shall be removed and replaced by the Contractor with approved face units at no additional cost to the State.

Place and compact backfill and unit infill simultaneously with the erection of the PWS and in accordance with *Compaction* in Section 203 Excavation and Embankment. Placement of infill in the wall and backfill behind the wall shall closely follow the erection of successive courses of face units.

G. Equipment Movement. Movement of construction equipment and all other vehicles and loads over and adjacent to PWS shall be done at the Contractor's risk. Control all operations and procedures to prevent misalignment of the PWS. Precautionary measures include, but are not limited to, keeping vehicular equipment at least 1 m behind the back of the face units. Compaction equipment used within 1 m of the back of the face units must conform to the *Compaction Equipment for Confined*

Areas in Section 203 Excavation and Embankment. Any damage to face units from any cause shall be repaired or replaced by the Contractor at no additional cost to the State.

554-3.06 Fill Type Retaining Wall Aesthetic Treatment. Provide aesthetic treatment as specified in the contract documents. Any damage to the treatment shall be repaired to the satisfaction of the Engineer at no additional cost to the State.

554-4 METHOD OF MEASUREMENT.

554-4.01. General. Vacant.

554-4.02. Mechanically Stabilized Earth System. A MSES will be measured in square meters of face area, measured to the nearest 0.1 square meter from the payment lines shown in the contract documents.

554-4.03. Mechanically Stabilized Wall System. A MSWS will be measured in square meters of face area, measured to the nearest 0.1 square meter from the payment lines shown in the contract documents.

554-4.04. Geosynthetically Reinforced Soil System. A GRSS will be measured in square meters of vertical face area, measured to the nearest 0.1 square meter from the payment lines shown in the contract documents.

554-4.05 Prefabricated Wall System. A PWS will be measured in square meters of vertical face area, measured to the nearest 0.1 square meter from the payment lines shown in the contract documents.

554-4.06 Fill Type Retaining Wall Aesthetic Treatment. Aesthetic treatment will be measured in square meters of treated face area, measured to the nearest 0.1 square meter from the payment lines shown in the contract documents. Include only those visual standards incorporated into the finished wall into the measurements.

554-5 BASIS OF PAYMENT

554-5.01. General. Vacant.

554-5.02 Mechanically Stabilized Earth System. Include in the unit price bid the cost of all labor, materials, and equipment, including backfill, reinforcing elements, leveling pads, fasteners, joint fillers, geotextiles, face panel and coping units, subsurface drainage system, and the cost of adding water for backfill compaction, unless items for Furnishing Water Equipment and Applying Water are included in the contract, necessary to satisfactorily complete the work.

554-5.03 Mechanically Stabilized Wall System. Include in the unit price bid the cost of all labor, material, and equipment, including backfill, infill, reinforcing elements, leveling pads, fasteners, geotextiles, face units and coping units, subsurface drainage system, and the cost of adding water for backfill compaction, unless items for Furnishing Water Equipment and Applying Water are included in the contract, necessary to satisfactorily complete the work.

554-5.04 Geosynthetically Reinforced Soil System. Include in the unit price bid the cost of all labor, materials, and equipment, including backfill, geosynthetic reinforcing elements, facing system, subsurface drainage system, and the cost of adding water for backfill compaction, unless items for

Furnishing Water Equipment and Applying Water are included in the contract, necessary to satisfactorily complete the work.

554-5.05 Prefabricated Wall System. Include in the unit price bid the cost of all labor, materials, and equipment, including backfill, leveling pads, joint fillers, geotextiles, face units and coping units, subsurface drainage system, and the cost of adding water for backfill compaction, unless items for Furnishing Water Equipment and Applying Water are included in the contract, necessary to satisfactorily complete the work.

554-5.06 Fill Type Retaining Wall Aesthetic Treatment. Include in the unit price bid the cost of all labor, material, and equipment needed to provide aesthetic treatment for the wall and the cost of production and transportation of visual standards from the precast facility to the project site for Region approval and back to the precast facility for use during production.

Payment will be made under:

Item No.	Item	Pay Unit
554.30XX	Geosynthetically Reinforced Soil System Wall	Square Meter
XX	*Facing System*	
01	*Welded Wire Forms*	
02	*Geocells*	
03	*Timbers*	
04	*Other; As Shown in the Contract Documents*	
554.31	Geosynthetically Reinforced Soil System Slope	Square Meter
554.40	Fill Type Retaining Wall (0 – 1.8 m)	Square Meter
554.41	Fill Type Retaining Wall (Greater than 1.8 m – 3.7 m)	Square Meter
554.42	Fill Type Retaining Wall (Greater than 3.7 – 5.5 m)	Square Meter
554.43	Fill Type Retaining Wall (Greater than 5.5 m – 7.3 m)	Square Meter
554.44	Fill Type Retaining Wall (Greater than 7.3 m – 9.1 m)	Square Meter
554.45	Fill Type Retaining Wall (Greater than 9.1 m)	Square Meter
554.5001	Fill Type Retaining Wall Aesthetic Treatment - Textured Surface (Hand Tooled, Raked, etc.), No Color	Square Meter
554.5002	Fill Type Retaining Wall Aesthetic Treatment - Textured Surface (Hand Tooled, Raked, etc.), Integral Color	Square Meter
554.5101	Fill Type Retaining Wall Aesthetic Treatment - Exposed Aggregate Finish, No Color	Square Meter
554.5102	Fill Type Retaining Wall Aesthetic Treatment - Exposed Aggregate Finish, Integral Color	Square Meter
554.5201	Fill Type Retaining Wall Aesthetic Treatment - Architectural Pattern, No Color	Square Meter
554.5202	Fill Type Retaining Wall Aesthetic Treatment - Architectural Pattern, Integral Color	Square Meter
554.53	Fill Type Retaining Wall Aesthetic Treatment - Other; As Shown in the Contract Documents	Square Meter

FILL TYPE RETAINING WALLS

Make the following changes to the Standard Specifications dated May 4, 2006 as modified by EI 08-020:

Delete SECTION 632 – Precast Modular Walls entirely and **Replace** it with the following:

SECTION 632 (VACANT)

Delete the Title and Scope of Section 704-06 and **Replace** it with the following:

SECTION 704-06 PRECAST CONCRETE WALL UNITS AND PRECAST CONCRETE CRIBBING

Scope. This specification covers the material and fabrication requirements of precast concrete wall units and precast concrete cribbing for prefabricated wall systems.

Make the following changes to the Standard Specifications dated May 4, 2006 as modified by EI 10-022:

Delete the Title of Section 704-07 and **Replace** it with the following:

SECTION 704-07 DRY CAST CONCRETE WALL UNITS

Delete the term "segmental retaining wall blocks" in the Scope, Material Requirements, and Basis of Acceptance sections of Section 704-07 and **Replace** it with "dry cast concrete wall units".

Delete the term "concrete retaining wall block units" in the Physical Properties section of Section 704-07 and **Replace** it with "dry cast concrete wall units".

Make the following changes to the Standard Specifications dated May 4, 2006 as modified by EI 09-027:

Delete the Title and Scope of Section 733-03 and **Replace** it with the following:

§733-03 – GEOSYNTHETICALLY REINFORCED SOIL SYSTEM SLOPE BACKFILL MATERIAL

SCOPE. This specification covers the material requirements and methods of testing backfill material generally used for the construction of over steepened slopes utilizing Geosynthetically Reinforced Soil System (GRSS).

Make the following changes to the Standard Specifications dated May 1, 2008:

Pages 332 through 338, **Delete** SECTION 554 in its entirety and **Replace** it with the following:

SECTION 554 – FILL TYPE RETAINING WALLS

554-1 DESCRIPTION. This work shall consist of furnishing and installing a fill type retaining wall at the location(s) and to the elevation(s) shown in the contract documents.

554-1.01. General. The fill type classification refers to the construction method used for the installation of the wall. Fill type retaining walls are retaining structures constructed from the base of the wall to the top (i.e. "bottom-up" construction).

