

NEW YORK STATE THRUWAY AUTHORITY
DEPARTMENT OF ENGINEERING

ALBANY, NY
APRIL 24, 2026

AMENDMENT NO. 2
TO

CONTRACT TAN 26-9A
D215077
NIAGARA SECTION PUMPHOUSE UPGRADE
ON I-190, MP N9.1
IN THE BUFFALO DIVISION
OF THE NEW YORK STATE THRUWAY
IN ERIE COUNTY

IN THE LETTING OF
APRIL 29, 2026

NOTE: This amendment shall be attached to and become a part of the Proposal for Contract **TAN 26-9A**.

NOTICE

For Electronic Bidders, the Project's amended EBSX file will automatically account for any necessary item changes (deletions, changes in quantities, or additions) that this Amendment may describe as being required regarding the project's estimated cost. Instructions to make physical changes to the Project Proposal's bid sheets are intended for "paper" Bidders who choose to submit bids via paper.

Questions and Answers for this project are available from the Authority's website, specifically at: https://content3.thruway.ny.gov/netdata/contractors/documents/d215077_tan26-9a_questions-and-answers-04-23-2026.pdf. This document may be updated periodically without formal issuance of an Amendment. Prospective bidders are advised to revisit this link weekly and before proposals are due, for any possible additional questions and answers information.

PROPOSAL

1. The Letting Date for this project has been rescheduled to May 6, 2026. All Bidders are authorized to **CHANGE** the Contract Proposal cover to read: **LETTING OF MAY 6, 2026**.
2. **DELETE** page 93 and **REPLACE** with the attached revised Specification Summary page for Item 627.0002 25, SITE CONSTRUCTION, page **93-A2**.
3. **DELETE** pages **122** through **127** and **REPLACE** with the attached revised specifications for Section 02456, Steel Sheet Piles, pages **122-A2** through **127A-A2**. The specifications have been revised to clarify responsibility for the connection details between the two wall systems.
4. **ADD** the attached new specifications for Section 02832, Segmental Retaining Walls, pages **147A-A2** through **147V-A2**.

The Bidder **MUST** complete Page **600** of the Proposal acknowledging receipt of this amendment. If the Bidder fails to complete the “Amendment Acknowledgement” sheet, his bid could be declared informal thereby delaying award of the contract.

PLEASE BE GOVERNED ACCORDINGLY WHEN SUBMITTING BIDS.

Brent E. Howard, P.E.
Chief Engineer

ITEM 627.0002 25**SITE CONSTRUCTION****1. SPECIFICATION SUMMARY**

1.01 This Item includes the following specifications:

- A. Section 02050 Demolition and Salvage
- B. Section 02240 Dewatering
- C. Section 02300 Earthwork
- D. Section 02456 Steel Sheet Piles
- E. Section 02516 Asphalt Paving
- F. Section 02575 Restoration of Surfaces
- G. Section 02628 PVC Gravity Sewer Pipe
- H. Section 02650 Precast Concrete Yard Structures
- I. Section 02704 Pipeline Pressure and Leakage Testing
- J. Section 02832 Segmental Retaining Walls
- K. Section 02925 Topsoil and Groundcover
- L. Section 02960 Temporary Bypass Pumping Systems

1.02 This item shall include, but not be limited to, the following:

- A. Preparatory work on site.

1.03 Items specifically not paid for under this item shall include, but not be limited to, the following:

- A. Not Used

SECTION 02456 - STEEL SHEET PILES

PART 1 - GENERAL

1.1 SCOPE

- A. Section includes materials and installation for sheet, continuous interlocking flat web, and continuous interlocking steel sheet piles.

