New Jersey Turnpike Authority
P.O. Box 5042, Woodbridge, NJ 07095

March 18, 2021

Document Change Announcement

2016 Standard Supplementary Specifications
Mechanically Stabilized Earth (MSE) Wall Design
DCA2021SS-02

Subject: Revisions to

Section 426 Mechanically Stabilized Earth (MSE) Walls
Section 925 Mechanically Stabilized Earth (MSE) Walls

Description of Change:

An update to the proprietary mechanically stabilized earth (MSE) wall specifications has been made to incorporate language regarding the corrosion protection of all ferrous materials used in the construction of MSE walls and to ensure there is no steel-to-steel contact between soil reinforcement connections and the concrete facing reinforcement.

Notice to New Jersey Turnpike Authority Staff and Design Consultants
Effective immediately, all contracts currently in the design phase shall incorporate the revisions herein. For advertised contracts awaiting the opening of bids this revision shall be incorporated via addendum. Contact your New Jersey Turnpike Authority Project Manager for instruction.

The revisions may be accessed on the Authority's webpage: https://www.njta.com/doing-business/professional-services

Recommended By:

3/22/21

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Approved By:

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Chief Engineer

Distribution: Senior Staff Engineering, Law, Maintenance and Operations Depts., UTCA, AGC, All Prequalified Consultant Firms, File

NOTE: The following text is DELETED from the latest version of the 2016 Standard Supplementary Specifications.

~~**426.02 Materials**~~

~~(A) MSE Wall Systems.~~

~~Delete the entire Paragraph and replace it with the following:~~

~~Refer to Subsection 925.07 for approved Wall Manufacturers.~~

~~The Contractor shall make their own arrangements to purchase the materials and services from one of the Wall Manufacturers. Selection of only one (1) type and material of soil reinforcing element and connection element will be permitted per wall. No more than two (2) Wall Manufacturers will be permitted for use on the Contract.~~

~~An on-site technical representative from the selected Wall Manufacturer shall be present to assist and instruct during the installation of the first two-panel courses of the first wall in the Contract, at a minimum.~~

NOTE: The following text are ADDITIONS to the latest version of the 2016 Standard Supplementary Specifications.

The following Section is deleted and replaced with the following:

SECTION 426 - MECHANICALLY STABILIZED EARTH (MSE) WALLS

426.01 Description.

This work shall include the design and construction of Mechanically Stabilized Earth (MSE) wall structures composed of precast concrete facing panels, cast-in-place and/or precast parapets, moment slabs, copings, concrete leveling pads, soil reinforcement elements, joint materials, fasteners, Select Backfill, and all other appurtenant items of construction within the Common Structure Volume (CSV) as shown on the Plans, included as part of the selected MSE Wall System, or as specified herein.

This work shall also include MSE wall structures constructed in two-stages at specified locations. The primary stage shall consist of soil reinforcement elements and Select Backfill with a flexible facing which consists of welded wire and geosynthetics. The secondary stage shall consist of precast concrete facing panels and all other appurtenances as shown on the Plans. The sequence of construction shall be as shown on the Plans.

Design and construction of MSE walls shall be in accordance with the current editions of the AASHTO LRFD Bridge Design and Construction Specifications with Interims, except as noted otherwise herein. The design shall be in accordance with the current NJTA Design Manual and shall be signed and sealed by an engineer licensed in the State of New Jersey.

All labor, materials, equipment, and tools required to prepare the site, construct the leveling pad, construct the wall, place and compact the Select Backfill, and construct the coping and traffic barrier shall be supplied by the Contractor.

The following are defined for the allocation of responsibilities as described herein:

"Engineer" shall be defined in paragraph 101.02B.

"Engineer of Record" shall be defined as the Professional Engineer licensed in NJ, responsible for the preparation of the Contract Documents.

"Wall Manufacturer" shall be defined as the MSE wall supplier/vendor and shall also include a Professional Engineer licensed in NJ, responsible for the preparation of the Working Drawings and calculations associated with the MSE Wall.

426.02 Materials.

Materials shall conform to the following Sections and Subsections:

CONCRETE 905.05

STEEL REINFORCING ELEMENTS 925.01

GEOSYNTHETIC REINFORCING ELEMENTS 925.02

SELECT BACKFILL FOR MSE WALLS WITH STEEL REINFORCING ELEMENTS 925.03

SELECT BACKFILL FOR MSE WALLS WITH GEOSYNTHETIC REINFORCING ELEMENTS . 925.04

HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE LINER SYSTEM 925.05

CLASS 2 GEOTEXTILE FABRIC 925.06

FILTER FABRIC 923.21

MSE WALL SYSTEMS 925.07

Precast concrete facing panels shall be Class P.

Materials shall conform to the current editions of AASHTO LRFD Bridge Design and Construction Specifications with Interims, modifications herein, and the provisions of the wall system selected for construction in the contract.

The Engineer of Record shall identify any unique conditions that may influence corrosion of metallic reinforcement including tidal, flood, shallow ground water, or stray electrical current and incorporate them into the Contract Documents. The Wall Manufacturer shall determine corrosion protection in accordance with site specific conditions, current AASHTO LRFD Bridge Design and construction Specifications, FHWA Geotechnical Engineering Circular No. 11, and FHWA Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforce Soil Slopes considering the potential for aggressive corrosion potential from these unique conditions identified.

Where aggressive corrosion conditions are encountered, the use of soil reinforcements fabricated from stainless steel Grade 316L may be considered provided all connections are composed of like metals, or alternatively are fabricated from a combination of galvanization and sacrificial streel adequate to provide the required service life. In such a case, design corrosion rates shall be submitted by the Wall Manufacturer for review and approval at the sole discretion of the Engineer of Record and final concurrence of the Authority.

The Wall Manufacturer shall make recommendations regarding the corrosion rates that shall provide the required 75- or 100-year service life. Galvanization shall be considered an acceptable form of metallic protection if in accordance with AASHTO LRFD Bridge Design Specifications. Aluminized and epoxy type coatings shall not be considered as an acceptable form of corrosion protection and shall not be approved for use. The Contractor shall furnish all metallic wall system components including, but not limited to steel straps, coil rods, coil loops, hairpin clips, with the same type of corrosion protection. Corrosion protection shall be galvanized unless otherwise approved by the Authority.