The fill type retaining walls are further classified according to the basic mechanism of lateral load support. These classifications include internally stabilized fill structures and externally stabilized fill structures.

The specification is supplemented with an Approved List which provides a listing of available designers and their corresponding fill type retaining walls. Fill type retaining walls are further defined in the pertinent subsequent section. For proprietary fill type retaining wall systems, approved designers, wall systems, and the components of each wall system appear on the Approved List, available on the Department's web site. Designers wishing to have their wall systems reviewed for placement on the Approved List shall follow the procedural directives of the Geotechnical Engineering Bureau as contained in Highway Design Manual Appendix 9A.

554-1.02 Definitions. Internally stabilized fill structures are structures which rely on friction developed between closely-spaced reinforcing elements and the backfill to resist lateral soil pressure and are subcategorized in the retaining wall subsections of this specification. Externally stabilized fill structures are structures which utilize the weight of the wall system elements and the weight of the infill to resist lateral soil pressure.

A. Wall System. A wall system is either a series of open top face units assembled to form bins which are connected in unbroken sequence or a combination of specific solid face units with a characteristic alignment and connection method, which utilize the weight of the wall system elements and the weight of the infill to resist lateral soil pressure. As indicated, the bin volume is infilled with backfill material to supplement the face unit geometry, adding to the stability of the system.

B. Internally Stabilized Wall System. A wall system which, when constructed beyond wall heights exceeding the maximum allowable unreinforced height per the Approved List, relies on reinforcing elements within the backfill to provide stability.

C. Internally Stabilized Earth System. A series of tensile reinforcing elements which, when placed in multiple layers within the backfill volume, improves the strength such that the vertical face of the stabilized earth volume is essentially self supporting.

D. Internally Stabilized Fill Structures.

1. Fill Structure. A fill type retaining wall as described in §554-1.01 *Fill Type Retaining Walls* which consists of either an internally stabilized wall system or an internally stabilized earth system.

i. Mechanically Stabilized Earth System (MSES). An MSES is an internally stabilized fill structure comprised of an unreinforced concrete leveling pad, precast concrete face panel units and coping units, earth backfill, subsurface drainage system, and reinforcing elements used to stabilize the backfill. Only MSES designers appearing on the Approved List

will be acceptable for use. All necessary materials, except backfill, leveling pad, and subsurface drainage system, are obtained from the approved wall system designer.

ii. Mechanically Stabilized Wall System (MSWS). An MSWS is an internally stabilized fill structure comprised of an unreinforced concrete or compacted granular fill leveling pad, face units (solid or open top) and coping units, earth backfill, subsurface drainage system, and reinforcing elements used to stabilize the backfill. Only MSWS designers with face units appearing on the Approved List will be acceptable for use. All necessary materials, except backfill, face unit infill, leveling pad material, backfill drainage materials, and cast-in-place concrete, are obtained from the designer.

iii. Geosynthetically Reinforced Soil System (GRSS). A GRSS is an internally stabilized fill structure comprised of earth backfill, geosynthetic reinforcing elements used for internal stabilization and surface protection to resist erosion.

a. GRSS Wall. For wall applications, the surface protection is the permanent facing elements (excluding precast units) or a geotextile face wrap which typically includes welded wire forms remaining from the installation operation.

b. GRSS Slope. For slope applications, the surface protection consists of a secondary reinforcing element to aid in stability of the slope face between primary reinforcing layers. To protect against erosion, the GRSS slope is covered by either a non-degradable erosion control mat or a granular fill slope protection blanket.

Although GRSS is a fill type retaining wall, it is not a part of the selection process outlined in §554-3.01A. *Fill Type Retaining Wall Selection* or supplemented by the Approved List for Fill Type Retaining Walls, as it is not a proprietary system. A GRSS will be designed and detailed in the contract documents by the Department or its representatives.

2. Leveling Pad. A compact surface which serves as a flat, level area for placing the initial course of face units.

i. Concrete. An unreinforced concrete slab.

ii. Granular. A compacted granular fill pad.

3. Face Unit. A structural unit incorporating a means for attaching the backfill reinforcing element, which restrains the alignment of the wall system during installation compaction operations and provides support for the front edge of the backfill for the life of the wall system.

i. Panel Unit. A precast concrete panel incorporating a means for attaching the backfill reinforcing element, forming part of the face area of the MSES.

ii. Solid Unit. A face unit which has a solid mass and incorporates a means for attaching the backfill reinforcing element, forming part of the face area of the MSWS.

iii. Open Top Unit. A face unit which has an open structure, to allow placement of infill material, and incorporates a means for attaching the backfill reinforcing element, forming part of the face area of the MSWS.

iv. Corner Unit. A corner unit is a face unit having two faces.

v. Geotextile Face Wrap. A layer of geotextile used to prevent loss of backfill, typically employed in a temporary wall application in conjunction with welded wire forms. In applications where a geotextile is used as the primary reinforcing element, it may be designed to also function as the face wrap.

a. Welded Wire Forms. A non-structural system used in temporary walls to aid in compaction near the face of the wall.

vi. Geocells. A three-dimensional, permeable polymeric honeycomb or web structure expandable panels used to confine fill materials to create structural stability.

vii. Timbers. A dressed piece of wood used as a building material.

viii.Gabions. A partitioned, wire fabric container filled with stone to form a flexible and permeable structure.

4. Alignment and Connection Device. Any device that is either built into or specially manufactured for the face units, such as shear keys, leading/trailing lips, or pins. The device is

used to provide alignment and maintain positive location for a face unit and also provide a means for connecting the reinforcing elements.

5. Fastener. Hardware used to connect the reinforcing element to the attaching device.

6. Coping. A precast or cast-in-place element placed on and attached to the top of the finished wall system to form a protective cap against the weather.

7. Joint Filler. Material used to fill the joints between face units.

8. Slip Joint. A vertical joint specific to the wall system used as a stress relief at wall step locations.

9. Geotextile. A permeable, planar polymeric textile material used to promote drainage, prevent infill and/or backfill material from releasing through the joints, or separating dissimilar granular materials.

10. Reinforcing Element. An inclusion connected to the face unit and extending into the backfill for the purpose of backfill stabilization.

i. Inextensible Reinforcement. A metal strip typically incorporating ribs on the top and bottom, or metal grids with design specific mesh openings.

ii. Extensible Reinforcement. Geogrid or geotextile sheets typically made from high density polyethylene/ polypropylene geogrids or high tenacity polyester geogrids, or high strength geotextiles.

11. Unit Infill. Granular material placed within the open structure of an open top face unit or contiguous to the bevel sides of a solid face unit.

12. Backfill. Granular material placed and compacted in conjunction with the reinforcing elements and face units.

13. Subsurface Drainage System. A system for removing water from behind the wall and channeling it to a point of positive drainage.

14. Identification Markers. Signs and marking tape, buried near the finished grade, to identify and prohibit excavation of the reinforced backfill.

E. Externally Stabilized Fill Structures.

1. Fill Structure. A fill type retaining wall as described in §554-1.01 *Fill Type Retaining Walls* which consists of a prefabricated face unit.

i. Prefabricated Wall System (PWS). A PWS is an externally stabilized fill structure comprised of prefabricated face units & coping units, including leveling pads, unit infill, earth backfill, joint filler material and geotextile, and a subsurface drainage system to reduce hydrostatic pressure on the wall system. Only PWS designers appearing on the Approved List will be acceptable for use. All necessary materials, except backfill, unit infill, backfill drainage materials, and cast-in-place concrete, are obtained from the designer.

When reinforcement is introduced to a PWS, they shall be reclassified as Mechanically Stabilized Wall Systems and the pertinent sections of the specification shall apply.

2. Leveling Pad. A compact surface which serves as a flat, level area for placing the initial course of face units.

i. Concrete. An unreinforced concrete slab.

ii. Granular. A compacted granular fill pad.