1.2 DELEGATED DESIGN

- A. The sheet pile retaining wall system shall be designed by the Contractor's Specialty Engineer.
- B. The Contractor shall retain a Professional Engineer licensed in the State of New York to perform the design of the sheet pile wall system and prepare and seal all design calculations and shop drawings.
- C. The Sheet Pile Design Engineer shall be responsible for the complete design of the wall system, including but not limited to:
 - 1. Earth pressures and surcharge loads
 - 2. Structural capacity of sheet piles
 - 3. Embedment depth and toe stability
 - 4. Global stability and overall system stability
 - 5. Tiebacks, anchors, or bracing if required
 - 6. Temporary and permanent conditions
 - 7. The connection detail between the sheet pile retaining wall and the adjacent precast block wall.
- D. The design shall be in accordance with all applicable codes, including NYSDOT and NYSTA requirements, and consistent with the geotechnical recommendations and the intent of the Contract Documents.
- E. Preliminary dimensions and details shown on the Drawings are provided for bidding purposes only. The Contractor's design shall govern. In the event of a conflict between the prescriptive requirements of this Section and the Contractor's delegated design, the Contractor's design shall govern, provided it meets the performance requirements and intent of the Contract Documents.

1.3 COORDINATION WITH ADJACENT STRUCTURES

- A. A. The Sheet Pile Design Engineer shall be responsible for the design of all interfaces and connections between the sheet pile wall and adjacent structures, including but not limited to the segmental retaining wall system specified in Section 02832.
- B. The design shall account for:
 - 1. Differential settlement and movement between systems
 - 2. Load transfer between wall systems
 - 3. Constructability and sequencing
 - 4. Drainage compatibility
 - 5. Long-term performance of both systems

- C. The Sheet Pile Design Engineer shall coordinate with the Segmental Retaining Wall Design Engineer to ensure compatibility between systems and to develop a complete and constructible connection detail.
- D. All connection and interface details shall be included in the sheet pile shop drawings and shall be sealed by a Professional Engineer licensed in the State of New York.
- E. All costs associated with coordination and interface design shall be considered incidental to the Work.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at the Project Site.

1.5 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For steel sheet piles and associated systems. Show fabrication and installation details for piles, including details of driving points, splices, and pile caps.
 - 1. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
- C. At least 2 weeks prior to fabrication, submit to ENGINEER, two copies of steel producer certificates in accordance with ASTM A1011/A101M, and mill test reports in accordance with CAN/CSA-G40.20/G40.21.
- D. Provide ENGINEER with copy of certification for fusion welding in accordance with CSA W47.1 and CSA W47.1S1.
- E. Pile-Driving Equipment Data: Include type, make, and rated energy range; weight of striking part of hammer; weight of drive cap; and type, size, and properties of hammer cushion.
- F. Pile-driving records.
- G. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Inspection and testing of steel sheet piling material will be carried out by testing laboratory designated by the ENGINEER at any time during the course of the work.
- C. Materials inspected or tested by the testing laboratory which fail to meet contract requirements will be rejected.
- D. Where tests or inspections by designated testing laboratory reveal work not in accordance with contract requirements, Contractor to pay costs for additional tests or inspections. Engineer to

approve corrected work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Use slings for lifting piling so that mass is evenly distributed and piling is not subject to excessive bending stresses.
- B. Store sheet piling on level ground or provide supports so that sheet piling is level when stored.
 - 1. Provide blocking at spacing not exceeding 5 meters so there is no excessive sagging in the piling.
 - 2. Overhang at ends not to exceed 0.5 meters.
 - 3. Block between lifts directly above blocking in lower lift.
- C. If material is stock-piled on structure, ensure that structure is not overloaded.