The Contractor shall place connections between the wire facing and precast concrete panels 4 inches or more from reinforcing steel in the precast concrete panels, to reduce the viability of macrocell corrosion. The Contractor shall coat connections between wire facings and precast concrete panels with a non-conductive bonding agent applied on all surfaces in contact with the precast concrete panels and fill between the wire facing and precast concrete panels. The non-conductive bonding agent shall have a resistivity of 50,000 ohm-cm or more and be applied at the maximum thickness recommended by the manufacturer.

The use of Geosynthetic Reinforcing will only be allowed where specified on the plans.

If geosynthetic reinforcement is connected to wall panels with metallic connection components, both the geosynthetic and metallic materials must be evaluated for electrochemical conditions of their respective material types and the Select Backfill material must satisfy the requirements of both 925.03 and 925.05 to ensure electrochemical compatibility.

Select Backfill conforming to the requirements herein shall be used within the CSV as shown on the Plans and specified in Subsection 925.03 and/or 925.04 and may be procured from off-site sources or from on-site borrow excavation.

Except as may be modified within this Section, all applicable provisions of Sections 400 and 900 shall apply in furnishing and installing MSE Wall Systems.

Levelling pads shall conform to the requirements of the Wall Manufacturer.

The Contractor shall make their own arrangements to purchase the materials and services from one of the Wall Manufacturers. Selection of only one (1) wall system, type and material of soil reinforcing element and connection element will be permitted per project. No more than one (1) Wall Manufacturer will be permitted for use on the Contract.

An on-site technical representative from the selected Wall Manufacturer shall be present to assist and instruct during the installation of the first two-panel courses of the first wall in the contract, as a minimum.

426.03 Methods of Construction.

(A) General.

Methods of construction shall conform to the current editions of AASHTO LRFD Bridge Design Specifications with Interims and AASHTO LRFD Bridge Construction Specifications with Interims, modifications herein and the provisions of the permitted wall system selected for construction in the contract.

Clearing, grubbing, and excavation shall be performed in accordance with Division 200, and as required by the Plans. If poor subgrade conditions are encountered in the opinion of the Engineer, the Engineer of Record shall be notified prior to the continuation of wall construction.

Each shipment of wall components shall be clearly marked with the Wall Manufacturer's name and batch identification. The Contractor shall provide an on-site storage area from time of delivery until installation. The Contractor shall protect all wall components from dirt, water and other sources of damage. Reinforcing elements shall be protected from cutting, distortion, or other damaging conditions during loading, transportation and unloading at the site.

Leveling pads shall be surveyed following installation prior to setting the first course of panels, and the results shall be submitted to the Engineer.

Reinforced wall fill placement shall closely follow erection of each course of facing panels. Select Backfill shall be placed in such a manner to avoid damage or disturbance of the wall materials, misalignment of facing panels, or damage to soil reinforcement or facing members. The Contractor shall place backfill to the level of the connection and in such a manner as to ensure that no voids exist directly beneath reinforcing elements.

Select Backfill shall be placed in maximum 12" thick loose lifts. Select Backfill shall be compacted to a minimum of 95% of the maximum dry density as determined by AASHTO T99 (Standard Proctor) or greater if specified by the Wall Manufacturer. The in-place compacted dry density of the Select Backfill shall be tested in accordance with AASHTO T310 Method B. In-place field density testing should be performed every 500 feet linearly after each succession of placement of lifts totaling 3 feet vertically. If the wall is less than 500 feet long, a minimum of two locations shall be tested per wall after each succession of placement of lifts totaling 3 feet vertically. Additional testing may be performed if deemed necessary by the Engineer. If greater than 30 percent of Select Backfill is retained on the ¾" sieve, laboratory Standard Proctor (AASHTO T99) and field density testing (AASHTO T310) is not required, and satisfactory compaction shall be considered less than 0.25" of displacement during the last pass of the compacting equipment, provided the lift thickness requirements specified herein are satisfied. The optimum Select Backfill moisture content to achieve minimum required compacted soil density shall be as determined by AASHTO T99.

The specified compaction of the Select Backfill shall be accomplished by use of large, smooth drum, vibratory rollers with the exception of the 5-foot zone directly behind the facing panels.

Within the 5-foot zone directly behind the facing panels, small, single or double drum, hand

operated, walk-behind vibratory rollers, or walk-behind vibrating plate compactors shall be used, and at least three passes shall be made.

The compaction equipment shall be capable of providing uniform density throughout the depth of the layer of the Select Backfill being compacted with no disturbance to the vertical or horizontal alignment of the previously placed panels.

If there is evidence of wall displacement or disturbance, compaction shall be stopped and an alternate method shall be implemented, which does not impact the wall.

Select Backfill material that is composed primarily of gravel with less than 40 percent passing the ¾ inch sieve shall be separated by a Class 2 Geotextile Fabric, as defined in Subsection 925.06, to within 3 feet below the wall coping. Adjoining sections of geotextile fabric shall be overlapped by a minimum of 12 inches.

At MSE wall locations where post construction settlement is expected but no ground improvement is specified, placement of the pavement box, barrier parapet, coping, moment slab or approach slab shall not begin until the anticipated additional post construction settlement is less than one inch. The Engineer will evaluate the actual settlement based on field instrumentation data to verify the diminished rate of settlement and the projected settlement remaining. The Engineer will be the sole judge to determine that the anticipated additional post construction settlement is less than one inch. Construction of the pavement box shall only be performed upon written authorization from the Engineer.

At two-stage MSE wall locations, placement of second stage shall not begin until and the anticipated additional post construction settlement is less than one inch. The Engineer will evaluate the actual settlement based on field instrumentation data to verify the projected settlement remaining. The Engineer will be the sole judge to determine t that the anticipated additional post construction settlement is less than one inch. Construction of the second stage shall only be performed upon written authorization from the Engineer.

For one or two stage MSE walls, ensure that the wall coping system will accommodate any construction or post construction settlement, without requiring cutting of the precast panels or units. The uppermost soil reinforcing element shall be located so as to not interfere with the coping and/or moment slab after a minimum anticipated settlement of 1 inch has taken place.