3. Face Unit. A prefabricated concrete element, incorporating alignment and connection devices, that is able to be arranged, stacked, placed, combined, or interchanged easily into an assembled wall system.

i. Solid Unit. A face unit which has a solid mass, utilizing the weight of the wall system elements to resist lateral soil pressure. A solid unit may require some infill material depending on the geometric bevel of the units.

ii. Open Top Unit. A face unit which has an open structure to allow placement of infill material, utilizing the weight of the wall system elements and the weight of the infill to resist lateral soil pressure.

4. Bin. Any volumetric space which is designated to be infilled, as defined in this section, and is encompassed within the dimensions of the open top unit.

5. Alignment and Connection Device. Any device that is either built into or specially manufactured for the face units, such as shear keys, leading/trailing lips, or pins. The device is used to provide alignment and maintain a positive location.

6. Coping. A precast or cast-in-place element placed on and attached to the top of the finished wall system to form a protective cap against the weather.

7. Joint Filler. Material used to fill the joints between face units.

8. Slip Joint. A vertical joint specific to the wall system used as a stress relief at wall step locations.

9. Geotextile. A permeable, planar polymeric textile material used to promote drainage, prevent infill and/or backfill material from releasing through the joints, or separating dissimilar granular materials.

10. Unit Infill. Granular material placed within the bin, such as the open structure of an open top face unit or contiguous to the bevel sides of a solid face unit.

11. Backfill. Granular material placed directly behind and/or above the bins in conjunction with the wall assembly.

12. Subsurface Drainage System. A system for removing water from behind the wall and channeling it to a point of positive drainage.

F. Aesthetic Treatment. A treatment applied to the face either during or after the manufacture of the face units to modify the appearance of the units and of the wall as a whole. Aesthetic treatment can include modifications to color, texture, architectural pattern, the addition of exposed surface aggregate (real or artificial), the addition of simulated joints or cracks, or any other treatment or material that modifies the appearance, provided that the structural integrity, function, or life span of the wall is not negatively impacted.

554-2 MATERIALS.

554-2.01. Fill Type Retaining Walls. Provide materials for the selected fill type retaining wall as outlined in the pertinent subsequent section.

554-2.02. Mechanically Stabilized Earth System. Not all materials listed below are required for each MSES. Ensure that the proper materials are supplied for the chosen system design. Provide materials meeting the following requirements:

A. MSES Leveling Pad. Provide leveling pad material meeting the requirements of Section 501 *Portland Cement Concrete - General*, Class A concrete.

1. Leveling Pad Placement. For precast leveling pad installations, a substitution of cushion sand, meeting the requirements of §703-06 *Cushion Sand,* in lieu of MSES backfill material directly beneath the leveling pad may be made to facilitate placement of the pad.

B. MSES Facing Panel Units. Fabricate precast concrete face panel units and incidental precast units in accordance with the requirements of §704-14 *Precast Concrete Panel Units*. The default aesthetic treatment for an MSES facing panel is a plain, smooth concrete finish of natural concrete (gray) color.

1. Coping Unit. Fabricate precast concrete coping units, and incidental precast units in accordance with the requirements of §704-14 *Precast Concrete Panel Units*.

C. MSES Fasteners and Attaching Devices. The fasteners and attaching devices are specific to each wall system and provided by the wall system manufacturer. The fasteners and attaching devices associated with each approved wall system appear on the Approved List under wall system components.

D. MSES Joint Fillers. Fill joints with material approved by DCES and approved by the wall system designer.

E. MSES Geotextile. Provide a geotextile meeting the requirements of §737-01B *Geotextile Separation.*

F. MSES Slip Joints. The type of slip joints are specific to each wall system and are designed and supplied by the wall system manufacturer.

G. MSES Metal Reinforcing Strips. Provide reinforcing strips of ASTM Designated metal grades and galvanize in accordance with the requirements of §719-01 *Galvanized Coatings and Repair Methods, Type I.* The reinforcing strips associated with each approved wall system appear on the Department's Approved List under wall system components.

H. MSES Metal Reinforcing Mesh. Fabricate the reinforcing mesh from cold drawn steel wire conforming to the requirements of §709-09 *Cold Drawn Wire for Concrete Reinforcement,* and weld into the finished mesh fabric in accordance with the requirements of §709-02 *Wire Fabric for Concrete Reinforcement.* Galvanize in accordance with §719-01 *Galvanized Coatings and Repair Methods, Type I.* The reinforcing mesh associated with each approved wall system appears on the Department's Approved List under wall system components.

I. MSES Geogrid Reinforcing Element. Provide geogrid reinforcing elements meeting the requirements of §737-07 *Geogrids.* The grid(s) associated with each approved wall system appear on the Approved List under wall system components.

J. MSES Backfill. Provide backfill material meeting the requirements of §733-02 *Mechanically Stabilized Earth System Backfill Material.*

K. MSES Subsurface Drainage System. Provide underdrain and geotextile material for a backfill drainage system as shown in the contract documents or conforming to the designers Installation Manual:

1. Underdrain Pipe. Provide optional underdrain pipe conforming to Section 605 *Underdrains.*

2. Geotextile Drainage. Provide geotextile conforming to the requirements of §737-01 *Geotextiles,* Geotextile Drainage, Strength Class 2, Drainage Class B.

L. MSES Identification Markers

1. Signs. These will be 7 in. x 10 in. (minimum) fiberglass. Include warning information as follows:

WARNING
Internally Stabilized Fill Structure
DO NOT EXCAVATE
Call Regional Office of NYS DOT

For signs installed on concrete units, provide ¼ in. diameter by 1 ½ in. long stainless steel nail drive expansion anchors meeting GSA Specifications FF-S-325.

For signs installed on timbers, provide ¼ in. diameter by 1 ½ in. long stainless steel wood screws.

2. Marking Tape. This will be polyethylene material 3 in. wide, 4 mil. thick. Include warning markings.

554-2.03. Mechanically Stabilized Wall System. Not all materials listed below are required for each MSWS. Ensure that the proper materials are supplied for the chosen system design. Provide materials meeting the following requirements:

A. MSWS Leveling Pad. MSWS height is measured from the top of the leveling pad to the top of the face coping unit.

1. Wall Heights Taller Than or Equal to 15 ft. For MSWS taller than or equal to 15 ft. in total height, provide a leveling pad of unreinforced Class A concrete - Section 501 *Portland Cement Concrete – General.*

2. Wall Heights Shorter Than 15 ft. For MSWS shorter than 15 ft. in total height, provide a leveling pad conforming to one of the following:

i. Concrete. Unreinforced Class A concrete - Section 501 *Portland Cement Concrete – General,* or

ii. Granular. Select Granular Fill - §733-11 *Select Granular Fill,* or Crushed Stone - §501-2.02, B.1.b. *Coarse Aggregate Type CA-2* in Table 501-2 Coarse Aggregate Gradations.

3. Leveling Pad Placement. For precast leveling pad installations, a substitution of cushion sand, meeting the requirements of §703-06 *Cushion Sand,* in lieu of MSWS backfill material directly beneath the leveling pad may be made to facilitate placement of the pad.

B. MSWS Facing System. Provide a facing system in accordance with the requirements below.

1. Solid Face Units. Provide face units fabricated and conforming to §704-07 *Dry Cast Concrete Wall Units* or §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.* The default treatment for a MSWS face unit is a split face finish of natural concrete (gray) color.

i. Coping Unit. Provide coping units fabricated and conforming to §704-07 *Dry Cast Concrete Wall Units* or §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.*

2. Open Top Face Unit. Provide face units meeting the requirements of §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.* The default treatment for a MSWS face unit is a plain, smooth concrete finish of natural concrete (gray) color.

i. Coping Unit. Provide coping units meeting the requirements of §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.*

C. MSWS Alignment and Connection Devices. Provide devices conforming to the designers Installation Manual.

D. MSWS Joint Fillers. Fill joints with material meeting the requirements of §705-07 *Premoulded Resilient Joint Filler* and approved by the wall system designer.