1.8 WASTE MANAGEMENT AND DISPOSAL

- A. Separate waste materials for reuse and recycling in accordance with Section 01355.
- B. Remove from site and dispose of packaging materials at appropriate recycling facilities.
- C. Divert unused metal materials from landfill to metal recycling facility for disposal approved by ENGINEER.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Steel sheet piles: to CAN/CSA-G40.21, including chemical and mechanical requirements grade 350W, and following:
- B. Continuous interlocking flat web with minimum web thickness 0.5 inches and minimum mass of 39.9 lbs per square foot.
- C. Continuous interlocking [Z] [trough] section: Minimum section properties shown are provided for bidding purposes only. Final section properties shall be as required by the Contractor's design.
 - 1. Minimum effective section modulus of 60.7 cubic inches per foot of wall.
 - 2. Minimum flange thickness of 0.6 inches.
 - 3. Minimum web thickness of 0.5 inches.
- D. Sheet piling: section modulus of 60.7 cubic inches per foot or equivalent as approved by ENGINEER.
 - 1. Special corners: provide fabricated special corners as specified by manufacturer for type

of sheet piling supplied.

2. Interlocks: to be such that section of interlock bar of 3.2 feet minimum length will pass along full length of pile without binding.
 3. Mark each piece of sheet piling legibly by stencilling or die-and-stamping with following information.
 - a. Heat Number.
 - b. Manufacturer's Name.
 - c. Length and Section Number.
 4. Do not precut lifting or slinging holes in sheet piles.
- E. Structural steel for wales, bearing plates, wales splices, capping channels, support angles and miscellaneous steel: to CAN/CSA-G40.21, Grade 300W.
- F. Tie rods, sleeve nuts and turnbuckles.
1. Tie rods: to ASTM A615
 2. Tie rods: to continuously threaded bar with double corrosion protection.
 3. Sleeve nuts, and connector sleeves: to have load capacity in excess of capacity of tie rod.
 4. Preassemble, mark and test tie rod assemblies in shop. Align threaded connection to following tolerances at sleeve nut or connector sleeve: [1/80 of normal rod diameter, deviation of centre line, 1 in 160.
- G. Nuts and bolts: hexagon nuts, bolts, and washers: to ASTM A307.
- H. Backfill material: to Section NYSDOT Standard Specification Volume 2, Section 203 – Excavation and Embankment and as indicated.
- 2.2 SOURCE QUALITY CONTROL: HOT ROLLED STEEL SHEET PILING
- A. Provide results of tests of sheet piling material to be used on project as follows:
1. One tension test and one bend test from each heat for quantities of finished materials less than 50 tons.
 2. Two tension tests and two bend tests from each heat for quantities of finished material exceeding 50 tons.
- B. Tension tests in accordance with CAN/CSA-G40.20/G40.21. Bend tests in accordance with ASTM A6/A6M.
- 2.3 SOURCE QUALITY CONTROL: COLD FORMED STEEL SHEET PILING
- A. Provide results of tension tests of sheet piling material to be used on project as follows:

1. One tension test from each heat for quantities of finished material less than 50 tons.
 2. Two tension tests from each heat for quantities of finished material exceeding 50 tons.
- B. Tension tests in accordance with CAN/CSA-G40.20/G40.21.
- C. Provide results of bend tests of sheet piling materials to be used on project as follows:
1. Bend tests in accordance with ASTM A6/A6M, with following amendments:
 - a. S14.1 Bend tests to be performed with material in condition as used in cold forming operation. Three tests to be made from each heat and each thickness of material produced. Bend test specimens to be taken from edge of each coil. Longitudinal axis of specimen to be transverse to coil rolling direction.
 - b. S14.1.1 Except as provided below, bend test specimens to have minimum width to thickness ratio of 8, with both edges parallel throughout section in which bending occurs, and is maintained.
 - c. S14.2 Minor surface separations less than 0.8 mm in depth related to superficial steel surface or subsurface discontinuities to not cause rejection. Surface separations in excess of 0.8mm depth and / or cracks normal to metal surface to cause rejection.