Wall materials damaged during backfill placement shall be removed and replaced by the Contractor, at no additional cost to the Authority. The Contractor may submit alternative corrective procedures to the Engineer for consideration. Proposed alternative corrective procedures shall have the concurrence of the Wall Manufacturer and Engineer of Record, in writing, prior to the acceptance by the Engineer.

(B) Construction Methods Specific to Steel Reinforced MSE Walls.

Soil reinforcement shall be uniformly tensioned to remove any slack in the connections to the facing panels. Where an individual soil reinforcement element has multiple connections to a facing panel, a minimum of two connections per layer per panel shall be in full contact upon tensioning the element, with maximum gaps of 1/16 inch at remaining connections.

Repairing scratches or other imperfections in corrosion protection on steel reinforcing elements shall be performed in accordance with Section 925 and the manufacturer's recommendations.

Select Backfill shall be spread by moving the machinery parallel to or away from the wall facing and in such a manner that the steel reinforcement remains normal to the face of the wall or at the specified angle. Construction equipment shall not operate directly on the reinforcement. A minimum fill thickness of three (3) inches over the steel reinforcement shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

(C) Construction Methods Specific to Geosynthetic Reinforced MSE Walls.

Geosynthetic reinforcement shall be stored in conditions above 20°F and not greater than 140°F. Geosynthetic reinforcement shall be covered and protected from sunlight prior to placement in the wall system.

Geosynthetic reinforcement shall not be unwrapped until just before installation Geosynthetic reinforcement shall not be left exposed for more than 1 day before covering, except when installed for erosion control devices, two stage walls, and temporary faces, where exposed in-place geotextile is planned.

Geosynthetic Reinforcement shall be held in place with wire staples or anchor pins to remain taught while placing Select Backfill. Steel anchor pins with a diameter of at least 3/16" and a length of at least 18" with a point at one end and a head at the other end that will retain a steel washer with an outside diameter of at least 1.5" or as per manufacturer's recommendations shall be used.

Geosynthetic Reinforcement shall be installed in accordance with the manufacturer's working drawings. Geosynthetic Reinforcement shall be placed in continuous longitudinal rolls perpendicular to the wall. Joints parallel to the wall shall not be permitted.

Geosynthetic Reinforcement coverage shall be continuous at each reinforcement elevation or as shown in the Working Drawings. Adjacent panels of Geosynthetic Reinforcement need not be overlapped, except when exposed in a wrap-around face system, at which time the adjacent reinforcement panels shall be overlapped or mechanically connected per the manufacturer's requirements.

During construction, the surface of the reinforced fill shall be kept horizontal. Geosynthetic Reinforcement shall be placed directly on the compacted horizontal fill surface. The reinforcement shall bear uniformly on the compacted reinforced soil from the facing connection to the free end of the reinforcing elements. The reinforcement placement elevation shall be at the connection elevation to two (2) inches higher than the connection elevation.

The Select Backfill shall be spread by moving the machinery parallel to or away from the wall facing and in such a manner that the Geosynthetic Reinforcement remains taut. Construction equipment shall not operate directly on the Geosynthetic Reinforcement. A minimum fill thickness of six (6) inches over the Geosynthetic Reinforcement shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

(D) Precast Panel Unit Production/Tolerances

All units shall be manufactured within the following tolerances:

(a) All dimensions shall be within 1/4 inch.

(b) Location of panel connection devices shall be within 1 inch.

(c) Squareness as determined by the difference between the two diagonals shall not exceed 1/2 inch

(d) Surface defects on smooth and textured formed surfaces measured over a length of 5 feet shall not exceed 1/4 inch and 5/16 inch, respectively.

Units shall be rejected because of failure to meet any of the requirements specified above. In addition, any or all of the following defects, as assessed by the Engineer shall be sufficient cause for rejection:

(a) Defects that indicate imperfect molding.

(b) Defects indicating honeycombed or open texture concrete.

(c) Defects in the physical characteristics of the concrete units, such as:

(1) Stained front face due to excess form oil or other reasons.

(2) Signs of aggregate segregation.

(3) Broken or cracked corners.

(4) Tie strips bent or damaged.

(5) Lifting inserts not usable.

(6) Exposed reinforcing steel.

(7) Cracks at the PVC pipe or pin.

(8) Insufficient concrete compressive strength.

(9) Deviation from flatness of exposed surface in excess of 1/8 inch per 5 feet

An additional inspection shall be made prior to erection to determine any damage which may have occurred during storage.

The Engineer will determine whether spalled, honeycombed, chipped, or otherwise defective concrete shall be repaired or be rejected. Repair of concrete, if allowed, shall be done in a manner satisfactory to the Engineer at no additional cost to the Authority.

Repair to concrete surfaces which will be exposed to view after completion or construction shall be approved by the Engineer.

(E) WALL CONSTRUCTION/TOLERANCES.

Finished MSE walls shall be erected within the following tolerances:

The overall vertical alignment tolerance, or plumbness, from top to bottom of the structure, shall not exceed 1/2 inch per 10 foot of wall height.

Deviation from horizontal alignment shall not exceed ¾ inch.

Vertical and horizontal alignment tolerance, or plumbness, shall not exceed ¾ inch when measured with a 10-foot straight edge on a selected wall section.

The maximum allowable offset between any two panels shall not exceed ¾ inch.

(F) HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE CONSTRUCTION.

Where an MSE wall is constructed supporting a roadway that will be subjected to chemical deicing, installation of a High Density Polyethylene (HDPE) geomembrane liner system, as shown on the Plans and specified in this Section 925.05 shall be included. All labor, materials, transportation, handling, storage, supervision, tools and other equipment that may be necessary to install and test the HDPE liner system shall be included.

Before liner installation, the area that is to be lined shall be smooth and free of sharp objects or debris of any kind. Atmospheric exposure of geomembrane to the elements following lay down shall be a maximum of fourteen (14) days. The Contractor shall install HDPE geomembrane liner free of holes and tears.

The HDPE shall be placed below the pavement, above the first row of reinforcement, over the parapet moment slab (where present), and over specified areas as shown on the plans. The HDPE shall be sloped to drain away from the facing panels.

HDPE shall not be installed during periods of precipitation or in conditions of excessive moisture such as fog or dew. The HDPE liner shall be placed in accordance with the HDPE manufacturer's recommendations and as approved by the Engineer.