E. MSWS Geotextile. Provide a geotextile meeting the requirements of §737-01B *Geotextile Separation.*

F. MSWS Slip Joints. The type of slip joints are specific to each wall system and are designed and supplied by the wall system manufacturer.

G. MSWS Reinforcing Element. Provide geogrid or geotextile reinforcing elements meeting the requirements of §737-07 *Geogrids.*

H. MSWS Unit Infill. Provide infill material meeting the requirements of §733-02 *Mechanically Stabilized Earth System Backfill Material.*

I. MSWS Backfill. Provide backfill material meeting the requirements of §733-02 *Mechanically Stabilized Earth System Backfill Material.*

J. MSWS Drainage System. Provide underdrain, geotextile material, and prefabricated structural drain for a backfill drainage system as shown in the contract documents or conforming to the designers Installation Manual:

1. Underdrain Pipe. Provide optional underdrain pipe conforming to Section 605 *Underdrains.*

2. Geotextile Drainage. Provide geotextile conforming to the requirements of §737-01 *Geotextiles*, Geotextile Drainage, Strength Class 2, Drainage Class B.

3. Prefabricated Composite Structural Drain. Provide structural drain conforming to the requirements of §737-04 *Prefabricated Composite Structural Drain.*

K. MSWS Identification Markers. Provide identification markers conforming to §554-2.02 L. *MSES Identification Markers.*

554-2.04. Geosynthetically Reinforced Soil System. Not all materials listed below are required for each GRSS. Ensure that the proper materials are supplied for the chosen system design. Provide materials meeting the following requirements:

A. GRSS Geosynthetic Reinforcing Element. Provide a geogrid or geotextile primary and secondary reinforcing elements meeting the requirements of §737-07 *Geogrids.*

B. GRSS Backfill. Provide backfill material conforming to the following:

1. Walls. Provide backfill material meeting the requirements of §733-14 *Select Structural Fill* with the exception that the pH requirements are waived.

2. Slopes. Provide backfill material meeting the requirements of §733-03 *Geosynthetically Reinforced Soil System Slope Backfill Material.*

C. GRSS Wall Facing Foundation. Provide a pad of material meeting the requirements of §703-02 *Crushed Stone, Size Designation 2.*

D. GRSS Facing System. Provide a facing system shown in the contract documents and in accordance with the requirements below.

1. Welded Wire Forms. Provide welded wire forms and wire struts as shown in the contract documents, conforming to the material requirements of §709-02 *Wire Fabric for Concrete Reinforcement.* For applications other than staging walls, provide galvanization to the forms in accordance with the requirements of ASTM A 641 Class 3 for zinc coating (including the zinc coating on the Style 2 fabric), ASTM A 856M Class 3 for Zn-5Al-MM coating, or ASTM A 809 for aluminum coating.

Provide geotextile face wrap material meeting the requirements of §737-01B *Geotextile Separation* and as shown in the contract documents.

Proposed alternate, non-structural facing systems used to aid in compaction near the face of the wall shall be included in the submittal outlined in §554-3.03 A. *GRSS Submittal.*

2. Geocells. Provide geocells, anchoring devices, and staples as shown in the contract documents, conforming to the material requirements of §737-08 *Geocells.*

Provide infill material conforming to §733-14 *Select Structural Fill,* with the added stipulation that the maximum particle size is 2 in. Where a vegetated face is called for, the outermost cells are to be filled with topsoil meeting the material requirements of §713-01 *Topsoil.*

3. Timbers. Provide timbers as shown in the contract documents, graded for an extreme fiber stress of at least 1000 psi conforming to the material requirements of §712-14 *Stress Graded Timber and Lumber.* Treat timbers in accordance with §708-31 *Wood Preservative - Waterborne* and applied in conformance with American Wood Preservers Association (AWPA) Use Category Designation UC4B.

4. As Shown in the Contract Documents. Provide materials in accordance with the contract documents. Precast units are excluded as a design-specific GRSS facing system,

E. GRSS Surface Protection. Provide erosion resistant covering of the finished GRSS slope surface meeting the requirements of §713-07 *Rolled Erosion Control Products and Soil Stabilizers* Class III Type C.

F. GRSS Drainage System. Provide underdrain and geotextile material for a backfill drainage system conforming to §554-2.02 K. *MSES Drainage System.*

G. GRSS Identification Markers. Provide identification markers conforming to §554-2.02 L. *MSES Identification Markers.*

554-2.05. Prefabricated Wall System. Not all materials listed below are required for each PWS. Ensure that the proper materials are supplied for the chosen system design. Provide materials meeting the following requirements:

A. PWS Leveling Pad. Provide a leveling pad conforming to the following:

1. Open Top Face Units. For PWS utilizing open top face units, provide a leveling pad of unreinforced Class A concrete - Section 501 *Portland Cement Concrete – General.*

For precast leveling pad installations, a substitution of cushion sand, meeting the requirements of §703-06 *Cushion Sand,* in lieu of PWS backfill material directly beneath the leveling pad may be made to facilitate placement of the pad.

2. Solid Face Units. For PWS utilizing solid face units, provide a leveling pad conforming to the requirements of §733-11 *Select Granular Fill* or §501-2.02, B.1.b. *Coarse Aggregate Type CA-2* in Table 501-2 Coarse Aggregate Gradations.

B. PWS Face Unit. Provide face units meeting the following:

1. Open Top Face Units. For PWS utilizing open top face units, provide units meeting the requirements of §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.* The default treatment for a PWS open top face unit is a plain, smooth concrete finish of natural concrete (gray) color.

i. Coping Unit. Provide coping units meeting the requirements of §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.*

2. Solid Face Units. For PWS utilizing solid face units, provide units meeting the requirements of §704-07 *Dry Cast Concrete Wall Units* or §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.* The default treatment for a PWS solid face unit is a split face finish of natural concrete (gray) color.

i. Coping Unit. Provide coping units fabricated and conforming to §704-07 *Dry Cast Concrete Wall Units* or §704-06 *Precast Concrete Wall Units and Precast Concrete Cribbing.*

C. PWS Joint Fillers. Fill joints with material meeting the requirements of §705-07 *Premoulded Resilient Joint Filler* and approved by the wall system designer.

D. PWS Geotextile. Provide a geotextile meeting the requirements of §737-01B *Geotextile Separation.*

E. PWS Slip Joints. The type of slip joints are specific to each wall system and are designed and supplied by the wall system manufacturer.

F. PWS Backfill. Provide backfill material meeting the requirements of §733-14 *Select Structural Fill.*

G. PWS Unit Infill. Provide unit infill material meeting the requirements of §733-14 *Select Structural Fill.*

For systems which allow plantings to integrate the structure into the surrounding environment, the front pocket of the unit shall be filled with a minimum of 8 in. of topsoil conforming to the material requirements as specified in §713-01 *Topsoil.*

H. PWS Drainage System. Provide underdrain, geotextile material, and prefabricated structural drain for a backfill drainage system as shown in the contract documents or conforming to the designers Installation Manual:

1. Underdrain Pipe. Provide optional underdrain pipe conforming to Section 605 *Underdrains.*

2. Geotextile Drainage. Provide geotextile conforming to the requirements of §737-01 *Geotextiles*, Geotextile Drainage, Strength Class 2, Drainage Class B.

3. Prefabricated Composite Structural Drain. Provide structural drain conforming to the requirements of §737-04 *Prefabricated Composite Structural Drain*.

554-2.06 Fill Type Retaining Wall Aesthetic Treatment. The requirements for color, texture and pattern will be described in the contract documents using industry-standard descriptions and terminology. Other requirements will be vividly described in the contract documents using special notes and sketches, as needed.

554-3 CONSTRUCTION DETAILS

554-3.01. General.