PART 3 - EXECUTION

3.1 DRIVING PILES

- A. Do not begin pile installation until required quality control tests have been completed and test results approved by the ENGINEER.
- B. Submit full details of methods and sequence of installation of piling to ENGINEER for approval prior to start of pile installation work. Details must include templates, bracing, setting, and driving sequence and number of piles in panels for driving.
- C. General: Continuously drive piles to elevations or penetration resistance indicated using vibratory methods. Establish and maintain axial alignment of leads and piles before and during driving.
- D. Heaved Piles: Redrive heaved piles to tip elevation at least as deep as original tip elevation with a driving resistance at least as great as original driving resistance.
- E. Driving Tolerances: Drive piles without exceeding the following tolerances, measured at pile heads:
 1. Location: 4 inches (102 mm) from location indicated after initial driving, and 6 inches (152 mm) after pile driving is completed.
 2. Plumb: Maintain 1 inch (25 mm) in 48 inches (1219 mm) from vertical, or a maximum of 4 inches (102 mm), measured when pile is aboveground in leads.

3. Batter Angle: Maximum 1 inch (25 mm) in 48 inches (1219 mm) from required angle, measured when pile is aboveground in leads.

- F. Withdraw damaged or defective piles and piles that exceed driving tolerances, and install new piles within driving tolerances.
- G. Cut off tops of driven piles square with pile axis and at elevations indicated.
- H. Pile-Driving Records: Maintain accurate driving records for each pile, compiled and attested to by a qualified professional engineer.

3.2 OBSTRUCTIONS

- A. If obstruction encountered during driving, leave obstructed pile and proceed to drive remaining piles.
- B. Advise ENGINEER immediately if not possible to drive pile to full penetration and obtain direction from ENGINEER on further steps required to complete work.

3.3 HOLES

- A. Patch holes in sheet pile wall, except where permanent holes are indicated.
 1. Use excess material equal in thickness to that of the piling to patch holes and overlap not less than hole diameter.
 2. Weld to develop full strength of plate.

3.4 CUTTING

- A. When flame cutting tops of piles, and flame cutting holes in piles approved by ENGINEER, use following procedure.
 1. When air temperature is above 0 degrees C, no pre-heat is necessary.
 2. When air temperature is below 0 degrees C, pre-heat until steel 25 mm on each side of line of cut has reached a temperature very warm to hand (approximately 35 degrees C). Tempil sticks may be used to measure temperature.
 3. Use torch guiding device to ensure smooth round holes or straight edges.
 4. Make cut smooth and free from notches throughout thickness. If grinding is employed to remove notch or crack, finished radius to be minimum 5 mm.

3.5 SPLICING

- A. Use full length piles unless splicing is indicated or approved on site by ENGINEER.

3.6 BACKFILLING

- A. Backfill in accordance with NYSDOT Standard Specification Volume 2, Section 203 – Excavation and Embankment and as indicated.

3.7 FIELD QUALITY CONTROL

- A. Special Inspections: Contractor will engage a qualified special inspector to perform inspections.
- B. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.
- C. Tests and Inspections:
 - 1. Dynamic Pile Testing: High-strain dynamic monitoring shall be performed and reported according to ASTM D4945 during initial driving and during restriking on 3 percent of piles.
 - 2. Weld Testing: In addition to visual inspection, welds shall be tested and inspected according to AWS D1.1/D1.1M.

END OF SECTION 02456

SECTION 02832 – SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes furnishing all materials and labor required for the design and construction of a precast concrete modular block (PMB) retaining wall with or without geosynthetic reinforcement. Precast modular block retaining wall blocks under this section shall be cast utilizing a wet-cast concrete mix and exhibit a final handling weight in excess of 1,000 lb (450 kg) per unit and may utilize concrete-reinforcing steel.
- B. Scope of Work: The work shall consist of furnishing materials, labor, equipment and supervision for the construction of a precast modular block (PMB) retaining wall structure in accordance with the requirements of this section and in acceptable conformity with the lines, grades, design and dimensions shown in the project site plans.
- C. The final design for the retaining wall system shall be designed by the Contractor's specialty engineer. The supplier shall provide complete design calculations and construction shop drawings prepared and sealed by a Professional Engineer licensed in the State of New York.