All seams of the HDPE geo-membrane liner system shall be, as per the manufacturer's specifications, sealed or overlapped to prevent leakage. Seams shall be oriented parallel to the line of maximum slope. Seams shall have a minimum finished overlap of 4 inches, unless a greater overlap is specified by the HDPE manufacturer.

Field testing of seams, according to the manufacturer's specifications, shall be conducted to verify satisfactory seaming conditions.

When backfilling, care shall be taken to prevent damage to the HDPE liner system. Any tears, punctures or holes incurred during the installation process shall be assessed by the Engineer and the membrane shall either be repaired in accordance with recommendations of the membrane manufacturer or replaced at the Engineer's discretion at no additional cost to the Authority.

Perforations through the liner shall be limited. Where penetrations are necessary, the Contractor shall provide details demonstrating the method(s) of sealing the penetration for approval by the Engineer.

(G) CONSTRUCTION STORMWATER MANAGEMENT.

At the end of each construction period, the Contractor shall slope the last placed layer of backfill away from the wall facing to direct runoff or rainwater away from the wall face. Surface runoff shall not be allowed to enter the wall construction site from adjacent areas.

426.04 Working Drawings.

Working Drawings shall be prepared and submitted in accordance with the requirements specified under Subsection 104.08. The CSV shown on the Plans is anticipated to envelop the majority of potential wall system reinforced earth volume requirements. However, should the limits of structure volume for the proposed wall system extend beyond the limits of the CSV, the wall system shall be submitted as a Substitution in accordance with this specification. The Substitution must be approved by the Engineer prior to submitting Working Drawings. At a minimum, Working Drawings shall include the following:

(A) Design calculations signed and sealed by a Professional Engineer licensed in the State of New Jersey, in conformance with current edition of AASHTO LRFD Bridge Design and Construction Specifications with Interims and modifications herein and the provisions of the approved wall system selected for construction in the contract. MSE walls shall be designed for a minimum 75-year design life. MSE walls which support embankments under bridge abutments shall be designed for a 100-year design life. All MSE wall components shall be designed for the 100-year flood elevation. Walls shall be designed for rapid drawdown conditions to account for the differences in hydrostatic pressure for a 100-year design flood; and/or rapid draining embankment material can be used as Select Backfill. Walls shall be designed for the extreme event limit state for seismic if required by AASHTO LRFD Bridge Design Specifications.

Load Factor Design (LFD) methodology shall be used for the Internal Strength and Stability for Barrier Parapet and Moment Slab System. Allowable Stress Design (ASD) methodology shall be used for External Stability for Moment Slab.

External stability of the wall including bearing capacity, settlement, global stability, and surface and subsurface drainage shall be the responsibility of the Engineer of Record.

Internal stability including but not limited to reinforcement tensile resistance, reinforcement pull-out resistance, reinforcement long term durability (i.e. corrosion, creep, and degradation from ultraviolet radiation connection details, coping, and moment slab will be the responsibility of the Wall Manufacturer's Professional Engineer Licensed in NJ preparing the Working Drawings.

Any out of tolerance joint spacing, wall plumbness, or other deformation of the wall will be the responsibility of the Contractor, unless the Contractor can adequately document with survey results that settlement occurred and the deformation was not a result of the construction means and methods to the satisfaction of the Engineer.

If the Wall Manufacturer preparing the Working Drawings elects to modify the unit weight and friction angle of the Select Backfill material, the Engineer shall be notified to verify with the Engineer of Record that the changes will not impact the wall's external stability. These modifications shall only be allowed with the approval of the Engineer of Record.

(A) General notes shall address design parameters, Select Backfill parameters, type of reinforcing elements, factors of safety and/or load and resistance factors and any project specific requirements related to construction.

(B) An elevation view of the wall showing:

Elevations along the top of the wall, at beginning and end of wall, at 25-foot intervals, at changes in grade, at changes in Common Structure Volume (CSV) limits; and at precast panel unit joints where indicative of wall geometry.

Elevations and step locations for leveling pads and/or footings.

The location of the final ground line.

Number and type of precast panel units.

A numbered panel layout for fabrication and erection purposes.

Designation of breaks in vertical alignments and elevations.

Locations and elevations/inverts of any utilities or drainage which passes through/below the retaining wall or the Common Structure Volume.

(C) A plan view of the wall showing:

The offset from the construction baseline to the face of precast wall units at all changes in horizontal alignment.

Right-of-Way (ROW) limits and their relationship to the wall with offsets and stations to wall corners and ends.

Locations of piles, drilled shafts, noise walls, sign structures, or other appurtenant items which are supported by the wall or its parapet/coping.

Locations and alignments of any utilities or drainage which passes through/below the retaining wall or the CSV.

The offset from the construction baseline to limits of CSV at all changes in horizontal alignment and offsets of CSV limits.

(D) Typical sections of wall showing:

Limits of cut and fill work.

Limits of Select Backfill, retained backfill behind the CSV, and surface and subsurface drainage materials.

Limits of CSV and associated appurtenant items such as surface and subsurface drainage features and soil reinforcing elements.

Location of final ground lines.

(E) Precast panel unit details for all panel types, including non-standard panels, with all dimensions necessary to construct the panels with locations in the member of all appurtenant items such as reinforcement steel, reinforcing element connection points, and lifting devices. In the case of two-stage construction, flexible facing details, connectors between first and second stage construction, precast panel units, fill type between flexible facing and precast panel units, and other pertinent details.

(F) Details for footings, leveling pads and footing or leveling pad step details, where required.

(G) Details for precast barriers, copings, connections to all appurtenant items such as railings, fences, lighting standards, and noise barriers.

(H) Details for wall construction and soil reinforcing element placement to accommodate any obstructions such as piles, drilled shafts, utilities, acute corners, slip joints, highway lighting systems, drainage structures and any other obstructions.

(I) Details for any cast in place elements with all dimensions necessary to construct the elements with locations in the member of all appurtenant items such as reinforcement steel.

(J) Detail for any architectural treatments such as facing finish, texture, and color.

(K) The Wall Manufacturer's working drawings including sequence of construction.

426.05 Substitutions.

Wherever requirements for wall components, proprietary components, or methods of construction are specified, it is intended to establish a standard of quality and shall not be interpreted to preclude substitutions by Contractors, subject to conditions given hereinafter.