A. Fill Type Retaining Wall Selection. Approved designers of proprietary Fill Type Retaining Walls, wall systems, and the components of each wall system appear on the Approved List, available on the Department's web site. Proprietary Fill Type Retaining Walls include Mechanically Stabilized Earth Systems, Mechanically Stabilized Wall Systems, and Prefabricated Wall Systems.

Select a designer appearing on the Approved List for Fill Type Retaining Walls. The selection shall be based on the maximum wall height shown in the contract documents.

B. Fill Type Retaining Wall Submittal. Obtain from the chosen designer a Fill Type Retaining Wall design stamped by a Professional Engineer. Submit the design package, including working drawings of the wall design, design calculations, and the designers Installation Manual at least 30 work days before starting work to the following:

1. Mechanically Stabilized Earth System. Submit the design package to the Deputy Chief Engineer Technical Services (DCETS) Attn: Materials Bureau in accordance with the requirements for Drawing in §704-03 *Precast Concrete – General*. The design shall be consistent with the design methods employed in obtaining acceptance to appear on the Department's Approved List. The design package shall also include identification of backfill material gradation type(s) (outlined in §733-02B *Gradation*) suitable for the construction of the wall system, fabrication drawings for precast panels and coping and, for treatments applied to the face panel units other than the default treatment, a face panel unit sample for color and texture approval by the Regional Landscape Architect.

2. Mechanically Stabilized Wall System. Submit the design package to the Deputy Chief Engineer Technical Services (DCETS) Attn: Geotechnical Engineering Bureau. The design shall be consistent with the design methods employed in obtaining acceptance to appear on the Department's Approved List. The design package shall also include identification of backfill material gradation type(s) (outlined in §733-02B *Gradation*) suitable for the construction of the wall system and, for treatments applied to the face units other than the default treatment, a face unit sample for color and texture approval by the Regional Landscape Architect.

3. Prefabricated Wall System.

i. Open Top Face Units. For PWS utilizing open top face units, submit the design package to the Deputy Chief Engineer Technical Services (DCETS) Attn: Materials Bureau in accordance with the requirements for Drawing in §704-03 *Precast Concrete – General*. The

design shall be consistent with the design methods employed in obtaining acceptance to appear on the Department's Approved List. The design package shall also include fabrication drawings for the face units and, for treatments applied to the face units other than the default treatment, a face unit sample for color and texture approval by the Regional Landscape Architect.

ii. Solid Face Units. For PWS utilizing solid face units, submit the design package to the Engineer for approval. For solid face units consisting of units manufactured via the wet-casting process, submit the design package in accordance with the requirements for Drawing in §704-03 *Precast Concrete – General.* The design shall be consistent with the design methods employed in obtaining acceptance to appear on the Department's Approved List. For treatments applied to the face units other than the default treatment, the design package submittal shall also include a face unit sample for color and texture approval by the Regional Landscape Architect.

After receipt of all pertinent information, the Department requires 10 work days or 2 work days per drawing sheet, whichever is greater, to review the submission.

554-3.02. Mechanically Stabilized Earth System.

A. Pre-Operation Meeting. A Pre-Operation Meeting will be held between the Engineer, Contractor, Regional Geotechnical Engineer, Geotechnical Engineering Bureau and other appropriate Department representatives to discuss the Contractors proposed construction methods. Begin work only after receiving the DCES written approval and holding the Pre-Operation Meeting.

Supply on-site technical assistance from a representative of the designated designer during the beginning of the installation until such time as outside consultation is no longer required.

B. MSES Excavation and Disposal. Excavation shall be conducted in accordance with the applicable requirements of Section 206 *Trench, Culvert and Structure Excavation* and the details specified in the contract documents.

C. MSES Foundation. Prior to erection of the wall system, the foundation shall be inspected and approved by the Engineer.

1. Placement Area. Grade the area under the MSES, level for a width equal to, or in excess of, the reinforcing element length. Prior to wall system construction, compact this area to a minimum of 90% of Standard Proctor Maximum Density. Treat all soils found to be unsuitable, or incapable of being satisfactorily compacted because of moisture content, in a manner directed by the Engineer, in conjunction with the recommendations of the Regional Geotechnical Engineer.

D. MSES Subsurface Drainage System. Install the subsurface drainage system simultaneously with the erection and backfill of the MSES to ensure a continuous, uninterrupted system to prevent the accumulation of destabilizing water pressure on the wall. In all cases, the subsurface drainage system will be installed to drain all intercepted water to a point of positive drainage.

E. MSES Facing Panel Unit Inspection, Storage, and Handling

1. Face Panel Units. An inspection will be made prior to installation to determine if any damage has occurred to the panel unit(s). Handle and store the panel units with care to prevent damage.

2. Damaged Panel Units. Repair damaged panel units in a manner approved by the Engineer. Replace panel units that are not repairable at no additional cost to the State.

F. MSES Leveling Pad. Provide an unreinforced concrete leveling pad as required by the contract documents. Cast the concrete, in accordance with the requirements Section 555 Structural Concrete, or place the precast leveling pad for the foundation of the MSES to ensure a flat surface for placing the initial course of precast facing panel units. Step the leveling pad to conform to grade changes as shown in the contract documents or approved Shop Drawings.

G. MSES Erection

1. Methods and Equipment. Install panel units in accordance with the designers approved shop drawings and Installation Manual, unless otherwise modified by the contract documents. Prior to installation of the panel units, furnish the Engineer with detailed information concerning the proposed construction method, as well as the equipment planned for use.

2. Panel Unit Installation

i. Place panel units such that, after completion of compaction, the tolerances of Table 554-1 *MSES Facing Panel Unit Alignment and Joint Offset Tolerances* are not exceeded. After placement, maintain each panel unit in position. If wedges are used, do not allow them to remain in place below three panel unit heights during installation, and compaction. Remove all wedges remaining in the top three panel unit heights upon completion of the MSES. External braces may be required for initial placements. Install joint fillers in the manner indicated by the Installation Manual.

ii. Correct all misalignments of installed panel units in excess of the tolerances allowed by Table 554-1 *MSES Facing Panel Unit Alignment and Joint Offset Tolerances*, at no additional cost to the State.

TABLE 554-1 MSES FACING PANEL UNIT ALIGNMENT AND JOINT OFFSET TOLERANCES	
Horizontal Alignment	± ¾ in./ 10 ft.
Joint Offset per Panel Unit	± ¾ in.
Overall Vertical Plumbness (Top to Bottom of Wall System)	± ½ in./ 10 ft.

H. MSES Backfill. Do not mix backfill material from different sources behind any wall without the written permission of the Director, Geotechnical Engineering Bureau.

1. Moisture Content. Place backfill materials, other than Type B and Type D, at or within 2% dry of the Optimum Moisture Content. Rework or replace all backfill material which is at a moisture content in excess of the Optimum Moisture content. Determine the Optimum Moisture Content in conformance with the latest Geotechnical Test Methods for compaction that incorporate moisture content determination. Rework or replace backfill material at no additional cost to the State.

2. Backfill Placement. Prior to placement of the reinforcing element, backfill and compact the area within 3 ft. of the panel units horizontally to 2 in. above the required reinforcing element elevation. Roughly grade the backfill beyond the 3 ft. line to the reinforcing element elevation.

i. Place granular backfill material in uniform layers not exceeding 12 in. loose lift thickness per layer. Compact each layer to a minimum of 95% of Standard Proctor Maximum Density.

ii. Place Type B and Type D backfill in uniform layers not exceeding 16 in. loose lift thickness. Compact in accordance with requirements determined by the Engineer.

3. Surface Drainage Control. Provide positive control and discharge of all surface drainage that will affect the installation of the MSES throughout the construction of the wall. Maintain all vertical drains, weeps, ditches, pipes, or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.

4. QA Program. The Department will sample and test backfill from the grade in accordance with the Quality Assurance Program outlined in §733-02 *Mechanically Stabilized Earth System Backfill Material.* If the material is determined to not meet the specification requirements, the material will be rejected.