The Contractor's specialty engineer shall be responsible for the design of the retaining wall system, including but not limited to internal stability, external stability (sliding, overturning, bearing), and global stability, in accordance with applicable codes, project geotechnical recommendations, and the requirements of the Contract Documents.

- D. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01, Division 02 and Division 03 also apply to this Section.

1.02 REFERENCES

- A. Where the specification and reference documents conflict, the Owner's designated representative will make the final determination of the applicable document.
- B. Definitions:
 - 1. Precast Modular Block (PMB) Unit – machine-placed, “wet cast” concrete modular block retaining wall facing unit.
 - 2. Geotextile – a geosynthetic fabric manufactured for use as a separation and filtration medium between dissimilar soil materials.
 - 3. Geogrid – a geosynthetic material comprised of a regular network of tensile elements manufactured in a mesh-like configuration of consistent aperture openings. When connected to the PMB facing units and placed in horizontal layers in compacted fill, the

geogrid prevents lateral deformation of the retaining wall face and provides effective tensile reinforcement to the contiguous reinforced fill material.

4. Drainage Aggregate – clean, crushed stone placed within and immediately behind the precast modular block units to facilitate drainage and reduce compaction requirements immediately adjacent to and behind the precast modular block units.
5. Unit Core Fill – clean, crushed stone placed within the hollow vertical core of a precast modular block unit. Typically, the same material used for drainage aggregate as defined above.
6. Foundation Zone – soil zone immediately beneath the leveling pad and the reinforced zone.
7. Retained Zone – soil zone immediately behind the drainage aggregate and wall infill for wall sections designed as modular gravity structures. Alternatively, in the case of wall sections designed with geosynthetic soil reinforcement, the retained zone is the soil zone immediately behind the reinforced zone.
8. Reinforced Zone – structural fill zone within which successive horizontal layers of geogrid soil reinforcement have been placed to provide stability for the retaining wall face. The reinforced zone exists only for retaining wall sections that utilize geosynthetic soil reinforcement for stability.
9. Reinforced Fill – structural fill placed within the reinforced zone.
10. Leveling Pad – hard, flat surface upon which the bottom course of precast modular blocks is placed. The leveling pad may be constructed with crushed stone or cast-in-place concrete. A leveling pad is not a structural footing.
11. Wall Infill – the fill material placed and compacted between the drainage aggregate and the excavated soil face in retaining wall sections designed as modular gravity structures.

C. Reference Standards

1. Design

- a. AASHTO LRFD Bridge Design Specifications, 7th Edition, 2014.
- b. Minimum Design Loads for Buildings and Other Structures – ASCE/SEI 7-10.
- c. International Building Code, 2018 Edition.
- d. FHWA-NHI-10-024 Volume I and GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes.
- e. FHWA-NHI-10-025 Volume II and GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes.
- f. National Concrete Masonry Association (NCMA) Design Manual for Segmental Retaining Walls (ASD), 3rd Edition

2. Precast Modular Block Units

- a. ACI 201 – Guide to Durable Concrete
- b. ACI 318 – Building Code Requirements for Structural Concrete
- c. ASTM A615 – Steel Bars for Concrete Reinforcement
- d. ASTM A767 – Galvanized Steel Bars for Concrete Reinforcement
- e. ASTM A775 – Epoxy-Coated Steel Reinforcing Bars
- f. ASTM C33 – Standard Specification for Concrete Aggregates