Substitution will be considered when such proposed substitution equals or exceeds that specified with respect to quality, workmanship, service, maintenance, economy, reliability of operation, code compliance, and aesthetics.

When the Contractor requests substitution, they shall first thoroughly investigate its proposed substitution and certify to the Engineer, in writing, that said proposed substitution is equal to that specified. The Contractor shall include with said certification all required data, samples, reports and tests to substantiate its

findings. The Engineer will decide if such substitution is equal to that specified; and if found to be so, may then approve the substitution. The Engineer's decision will be final and binding to all parties.

Where proposed substitution requires modifications to the CSV shown on the Plans or the selected wall system extends beyond the limits of the CSV shown on the Plans, the Contractor shall quantify all impacts and adjustments to affected item quantities such as but not limited to excavation, backfill, and sheeting and the Project schedule as a part of its substitution request. Additional costs which arise from quantity or schedule impacts of the substitution shall be borne solely by the Contractor. Approval of the disposition of the pay limits and quantities to accommodate the substitution shall be integral to the approval of the substitution.

Approved substitutions shall be at no additional cost to the Authority. Rejection of a requested substitution shall not be considered as a basis for a claim against the Authority, including claims of delay of time and loss of money.

426.06 Measurement.

(A) Mechanically Stabilized Earth Walls will be measured by the total square feet of wall panel area supplied and constructed in the completed wall. The area measured will be the product of the average vertical height between final rear face and front face ground lines and the total lengths of the wall as given on the Plans. Within the CSV or except as may otherwise be provided for, no quantity other than the square foot wall area as defined above will be measured for payment.

(B) Common Structure Volume (CSV)

The CSV is the volume that contains all components of all retaining wall systems considered for construction at a given site. The limits of the CSV are defined as:

End Limit Planes: Vertical planes, normal or radial to the wall alignment, at begin and end stations of the wall system.

Forward Limit Plane: Vertical plane(s) two feet or other designated distance shown on the Plans forward of the fascia. The fascia is defined as the forward limit of wall coping or barrier parapet face, wall panel or unit face or other physical feature as shown on the plans

Rear Limit Plane: Vertical plane(s) at the rear limits of the Select Backfill. For the purposes of defining the CSV, this limit will be located parallel to the Forward Limit Plane and at minimum distance of 70% of the average vertical dimension between the Bottom Limit Plane and the Top Limit Plane, plus one (1) foot and will include any porous fill, all wall appurtenances such as drainage systems, pertinent retained fill and any work to be included in the wall pay item.

Bottom Limit Plane: Horizontal Plane(s) at the lower elevations of the wall to include the leveling pad(s)/footing(s), the undersides of the Select Backfill or modular units and excavations required for the construction of the Select Backfill or modular units, extending between the Forward and Rear Limit Planes of the CSV.

Top Limit Plane: Plane(s) defining the configuration (slope, roadway, pavement box, etc.) at the top of the wall extending between the forward and rear limits of the CSV. Where finished grade of an MSE wall is defined by a pavement system, the CSV Top Limit Plane shall be defined as the underside of the pavement system subgrade material as noted in the Plans.

Unless otherwise noted in the Plans or Specifications, all components of the wall system and all components, elements or appurtenances , such as copings, parapets, barriers, moment slabs, wall underdrains, geo-membrane liner systems, etc., founded on or located within the CSV or attached to any component of the wall system within the CSV shall be included in the MSE wall.

426.07 Payment

Payment will be made under:

PAY ITEM	*PAY UNIT*
MECHANICALLY STABILIZED EARTH WALLS	SQUARE FOOT

No additional payment will be made for Substitutions under Subsection 426.05.

No additional payment will be made for costs resulting from submission, approval or rejection of Substitutions under Subsection 426.05.

Payment for electrical items will be made in accordance with Division 600, unless otherwise noted on the Plans.

NOTE: The following text are ADDITIONS to the latest version of the 2016 Standard Supplementary Specifications.

Delete this Section and replace it with the following:

SECTION 925 - MECHANICALLY STABILIZED EARTH (MSE) WALLS

Materials within this section shall conform to the current editions of AASHTO LRFD Bridge Design and Construction Specifications with Interims except as noted herein, and in accordance with provisions of the wall system selected for construction in this contract, as approved by the Engineer.

The following are defined for the allocation of responsibilities as described herein:

"Engineer" shall be as defined in paragraph 101.02(B).

"Wall Manufacturer" shall be defined as the approved MSE wall supplier/vendor and shall also include a Professional Engineer licensed in NJ, responsible for the preparation of the Working Drawings and calculations associated with the MSE Wall.

925.01 Steel Reinforcing Elements.

(A) STEEL REINFORCING ELEMENTS.

(1) Steel wire mesh and embedded loops shop fabricated from cold drawn steel wire shall meet the minimum requirements of ASTM A82. Steel wire mesh shall be welded into the finished mesh fabric in accordance with ASTM A185. This type of Steel Reinforcing Element is also referred to as a "Bar Mat".

(2) Steel strips hot rolled from bars to the required shape and dimensions with physical and mechanical properties meeting ASTM A572/572M Grade 65 or as shown on the approved Working Drawings. Shop-fabricated hot rolled steel tie straps shall meet the minimum requirements of ASTM A1011/A1011 M, Grade 50, or as shown on the approved Working Drawings

(A) CORROSION PROTECTION.

Steel reinforcing strips, tie strips, reinforcing mesh, connectors and all ferrous materials in direct earth contact used in permanent walls shall have corrosion protection as specified in the most current version of the AASHTO LRFD Bridge Design Specifications, the AASHTO LRFD Bridge Construction Specifications and as shown on the Working Drawings. Galvanization shall be applied in accordance with AASHTO M 111 (ASTM A123) for strip type, bar mat, or grid type reinforcements and ASTM A153 for accessory parts such as bolts and tie strips. Galvanization shall be applied after fabrication in accordance with ASTM A123. All steel reinforcement and connection hardware shall be made from the same metal alloy and galvanized, unless otherwise approved. by

All metallic elements in direct contact with one another shall be of the same alloy and have the same type of coating. Steel-to-steel contact between the soil reinforcement connections and the concrete facing steel reinforcement shall be prevented so that contact between dissimilar metals, e.g., bare facing reinforcement steel and galvanized soil reinforcement steel, does not occur.