I. MSES Reinforcing Elements. Place reinforcing elements in accordance with the designer's recommendations or as described in the designers Installation Manual. Before attaching the reinforcing elements to the panel units, repair all damage to the zinc coating in accordance with the requirements of §719-01 *Galvanized Coatings and Repair Methods, Type I.*

1. Placement. Place reinforcing elements normal to the panel units unless indicated otherwise by the contract documents or approved shop drawings. Take care to avoid breaking, distorting, or disturbing the reinforcing elements. Replace reinforcing elements which are broken or distorted.

2. Connections. Prior to the attachment of the reinforcing elements, as required, fill all openings, or attachment locations, with grease, or other protective material. Obtain the grease or other protective materials from the chosen designer. Connect reinforcing elements to the face panel unit before placement of subsequent face panel units, or as directed by the approved shop drawings.

J. MSES Identification Markers. Install MSES identification markers.

Place the marking tape at the highest possible elevation that will not damage the tape. For walls supporting a pavement section, install the tape 6 in. below top of subbase elevation. For walls supporting earth, install the tape 6 in. below finished grade. Install the marking tape on top of the reinforced backfill area, parallel to the wall face in rows at 5 ft. intervals until the back edge of the reinforced backfill area is reached.

Drill two, 5/16 in. diameter, holes for mounting, located ½ in. from the ends of the sign and 3 ½ in. from the top of the sign. Secure the sign using anchorage appropriate for the supporting material.

K. Equipment Movement. Movement of construction equipment and all other vehicles and loads over and adjacent to MSES shall be done at the Contractor's risk. Govern the operations and procedures to prevent misalignment of the installed panel units. Precautionary measures include, but are not limited to, keeping vehicular equipment a minimum of 3 ft. from the panel units. Within 3 ft. of the panel units use compaction equipment meeting the requirements of *Compaction Equipment for Confined Areas* in Section 203 Excavation and Embankment. Operate rubber tired equipment on top of reinforcing elements only at low speeds (less than 5 mph) and without making sharp turns or braking sharply. Do not operate tracked equipment directly on reinforcing elements. Cover reinforcing elements with a minimum 6 in. thick soil layer prior to operating tracked equipment over reinforced areas. Repair or replace damaged reinforcing elements in strict accordance with the

designers written instructions at no additional cost to the State.

554-3.03. Mechanically Stabilized Wall System.

A. Pre-Operation Meeting. A Pre-Operation Meeting will be held between the Engineer, Contractor, Regional Geotechnical Engineer, Geotechnical Engineering Bureau and other appropriate Department representatives to discuss the Contractors proposed construction methods. Begin work only after receiving the DCETS written approval and holding the Pre-Operation Meeting.

Supply on-site technical assistance from a representative of the designated designer during the beginning of the installation until such time as outside consultation is no longer required.

B. MSWS Excavation and Disposal. Excavation shall be conducted in accordance with the applicable requirements of Section 206 *Trench, Culvert and Structure Excavation* and the details specified in the contract documents.

C. MSWS Foundation. Prepare the foundation in accordance with the requirements of §554-3.02 C. *MSES Foundation.*

D. MSWS Subsurface Drainage System. Install the subsurface drainage system simultaneously with the erection and infill/backfill of the MSWS to ensure a continuous, uninterrupted system to prevent the accumulation of destabilizing water pressure on the wall. In all cases, the subsurface drainage system will be installed to drain all intercepted water to a point of positive drainage.

E. MSWS Leveling Pad. Provide an unreinforced concrete leveling pad or compacted granular fill leveling pad as shown in the contract documents to ensure a flat surface for placing the initial course of face units. Step the leveling pad to conform to grade changes as shown in the contract documents or approved Shop Drawings.

1. Concrete. Cast the concrete leveling pad, in accordance with the requirements of Section 555 Structural Concrete, or place the precast leveling pad, for the foundation of the MSWS.

2. Granular. Place and compact granular fill in conformance with Section 203 Excavation and Embankment.

F. MSWS Facing Unit Erection

1. Solid Face Unit Erection

i. Methods and Equipment. Install face units in accordance with the designers approved shop drawings and Installation Manual, unless otherwise modified by the contract documents. Prior to installation of the face units, furnish the Engineer with detailed information concerning the proposed construction method, as well as the equipment planned for use.

ii. Face Unit Installation.

a. Install by placing, positioning, and aligning face units in conformance with the designers Installation Manual and within the tolerances in Table 554-2 *MSWS Solid Face Unit Alignment Tolerances.*

b. Correct all misalignments of installed face units that exceed the tolerances allowed in Table 554-2 *MSWS Solid Facing Unit Alignment Tolerances.*

TABLE 554-2 MSWS SOLID FACE UNIT ALIGNMENT TOLERANCES	
Vertical Control	± ¼ in. over a distance of 10 ft.
Horizontal Control	± ½ in. over a distance of 10 ft.
Rotation from established plan wall batter	± ½ in. over a distance of 10 ft.

2. Open Top Face Unit Erection. During erection, any face unit damaged beyond repair shall be removed and replaced by the Contractor with approved face units at no additional cost to the State.

i. All face units shall be assembled and handled in accordance with the designer's instructions and the contract documents. Erect the face units conforming to the lines, grades, and typical sections shown on the contract documents and in accordance with the designated manufacturer's installation manual.

ii. Place the face units side by side and in full contact with the installed leveling pad.

iii. Maintain the minimum face unit tolerances shown in Table 554-3 *MSWS Open Top Face Unit Tolerances.* Correct all misalignments of installed face units that exceed the tolerances allowed in a manner satisfying the Engineer:

TABLE 554-3 MSWS OPEN TOP FACE UNIT ALIGNMENT TOLERANCES	
Vertical control (plumbness)	± ¾ in. over a distance of 10 ft.
Horizontal location control (alignment)	± ¾ in. over a distance of 10 ft.
Vertically overall (plumbness from top to bottom)	± ½ in. over a height of 10 ft.

iv. Adjust face unit spacing for curved sections according to the manufacturer's installation recommendations.

G. MSWS Facing Unit Bin Infill

1. Solid Face Unit Bin Infill

i. Placement. Place unit infill to the limits indicated in the contract documents. Before installing the next course of face units, compact the unit infill and brush the tops of the face units clean to ensure an even placement area.

ii. Protection. Protect unit infill from contamination during construction.

2. Open Top Face Unit Bin Infill.

i. Placement. Place and compact backfill and face unit infill simultaneously with the erection of the PWS and in accordance with *Compaction* in Section 203 Excavation and Embankment. Placement of infill in the wall and backfill behind the wall shall closely follow the erection of successive courses of face units.

ii. Protection. Protect unit infill from contamination during construction.

H. MSWS Backfill. Do not mix backfill material from different sources behind any wall without the written permission of the Director, Geotechnical Engineering Bureau.

1. Moisture Content. Place backfill materials (other than Types B and D) at or within 2% dry of the Optimum Moisture Content. Rework or replace all material which is at a moisture content exceeding the Optimum Moisture Content. Determine Optimum Moisture Content in conformance with Geotechnical Test Methods (excluding GTM-6) for compaction that incorporates moisture content determination. Rework or replace backfill material at no additional cost to the State.

2. Backfill Placement. Prior to placement of the reinforcing element, backfill and compact the area within 3 ft. of the face units horizontally to 2 in. above the required reinforcing element elevation. Roughly grade the backfill beyond the 3 ft. line to the reinforcing element elevation.

i. Place granular backfill material in uniform layers so that the compacted thickness of each layer does not exceed 10 in. or one unit height, whichever is less. Compact each layer to a minimum of 95% of Standard Proctor Maximum Density.

ii. Place Types B and D backfill in uniform layers so that the compacted thickness of each layer does not exceed 10 in. or one unit height, whichever is less. Compact each layer in conformance with *Compaction* in Section 203 Excavation and Embankment.

3. Separation Geotextile. Place the geotextile separation, if required, loosely but in intimate contact with the soil so that placement of the overlying material will not stretch or tear the geotextile.