- g. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - h. ASTM C94 – Standard Specification for Ready-Mixed Concrete.
 - i. ASTM C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - j. ASTM C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - k. ASTM C150 – Standard Specification for Portland Cement
 - l. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - m. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
 - n. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete.
 - o. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
 - p. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - q. ASTM C666 – Standard Test Method for Concrete Resistance to Rapid Freezing and Thawing.
 - r. ASTM C845 - Standard Specification for Expansive Hydraulic Cement.
 - s. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
 - t. ASTM C989 - Standard Specification for Slag Cement for Use in Concrete and Mortars.
 - u. ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete.
 - v. ASTM C1157 - Standard Performance Specification for Hydraulic Cement.
 - w. ASTM C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
 - x. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures.
 - y. ASTM C1611 – Standard Test Method for Slump Flow of Self-Consolidating Concrete.
 - z. ASTM C1776 – Standard Specification for Wet-Cast Precast Modular Retaining Wall Units.
 - aa. ASTM D6638 – Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units (Modular Concrete Blocks).
 - bb. ASTM D6916 – Standard Test Method for Determining Shear Strength Between Segmental Concrete Units (Modular Concrete Blocks).
3. Geosynthetics
- a. AASHTO M 288 – Geotextile Specification for Highway Applications.
 - b. ASTM D3786 – Standard Test Method for Bursting Strength of Textile Fabrics Diaphragm Bursting Strength Tester Method.
 - c. ASTM D4354 – Standard Practice for Sampling of Geosynthetics for Testing.
 - d. ASTM D4355 – Standard Test Method for Deterioration of Geotextiles
 - e. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

- f. ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - g. ASTM D4595 – Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
 - h. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - i. ASTM D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile.
 - j. ASTM D4759 – Standard Practice for Determining Specification Conformance of Geosynthetics.
 - k. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
 - l. ASTM D4873 – Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
 - m. ASTM D5262 – Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics.
 - n. ASTM D5321 – Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
 - o. ASTM D5818 – Standard Practice for Exposure and Retrieval of Samples to Evaluate Installation Damage of Geosynthetics.
 - p. ASTM D6241 – Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
 - q. ASTM D6637 – Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method.
 - r. ASTM D6706 – Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil.
 - s. 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.
4. Soils
- a. AASHTO M 145 – AASHTO Soil Classification System.
 - b. AASHTO T 104 – Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
 - c. AASHTO T 267 – Standard Method of Test for Determination of Organic Content in Soils by Loss of Ignition.
 - d. ASTM C33 – Standard Specification for Concrete Aggregates.
 - e. ASTM D448 – Standard Classification for Sizes of Aggregates for Road and Bridge Construction.
 - f. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort. (12,400 ft-lbf/ft (2,700 kN-m/m)).
 - g. ASTM D1241 – Standard Specification for Materials for Soil-Aggregate Subbase, Base and Surface Courses.

- h. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
 - i. ASTM D1557 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort. (56,000 ft-lbf/ft (2,700 kN-m/m)).
 - j. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - k. ASTM D2488 – Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
 - l. ASTM D3080 – Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions.
 - m. ASTM D4254 – Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - n. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - o. ASTM D4767- Test Method for Consolidated-Undrained Triaxial Compression Test for Cohesive Soils.
 - p. ASTM D4972 – Standard Test Method for pH of Soils.
 - q. ASTM D6913 – Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
 - r. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Aggregate by Nuclear Methods (Shallow Depth).
 - s. ASTM G51 – Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing.
 - t. ASTM G57 – Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method.
5. Drainage Pipe
- a. ASTM D3034 – Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - b. ASTM F2648 – Standard Specification for 2 to 60 in [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preconstruction Meeting. As directed by the Owner, the General Contractor shall schedule a preconstruction meeting at the project site prior to commencement of retaining wall construction. Participation in the preconstruction meeting shall be required of the General Contractor, Retaining Wall Design Engineer (RWDE), Retaining Wall Installation Contractor (RWIC), Grading Contractor, and Inspection Engineer. The General Contractor shall provide notification to all parties at least 10 calendar days prior to the meeting.

- 1. Preconstruction Meeting Agenda:
 - a. The RWDE shall explain all aspects of the retaining wall construction drawings.

- b. The RWDE shall explain the required bearing capacity of soil below the retaining wall structure and the shear strength of in-situ soils assumed in the retaining wall design to the Inspection Engineer.
- c. The RWDE shall explain the required shear strength of fill soil in the reinforced, retained and foundation zones of the retaining wall to the Inspection Engineer.
- d. The RWDE shall explain any measures required for coordination of the installation of utilities or other obstructions in the reinforced or retained fill zones of the retaining wall.
- e. The RWIC shall explain all excavation needs, site access and material staging area requirements to the General Contractor and Grading Contractor.