If galvanization is scratched or otherwise damage it shall be field repaired as per the requirements of ASTM A780 prior to installation to the satisfaction of the Engineer and in accordance with the manufacturer's recommendations, at no additional cost to the Authority.

(B) QUALITY CONTROL.

The Contractor shall submit the Wall Manufacturer's written certification that the material was manufactured, sampled, tested, and inspected in accordance with, and meets the requirements specified above and the Wall Manufacturer's internal quality control process.

Additional Quality Control testing shall be specified in the Working Drawings as deemed necessary by the Wall Manufacturer, including the test designation, acceptable result, and frequency of testing.

(C) Quality Assurance.

Quality Assurance testing of steel reinforcing elements will be performed if deemed necessary by the Engineer in accordance with 925.01(A).

925.02 Geosynthetic Reinforcing Elements.

(A) Geosynthetic Reinforcing Elements.

The following information for each product shall be submitted by the Wall Manufacturer for verification purposes:

(1) Geosynthetic type and structure.

(2) Spacing and dimensions of geogrids.

(3) Polymer(s) used for fibers, ribs, etc.

(4) Polymer(s) used for coating, if present.

(5) Roll size (length, width, area, and weight .

(6) Typical lot size.

(7) Polymer source used for product.

(8) The primary resin used in manufacturing shall be identified as follows:

(a) High Density Polyethylene (HDPE) resin type, class, grade and category in accordance with ASTM D1248 shall be identified. For example Type III, Class A, Grade E5, Category 5.

(b) Polypropylene (PP) resins, group, class and grade in accordance with ASTM D4101 shall be identified. For example Group 1, Class 1, Grade 4.

(c) Polyester (PET) resins minimum production intrinsic viscosity (ASTM D4603) and maximum carboxyl end groups (ASTM D7409) shall be identified.

(B) Protection.

The UV resistance as measured by ASTM D4355 shall be the minimum value included in the Working Drawings.

(C) Quality Control.

Geosynthetic properties certifications with Minimum Average Roll Value (MARV), as defined in ASTM D4439, shall be provided from a laboratory accredited by the Geosynthetic Accreditation Institute-Laboratory Accreditation Program (GAI-LAP). For the testing geosynthetics, a "lot" shall be defined as a single day's production. The table below shall be completed and included in the Working Drawings by the Wall Manufacturer.

Test		Procedure	Testing Rate (Per SF Reinforcement)	Acceptable Result and Unit
Ultimate Tensile Strength	or	ASTM D6637	To be included in the Working Drawings by the Wall Manufacturer.	
Wide Width Tensile		ASTM D4595		
Creep (Extrapolate to Design Life)[1,2]		ASTM D5262/D6992		
Resistance to UV Degradation		ASTM D4355		
Hydrolysis Resistance (For PET Only)		ASTM D7409		
Intrinsic Viscosity		ASTM D4603		

Test	Procedure	Testing Rate (Per SF Reinforcement)	Acceptable Result and Unit
Stress Cracking Resistance (For HDPE Only)	ASTM D1693		
1	ASTM D5262 Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics should have a minimum of 10,000 hours.		
2	ASTM D6992 Standard Test Method for Accelerated Tensile Creep and Creep Rupture of Geosynthetic Materials Based on Time Temperature Superposition Using the Stepped Isothermal Method should have sufficient data to provide a prediction of behavior to a minimum of 10^6 hours		

(D) Quality Assurance.

Quality Assurance testing of geosynthetic reinforcing elements will only be performed if deemed necessary by the Engineer.

925.03 Select Backfill for MSE Walls with Steel Reinforcing Elements.

(A) All pre-construction and production samples shall be tested by an AASHTO Materials Reference Laboratory (AMRL) accredited geotechnical laboratory. The laboratory utilized shall be certified for the given test being performed where offered by AMRL accreditation.

(B) Select Backfill used in the MSE CSV (Common Structure Volume) shall be reasonably free from deleterious materials, shale or poor durability particles and shall conform to the following gradation limits as determined by AASHTO T 27:

Sieve Size	Percent Passing
4 inches	100
¾ inch	30-100
No. 4	5-85
No. 40	0-60
No. 200	0-15

The upper three feet of Select Backfill shall contain no stones greater than three inches in their greatest dimension, and shall not be composed primarily of gravel with less than 40 percent passing the ¾" sieve. No. 57 Coarse Aggregate in accordance with ASTM C33 shall be utilized in the CSV below the 100 year flood elevation.

(C) Recycled Concrete Aggregate (RCA) and Reclaimed Asphalt Pavement (RAP) shall not be permitted to be included in Select Backfill material.

(D) Only one Select Backfill material shall be used per wall. Select Backfill shall meet the following criteria:

Property	Standard	Test Procedure
Standard Proctor, lbs/ft^3	Maximum Dry Density within ±15% of the Unit Weight Approved on the Working Drawings.	AASHTO T 99
Organic Content, %	< 1.00% of Total Sample Weight	AASHTO T 267
Plasticity Index, PI %	≤ 6	AASHTO T 90
Resistivity, Ω – cm	> 3,000 (at 100% saturation)	AASHTO T 288[1]
pH, dim.	Acceptable Range of 5 – 10	AASHTO T 289

Property	Standard	Test Procedure
Chloride, ppm	< 100 ppm	AASHTO T 291 or ASTM D 4327
Sulfates, ppm	< 200 ppm	AASHTO T 290 or ASTM D 4327
Soundness (Magnesium Sulfate), % Loss	< 30% after 4 Cycles	AASHTO T 104[2]
Soundness (Sodium Sulfate), % Loss	< 15% after 5 Cycles	AASHTO T 104[2]
Internal Angle of Friction, ϕ, Degrees	≥ Value Specified (In Wall Manufacturer's Working Drawings[3])	AASHTO T 236[4]

1 ASTM G187 may be substituted for AASHTO T 288 in instances where insufficient material passing the No. 10 sieve is present. This test shall be completed on materials passing the number 4 sieve with an appropriately sized resistivity box utilized. Alternatively the sample may be crushed to obtain sufficient material passing the No. 10 sieve and retained on the number 100 sieve such that AASHTO T 288 can be performed.