4. Surface Drainage Control. Provide positive control and discharge of all surface drainage that will affect the installation of the MSWS throughout the construction of the wall. Maintain all vertical drains, weeps, ditches, pipes, or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.

5. QA Program. The Department will sample and test backfill from the grade in accordance with the Quality Assurance Program outlined in §733-02 *Mechanically Stabilized Earth System Backfill Material.* If the material is determined to not meet the specification requirements, the material will be rejected

I. MSWS Reinforcing Element

1. Reinforcing Element Placement. Place the reinforcing element normal to face units unless otherwise indicated in the contract documents. Replace all broken, damaged or distorted reinforcing elements at no additional cost to the State.

2. Reinforcing Element Connection. Install the reinforcing element within/between courses of face units conforming to the designers Installation Manual. Pull taut and secure the reinforcing element before placing the backfill.

J. MSWS Identification Markers. Install MSWS identification markers in accordance with the requirements of §554-3.02 J. *MSES Identification Markers.*

K. Equipment Movement. Movement of construction equipment and all other vehicles and loads over and adjacent to MSWS shall be done at the Contractor's risk. Control all operations and procedures to prevent misalignment of the face units. Precautionary measures include, but are not limited to, keeping vehicular equipment at least 3 ft. behind the back of the face units. Compaction

equipment used within 3 ft. of the back of the face units must conform to *Compaction Equipment for Confined Areas* in Section 203 Excavation and Embankment. Operate rubber tired equipment on top of reinforcing elements only at low speeds (less than 5 mph) and without making sharp turns or braking sharply. Do not operate tracked equipment directly on reinforcing elements. Cover reinforcing elements with a minimum 6 in. thick soil layer prior to operating tracked equipment over reinforced areas. Repair or replace damaged reinforcing elements in strict accordance with the designers written instructions at no additional cost to the State.

554-3.04. Geosynthetically Reinforced Soil System.

A. GRSS Submittal. Submit the geogrid or geotextile reinforcing element certifications, verifying that the material meets the requirements of §737-07 *Geogrids* for the specified long term design tensile strength shown in the contract documents, to the Engineer prior to start of work. Begin work only after receiving the Engineer's approval.

Supply on-site technical assistance from a representative of the geosynthetic reinforcing element manufacturer until such time as outside consultation is no longer required.

B. GRSS Storage of Geosynthetic. Store and protect geosynthetic materials in accordance with the manufacturer's recommendations prior to installation.

C. GRSS Excavation and Disposal. Excavation shall be conducted in accordance with the applicable requirements of Section 206 *Trench, Culvert and Structure Excavation* and the details specified in the contract documents.

D. GRSS Foundation. Prior to erection of the GRSS system, the foundation shall be inspected and approved by the Engineer.

Grade the area under the GRSS level for the width shown in the contract documents. A minimum of 90% of Standard Proctor Maximum Density will be required.

For GRSS wall systems, a pad of crushed stone shall be incorporated into the foundation directly below the wall facing.

E. GRSS Subsurface Drainage System. Install the subsurface drainage system simultaneously with the erection and backfill of the GRSS to ensure a continuous, uninterrupted system to prevent the accumulation of destabilizing water pressure on the wall. In all cases, the subsurface drainage system will be installed to drain all intercepted water to a point of positive drainage.

F. GRSS Placement of Materials.

1. Geosynthetic Reinforcing Element. Place and secure the primary and secondary reinforcing element in accordance with the manufacturer's recommendations, in continuous strips without joints, seams or connections throughout the embedment length, to the line, grade and orientation shown in the contract documents. Place reinforcing elements to lay flat with no creases and pull taut to remove any slack prior to placement of backfill.

2. Welded Wire Forms. Place welded wire forms where required, as shown in the contract documents. Position and connect the welded wire forms to overlap 2 in. with adjacent forms and connect with wire ties. Install wire struts as shown in the contract documents and as required to stiffen the welded wire forms.

3. Geotextile Face Wrap. Place geotextile face wrap as shown in the contract documents. If used in conjunction with welded wire forms, place the geotextile face wrap so as to conform closely to the welded wire forms.

4. Backfill. Replace any damaged geosynthetic prior to placement of any overlying material at no cost to the State. Place the backfill onto the geosynthetic reinforcing elements in such a manner that no damage occurs. Progress placement of backfill materials so as to minimize the development of slack in the reinforcing element. The thickness of a compacted lift of backfill is not to exceed 12 in. or the measured vertical distance between geosynthetic layers, whichever is less. Compact the backfill to a minimum of 95% of Standard Proctor Maximum Density in accordance with the requirements contained in *Compaction* in Section 203 Excavation and Embankment. Only hand operated equipment is allowed within 3 ft. of the face. Lift thickness may have to be reduced to achieve required compaction.

5. Surface Protection. Place and secure erosion control material in accordance with Section 209 *Soil Erosion and Sediment Control* and as shown in the contract documents.

6. Permanent Facing. Place and connect permanent facing as shown in the contract documents.

7. Surface Drainage Control. Provide positive control and discharge of all surface drainage that will affect the installation of the GRSS throughout the construction of the wall. Maintain all vertical drains, weeps, ditches, pipes, or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost.

G. GRSS Construction Monitoring. Monitor the system face during fill placement and compaction. If verticality or the required batter of a system is not being maintained, stop work until compaction equipment and/or operational procedures are modified.

H. GRSS Identification Markers. For applications other than staging walls, install GRSS identification markers in accordance with the requirements of §554-3.02 J. *MSES Identification Markers.*

I. Equipment Movement. Movement of construction equipment and all other vehicles and loads over and adjacent to GRSS shall be done at the Contractor's risk. Operate rubber tired equipment on top of reinforcing elements only at low speeds (less than 5 mph) and without making sharp turns or braking sharply. Do not operate tracked equipment directly on reinforcing elements. Cover reinforcing elements with a minimum 6 in. thick soil layer prior to operating tracked equipment over reinforced areas. Repair or replace damaged reinforcing elements in accordance with the manufacturer's written instructions at no additional cost to the State.

554-3.05. Prefabricated Wall System.

A. PWS Excavation and Disposal. Excavation shall be conducted in accordance with the applicable requirements of Section 206 *Trench, Culvert and Structure Excavation* and the contract documents.

B. PWS Foundation. Prior to erection of the wall system, the foundation shall be inspected and approved by the Engineer.

Grade the area under the PMWS level for the width shown in the contract documents. A minimum of 90% of Standard Proctor Maximum Density will be required.

Construct the wall system to meet the line and grade shown in the contract documents.

C. PWS Subsurface Drainage System. Install the subsurface drainage system simultaneously with the erection and infill/backfill of the PWS to ensure a continuous, uninterrupted system to prevent the accumulation of destabilizing water pressure on the wall. In all cases, install the subsurface drainage system to drain all intercepted water to a point of positive drainage.

D. PWS Leveling Pad. Provide an unreinforced concrete leveling pad or compacted granular fill leveling pad as shown in the contract documents to ensure a flat surface for placing the initial course of face units. Step the leveling pad to conform to grade changes as shown in the contract documents or approved Shop Drawings.

1. Concrete. Cast the concrete leveling pad, in accordance with the requirements of Section 555 Structural Concrete, or place the precast leveling pad, for the foundation of the PWS.

2. Granular. Place and compact granular fill in conformance with Section 203 Excavation and Embankment.

E. PWS Erection. During erection, remove and replace any face units damaged beyond repair with approved face units at no additional cost to the State.

1. Assembly. All PWS shall be assembled and handled in accordance with the designer's instructions and the contract documents. Erect the PWS conforming to the lines, grades, and typical sections shown on the contract documents and in accordance with the designated manufacturer's installation manual.