1.04 SUBMITTALS

- A. Product Data. At least 14 days prior to construction, the General Contractor shall submit the retaining wall product submittal package to the Owner's Representative for review and approval. The submittal package shall include technical specifications and product data from the manufacturer for the following:
 1. Precast Modular Block System brochure
 2. Precast Modular Block concrete test results specified in paragraph 2.01, subparagraph B of this section as follows:
 - a. 28-day compressive strength
 - b. Air content
 - c. Slump or Slump Flow (as applicable)
 3. Drainage Pipe
 4. Geotextile
 5. Geosynthetic Soil Reinforcement (if required by the retaining wall design). The contractor shall provide certified manufacturer test reports for the geosynthetic soil reinforcement material in the manufactured roll width specified. The test report shall list the individual roll numbers for which the certified material properties are valid.
- B. Installer Qualification Data. At least 14 days prior to construction, the General Contractor shall submit the qualifications of the business entity responsible for installation of the retaining wall, the RWIC, per paragraph 1.07, subparagraph A of this section.
- C. Retaining Wall Design Calculations and Construction Shop Drawings. At least 14 days prior to construction, the General Contractor shall furnish electronic versions construction shop drawings and the supporting structural calculations report to the Owner for review and approval. This submittal shall include the following:
 1. Signed, sealed and dated drawings and engineering calculations prepared in accordance with these specifications.
 2. Qualifications Statement by the RWDE summarizing their Experience.
 3. Certificate of Insurance of the RWDE as specified in paragraph 1.06, subparagraph B of this section.

1.05 CONSTRUCTION SHOP DRAWING PREPARATION

- A. The RWDE shall coordinate the retaining wall construction shop drawing preparation with the project Civil Engineer, project Geotechnical Engineer and Owner's Representatives. The General Contractor shall furnish the RWDE the following project information required to prepare the construction shop drawings. This information shall include, but is not limited to, the following:
1. Current versions of the site, grading, drainage, utility, erosion control, landscape, and irrigation plans;
 2. report of geotechnical investigation and all addenda and any supplemental reports;
 3. recommendations of the project Geotechnical Engineer regarding effective stress shear strength and total stress shear strength (when applicable) parameters for in-situ soils in the vicinity of the proposed retaining wall(s) and for any fill soil that may potentially be used as backfill in retained and/or foundation zones of the retaining wall.
- B. The RWDE shall provide the Owner with a certificate of professional liability insurance verifying the minimum coverage limits of \$1 million per claim and \$1 million aggregate.
- C. Design of the precast modular block retaining wall shall satisfy the requirements of this section. Where local, State, or national design or building code requirements exceed these specifications, these requirements shall also be satisfied.
- D. The RWDE shall note any exceptions to the requirements of this section by listing them at the bottom right corner of the first page of the construction shop drawings.
- E. Approval or rejection of the exceptions taken by the Retaining Wall Design Engineer (RWDE) will be made in writing as directed by the Owner.
- F. The RWDE shall determine the appropriate standard(s) to be utilized, and to which the precast modular block design shall be based upon, except as noted herein. Refer to Part 1.03, Paragraph C, Part 1.
- G. In the event that a conflict is discovered between these specifications and a reasonable interpretation of the design specifications and methods referenced in paragraph F above, these specifications shall prevail. If a reasonable interpretation is not possible, the conflict shall be resolved per the requirements in paragraph 1.03, subparagraph A of this section.
- H. Soil Shear Parameters. The RWDE shall prepare the construction shop drawings based upon soil shear strength parameters from the available project data and the recommendations of the project Geotechnical Engineer. If insufficient data exists to develop the retaining wall design, the RWDE shall communicate the specific deficiency of the project information or data to the Owner in writing.