2 Soundness by AASHTO T 104 may be performed with either Magnesium Sulfate or Sodium Sulfate, both are not required.

3 Internal angle of friction specified in the wall manufacturer's Working Drawings shall be between 34 and 38 degrees.

4 Conduct the test with the sample compacted to 95% of the maximum dry density and moister than of the optimum moisture content, obtained from the Standard Proctor (AASHTO T 99 Methods C or D with oversized correction factor as outlined in note 7 of AASHTO T99) on only the material passing the No. 10 sieve. Conduct the test at 0.5 tsf, 1.0 tsf, and 2.0 tsf confining pressures. Report the minimum friction angle obtained.

(E) Pre-Construction Testing Requirements:

The Contractor shall provide laboratory test results from an AMRL accredited laboratory in the following quantities from each source proposed documenting that Subsections 925.03 (B) through (D) of the "Select Backfill Material for MSE Walls with Steel Reinforcing Elements" section are satisfied for a representative sample of the proposed material, along with a certificate of compliance that the material satisfies this specification from each source to be used. The initial sample's results shall be provided to the Engineer a minimum of 14 days prior to the start of construction on MSE Walls.

Parameter	Test	Quantity of Tests Required
Gradation	AASHTO T 27	3
Standard Proctor	AASHTO T 99	
Organic Content	AASHTO T 267	
Plasticity Index	AASHTO T 90	
Resistivity	AASHTO T 288	If Resistivity > 10,000 Ω-cm at 100% Saturation, **1 Test** If 5,000 ≤ Resistivity < 10,000 Ω-cm at 100% Saturation, **3 Tests** If Resistivity < 5,000 Ω-cm at 100% Saturation, **5 Tests**
pH	AASHTO T 289	If Resistivity > 10,000 Ω-cm at 100% Saturation, **3 Tests** If 5,000 ≤ Resistivity < 10,000 Ω-cm at 100% Saturation, **6 Tests** If Resistivity < 5,000 Ω-cm at 100% Saturation, **10 Tests**
Chloride Content	AASHTO T 291 or ASTM D 4327	
Sulfate Content	AASHTO T 290 or ASTM D 4327	
Soundness	AASHTO T 104	1
Internal Angle of Friction[1]	AASHTO T 236	1

1 Where greater than 75% of the particles of the Select Backfill are retained on the ¾" sieve, the direct shear and tri-axial compression test requirements may be waived if a 34 degree internal angle of

Parameter	Test	Quantity of Tests Required

friction was used in the Wall Manufacturer's design as documented on the Working Drawings.

(F) Production Testing Requirements:

The Contractor shall provide Quality Control (QC) laboratory test results at the following specified frequencies. The samples shall be taken from the source and the results shall be received prior to the material being delivered on site:

Parameter	Test	Frequency
Gradation	AASHTO T 27	Every **2,000 CY** with a Minimum of 2 Tests per Structure
Standard Proctor	AASHTO T 99	
Organic Content	AASHTO T 267	
Plasticity Index	AASHTO T 90	
Resistivity	AASHTO T 288	If Previous Test ≤ 5,000 Ω-cm at 100% Saturation, Every **2,000 CY** with a Minimum of 2 Tests per Structure or If Previous Test > 5,000 Ω–cm at 100% Saturation, Every **4,000 CY** with a Minimum of 2 Tests per Structure
pH[1,2]	AASHTO T 289	If Previous Test ≤ 5,000 Ω-cm at 100% Saturation, Every **1,000** CY with a Minimum of 2 Tests per Structure or If Previous Test > 5,000 Ω–cm at 100% Saturation, Every **2,000 CY** with a Minimum of 2 Tests per Structure and Chloride and Sulfate Content Tests may be Waived by the Engineer
Chloride Content[2]	AASHTO T 291 or ASTM D 4327	
Sulfate Content[2]	AASHTO T 290 or ASTM D 4327	
Soundness	AASHTO T 104	Every **4,000 CY** with a Minimum of 2 Tests per Structure
Internal Angle of Friction[3]	AASHTO T 236	Every **4,000 CY** with a Minimum of 2 Tests per Structure

1 A pH result outside the specified limits is cause for rejection of the material placed since the last pH test.

2 Backfill sources shall be rejected if resistivity measured for any one sample is less than 700 Ω-cm, chloride content > 500 ppm or sulfate content > 1000 ppm.

3 Where greater than 75% of the particles of the Select Backfill are retained on the ¾" sieve, the direct shear and tri-axial compression test requirements may be waived if a 34 degree internal angle of friction was used in the Wall Manufacturer's design as documented on the Working Drawings.

(G) Failing results shall be addressed as follows:

(1) Repeat failing QC tests at the Contractor's expense on a resample.

(2) Resampled tests shall be averaged with the failing sample test to determine the final tested soil properties.

(3) If the average of the failing sample and the resampled test also fails, the material shall be removed at the Contractor's expense up to the location where materials with passing test results were placed.

(H) Quality Assurance Testing:

The Engineer will utilize a laboratory certified by AMRL. The selected laboratory utilized shall be certified for the given test to be performed where offered by AMRL accreditation, and other than the Contractor's laboratory performing QC testing, to perform Quality Assurance (QA) testing on Select Backfill sampled from the source or on site at the following frequencies:

The Engineer will perform a full series of QA testing on every 4,000 CY including all tests in subsections 925.03 (4) through (6) of the "Select Backfill Material for MSE Walls with Steel Reinforcing Elements" section, or additionally as deemed necessary by the Engineer based on a change in the appearance or

behavior of the Select Backfill. The Engineer may waive some QA testing as follows:

(1) Plasticity Index, if less than 30 percent passes the No. 40 sieve

(2) Chloride Content, if QA resistivity test yields ≥ 5,000 Ω-cm

(3) Sulfate Content, if QA resistivity test yields ≥ 5,000 Ω-cm

(4) Soundness, if being quarried from a consistent source that is well documented to be capable of producing material with sufficient soundness.

(5) Internal Friction Angle, if a friction angle of 34 degrees or less is specified in the Working Drawings and greater than 75% of the particles of the Select Backfill are retained on the 3/4" inch sieve.

925.04 Select Backfill for MSE Walls with Geosynthetic Reinforcing Elements.

(A) All pre-construction and production samples shall be tested by an AMRL accredited geotechnical laboratory. The laboratory utilized shall be certified for the given test to be performed where offered by AMRL accreditation.