2. Placement. Place the PWS side by side and in full contact with the installed leveling pad.

3. Tolerances. Maintain the minimum PWS tolerances shown in Table 554-2 *MSWS Solid Face Unit Alignment Tolerances* or Table 554-3 *MSWS Open Top Face Unit Alignment Tolerances* as appropriate. Correct all misalignments of installed face units that exceed the tolerances allowed in a manner satisfying the Engineer:

4. Adjustments. Adjust PWS spacing for curved sections according to the manufacturer's installation recommendations.

5. Coping. Apply the coping unit to the top of the wall using mastic adhesive, in accordance with, and conforming to the unit manufacturer's installation recommendations.

F. PWS Infill and Backfill. Immediately prior to backfilling, the Engineer will inspect the face units for damage. Face units which are damaged beyond repair shall be removed and replaced by the Contractor with approved face units at no additional cost to the State.

Place and compact backfill and unit infill simultaneously with the erection of the PWS and in accordance with *Compaction* in Section 203 Excavation and Embankment. Placement of infill in the wall and backfill behind the wall shall closely follow the erection of successive courses of face units.

G. Equipment Movement. Movement of construction equipment and all other vehicles and loads over and adjacent to PWS shall be done at the Contractor's risk. Control all operations and procedures to prevent misalignment of the PWS. Precautionary measures include, but are not limited to, keeping vehicular equipment at least 3 ft. behind the back of the face units. Compaction equipment used within 3 ft. of the back of the face units must conform to the *Compaction Equipment for Confined*

Areas in Section 203 Excavation and Embankment. Any damage to face units from any cause shall be repaired or replaced by the Contractor at no additional cost to the State.

554-3.06 Fill Type Retaining Wall Aesthetic Treatment. Provide aesthetic treatment as specified in the contract documents. Any damage to the treatment shall be repaired to the satisfaction of the Engineer at no additional cost to the State.

554-4 METHOD OF MEASUREMENT.

554-4.01. General. Vacant.

554-4.02. Mechanically Stabilized Earth System. A MSES will be measured in square feet of face area, measured to the nearest square foot from the payment lines shown in the contract documents.

554-4.03. Mechanically Stabilized Wall System. A MSWS will be measured in square feet of face area, measured to the nearest square foot from the payment lines shown in the contract documents.

554-4.04. Geosynthetically Reinforced Soil System. A GRSS will be measured in square feet of vertical face area, measured to the nearest square foot from the payment lines shown in the contract documents.

554-4.05 Prefabricated Wall System. A PWS will be measured in square feet of vertical face area, measured to the nearest square foot from the payment lines shown in the contract documents.

554-4.06 Fill Type Retaining Wall Aesthetic Treatment. Aesthetic treatment will be measured in square feet of treated face area, measured to the nearest square foot from the payment lines shown in the contract documents. Include only those visual standards incorporated into the finished wall into the measurements.

554-5 BASIS OF PAYMENT

554-5.01. General. Vacant.

554-5.02 Mechanically Stabilized Earth System. Include in the unit price bid the cost of all labor, materials, and equipment, including backfill, reinforcing elements, leveling pads, fasteners, joint fillers, geotextiles, face panel and coping units, subsurface drainage system, and the cost of adding water for backfill compaction, unless items for Furnishing Water Equipment and Applying Water are included in the contract, necessary to satisfactorily complete the work.

554-5.03 Mechanically Stabilized Wall System. Include in the unit price bid the cost of all labor, material, and equipment, including backfill, infill, reinforcing elements, leveling pads, fasteners, geotextiles, face units and coping units, subsurface drainage system, and the cost of adding water for backfill compaction, unless items for Furnishing Water Equipment and Applying Water are included in the contract, necessary to satisfactorily complete the work.

554-5.04 Geosynthetically Reinforced Soil System. Include in the unit price bid the cost of all labor, materials, and equipment, including backfill, geosynthetic reinforcing elements, facing system, subsurface drainage system, and the cost of adding water for backfill compaction, unless items for Furnishing Water Equipment and Applying Water are included in the contract, necessary to satisfactorily complete the work.

554-5.05 Prefabricated Wall System. Include in the unit price bid the cost of all labor, materials, and equipment, including backfill, leveling pads, joint fillers, geotextiles, face units and coping units, subsurface drainage system, and the cost of adding water for backfill compaction, unless items for Furnishing Water Equipment and Applying Water are included in the contract, necessary to satisfactorily complete the work.

554-5.06 Fill Type Retaining Wall Aesthetic Treatment. Include in the unit price bid the cost of all labor, material, and equipment needed to provide aesthetic treatment for the wall and the cost of production and transportation of visual standards from the precast facility to the project site for Region approval and back to the precast facility for use during production.

Payment will be made under:

Item No.	Item	Pay Unit
554.30XX	Geosynthetically Reinforced Soil System Wall	Square Feet
XX	*Facing System*	
01	*Welded Wire Forms*	
02	*Geocells*	
03	*Timbers*	
04	*Other; As Shown in the Contract Documents*	
554.31	Geosynthetically Reinforced Soil System Slope	Square Feet
554.40	Fill Type Retaining Wall (0 – 6 ft.)	Square Feet
554.41	Fill Type Retaining Wall (Greater than 6 ft. – 12 ft.)	Square Feet
554.42	Fill Type Retaining Wall (Greater than 12 ft. – 18 ft.)	Square Feet
554.43	Fill Type Retaining Wall (Greater than 18 ft. – 24 ft.)	Square Feet
554.44	Fill Type Retaining Wall (Greater than 24 ft. – 30 ft.)	Square Feet
554.45	Fill Type Retaining Wall (Greater than 30 ft.)	Square Feet
554.5001	Fill Type Retaining Wall Aesthetic Treatment - Textured Surface (Hand Tooled, Raked, etc.), No Color	Square Feet
554.5002	Fill Type Retaining Wall Aesthetic Treatment - Textured Surface (Hand Tooled, Raked, etc.), Integral Color	Square Feet
554.5101	Fill Type Retaining Wall Aesthetic Treatment - Exposed Aggregate Finish, No Color	Square Feet
554.5102	Fill Type Retaining Wall Aesthetic Treatment - Exposed Aggregate Finish, Integral Color	Square Feet
554.5201	Fill Type Retaining Wall Aesthetic Treatment - Architectural Pattern, No Color	Square Feet
554.5202	Fill Type Retaining Wall Aesthetic Treatment - Architectural Pattern, Integral Color	Square Feet
554.53	Fill Type Retaining Wall Aesthetic Treatment - Other; As Shown in the Contract Documents	Square Feet

Make the following changes to the Standard Specifications dated May 1, 2008 as modified by EI 08-020:

Delete SECTION 632 – Precast Modular Walls entirely and **Replace** it with the following:

SECTION 632 (VACANT)

Delete the Title and Scope of Section 704-06 and **Replace** it with the following:

SECTION 704-06 PRECAST CONCRETE WALL UNITS AND PRECAST CONCRETE CRIBBING

Scope. This specification covers the material and fabrication requirements of precast concrete wall units and precast concrete cribbing for prefabricated wall systems.

Make the following changes to the Standard Specifications dated May 1, 2008 as modified by EI 10-022:

Delete the Title of Section 704-07 and **Replace** it with the following:

SECTION 704-07 DRY CAST CONCRETE WALL UNITS

Delete the term "segmental retaining wall blocks" in the Scope, Material Requirements, and Basis of Acceptance sections of Section 704-07 and **Replace** it with "dry cast concrete wall units".

Delete the term "concrete retaining wall block units" in the Physical Properties section of Section 704-07 and **Replace** it with "dry cast concrete wall units".

Make the following changes to the Standard Specifications dated May 1, 2008 as modified by EI 09-027:

Delete the Title and Scope of Section 733-03 and **Replace** it with the following:

§733-03 – GEOSYNTHETICALLY REINFORCED SOIL SYSTEM SLOPE BACKFILL MATERIAL

SCOPE. This specification covers the material requirements and methods of testing backfill material generally used for the construction of over steepened slopes utilizing Geosynthetically Reinforced Soil System (GRSS).