(B) Select Backfill shall be reasonably free from deleterious materials, shale or poor durability particles and shall conform to the following gradation limits as determined by AASHTO T 27:

Sieve Size	Percent Passing
¾ inch	100
No. 4	5-85
No. 40	0-60
No. 200	0-10

No. 8 Coarse Aggregate in accordance with ASTM C33 shall be utilized in the Common Structure Volume below the 100 year flood plain.

(C) Recycled Concrete Aggregate (RCA) and Reclaimed Asphalt Pavement (RAP) shall not be permitted to be included in Select Backfill material.

(D) Select Backfill shall satisfy the following criteria:

Property	Standard	Test Procedure
Standard Proctor, lbs/ft³	Maximum Dry Density within ±15% of the Unit Weight Approved on the Working Drawings.	AASHTO T 99
Organic Content, %	< 1.00% of Portion Passing No. 10 Sieve	AASHTO T 267
Plasticity Index, PI %	≤ 6	AASHTO T 90
pH	5 - 8 Permanent, 3 – 10 Temporary	AASHTO T 289
Soundness (Magnesium Sulfate), % Loss	< 30% after 4 Cycles	AASHTO T 104[1]
Soundness (Sodium Sulfate), % Loss	< 15% after 5 Cycles	AASHTO T 104[1]
Internal Angle of Friction, ϕ, Degrees	≥ Value Specified (In Wall Manufacturer's Working Drawings[2])	AASHTO T 236[3]

1 Soundness by AASHTO T 104 may be performed with either Magnesium Sulfate or Sodium Sulfate, both are not required.

2 Internal angle of friction specified in the wall manufacturer's working drawings shall be between 30 and 38 degrees.

3 Conduct the test with the sample compacted to 95% of the maximum dry density and moister than of the optimum moisture content, obtained from the Standard Proctor (AASHTO T 99 Methods C or D with oversized correction factor as outlined in note 7 of AASHTO T99) on only the material passing the No. 10 sieve. Conduct the test at 0.5 tsf, 1.0, tsf, and 2.0tsf confining pressures. Report the minimum friction angle obtained.

(E) Pre-Construction Sample Testing Requirements:

The Contractor shall provide laboratory test results from an AMRL accredited laboratory in the following quantities from each source proposed documenting that Subsections 925.04 (B) through (D) of the "Select Backfill for MSE Walls Reinforced with HDPE Geo-Grids" section are satisfied for a representative sample of the proposed material, along with a certificate of compliance that the material satisfies this specification. The initial sample's results shall be provided to the Engineer a minimum of 14 days prior to the start of construction on MSE Walls.

Parameter	Test	Number of Tests Required
Gradation	AASHTO T 27	3 Tests
Standard Proctor	AASHTO T 99	
Organic Content	AASHTO T 267	
Plasticity Index	AASHTO T 90	
pH	AASHTO T 289	**3 Tests**
Soundness	AASHTO T 104	1 Test
Internal Angle of Friction	AASHTO T 236	1 Test

(F) Production or Samples Testing Requirements:

The Contractor shall provide Quality Control (QC) laboratory test results at the following specified frequencies. The samples shall be taken from the source and the results shall be received prior to the material being delivered on site:

Parameter	Test	Frequency
Gradation	AASTHO T 27	Every **2,000 CY** with a Minimum of 2 Tests per Structure
Standard Proctor	AASHTO T 99	
Organic Content	AASHTO T 267	
Plasticity Index	AASHTO T 90	
pH[1]	AASHTO T 289	
Soundness	AASHTO T 104	Every **4,000 CY** with a Minimum of 2 Tests per Structure
Internal Angle of Friction	AASHTO T 236	Every **4,000 CY** with a Minimum of 2 Tests per Structure

1 A pH result outside the specified limits is cause for rejection of the material placed since the last pH test.

(G) Failing results shall be addressed as follows:

(1) Repeat failing QC tests at the Contractor's expense on a resample.

(2) Resampled tests shall be averaged with the failing sample test to determine the final tested soil properties.

(3) If the average of the failing sample and the resampled test also fails the material shall be removed at the Contractor's expense up to the location where materials with passing test results was placed, with the exception of Note One in the table above.

(H) Quality Assurance Testing Recommendations:

The Engineer will utilize a third party independent AMRL certified laboratory, other than the Contractor's laboratory performing QC testing, to perform Quality Assurance (QA) testing on Select Backfill sampled from the source or on site at the following frequencies:

The Engineer shall perform a full series of QA testing on every 4,000 CY including all tests in Subsections 925.04 (4) through (6) of the "Select Backfill Material for MSE Walls with Geosynthetic Reinforcing

Elements" section, or additionally as deemed necessary by the Engineer based on a change in the appearance or behavior of the Select Backfill. The Engineer may waive some QA testing as follows:

(1) Plasticity Index, if less than 30 percent passes the No. 40 sieve

(2) Soundness, if being quarried from a consistent source that is well documented to be capable of producing material with sufficient soundness.

(3) Internal Friction Angle, if a friction angle of 34 degrees or less is specified in the Working Drawings

925.05 High Density Polyethylene (HDPE) Geomembrane Liner System.

HDPE geo-membrane liner systems shall have a nominal thickness of 30 mils. The geomembrane shall be manufactured of new, first quality resin and shall be compounded and manufactured specifically for the intended purpose. The resin manufacturer shall certify each batch for the following properties:

Property	Test Method	Requirements
Specific Gravity	ASTM D792	> 0.940
Melt Index	ASTM D1238	< 0.4g/10 min.
Carbon Black Content	ASTM D1603	2% - 3%

The HDPE supplier shall submit this certification for the Engineer's verification of the material.

The surface of the HDPE geo-membrane liner system shall not have striations, roughness, pinholes or bubbles and shall be free of holes, blisters and any foreign matter, such as soil or oil accumulation.

925.06 Class 2 Geotextile Fabric.

Class 2 Geotextile Fabric shall be in accordance with AASHTO M 288 designed for filtration performance following the guidelines in FHWA NHI-07-092 (Holtz et al., 2008).

925.07 MSE Wall Systems

Refer to the QPL for approved suppliers.