- I. Allowable bearing pressure requirements for each retaining wall shall be clearly shown on the construction drawings.
- J. Global Stability. Overall (global) stability shall be evaluated in accordance with the principals of limit equilibrium analysis as set forth in FHWA-NHI-10-024 Volume I and FHWA-NHI-10-025 Volume II GEC 11 Design of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, or other methods, as determined by the RWDE, as referenced in Section 1.06, Part F. The minimum factors of safety shall be as follows:

| | |
|--------------------------------|-----|
| Normal Service (Static) | 1.3 |
| Seismic | 1.1 |
| Rapid Drawdown (if applicable) | 1.2 |

Note: RWDE to select appropriate FOS

- K. Seismic Stability. Seismic loading shall be evaluated in accordance with AASHTO Load and Resistance Factor Design (LRFD) methodology, or NCMA (ASD) methodology as determined by the RWDE as referenced in Section 1.06, Part F.

1.06 QUALITY ASSURANCE

- A. RWIC Qualifications. In order to demonstrate basic competence in the construction of precast modular block walls, the RWIC shall possess the following:
1. Experience.
 - a. Construction experience with a minimum of 3,000 sq ft (280 sq m) of the proposed precast modular block retaining wall system.
 2. RWIC experience documentation for each qualifying project shall include:
 - a. Project name and location
 - b. Date (month and year) of construction completion
 - c. Contact information of Owner or General Contractor
 - d. Type (trade name) of precast modular block system used
 - e. Maximum height of the wall constructed
 - f. Face area of the wall constructed
 3. In lieu of these specific requirements, the contractor may submit alternate documentation demonstrating competency in Precast Modular Block retaining wall construction.
- B. RWDE (RWDE) Qualifications and Statement of Experience. The RWDE shall submit a written statement affirming that he or she has the following minimum qualifications and experience.
1. The RWDE shall be licensed to practice in the jurisdiction of the project location.
 2. The RWDE shall be independently capable of performing all internal and external stability analyses, including those for seismic loading, compound stability, rapid draw-down and deep-seated, global modes of failure.
 3. The RWDE shall affirm in writing that he or she has personally supervised the design of the retaining walls for the project, that the design considers all the requirements listed in

paragraph 1.06 and that he or she accepts responsibility as the design engineer of record for the retaining walls constructed on the project.

4. The RWDE shall affirm in writing that he or she has designed a minimum of approximately 3,000 face sq ft (280 face sq m) of modular block earth retaining walls within the previous five (5) years.
 5. In lieu of these specific requirements, the engineer may submit alternate documentation demonstrating competency in Precast Modular Block retaining wall design.
- C. The Owner reserves the right to reject the services of any engineer, engineering firm, or contractor who, in the sole opinion of the Owner, does not possess the requisite experience or qualifications.

1.07 QUALITY CONTROL

- A. The Owner's Representative shall review all submittals for materials, design, RWDE qualifications and the RWIC qualifications.
- B. The General Contractor shall retain the services of an Inspection Engineer who is experienced with the construction of precast modular block retaining wall structures to perform inspection and testing. The cost of inspection shall be the responsibility of the General Contractor. Inspection shall be continuous throughout the construction of the retaining walls.
- C. The Inspection Engineer shall perform the following duties:
 1. Inspect the construction of the precast modular block structure for conformance with construction shop drawings and the requirements of this specification.
 2. Verify that soil or aggregate fill placed and compacted in the reinforced, retained and foundation zones of the retaining wall conforms with paragraphs 2.04 and 2.05 of this section and exhibits the shear strength parameters specified by the RWDE.
 3. Verify that the shear strength of the in-situ soil assumed by the RWDE is appropriate.
 4. Inspect and document soil compaction in accordance with these specifications:
 - a. Required dry unit weight
 - b. Actual dry unit weight
 - c. Allowable moisture content
 - d. Actual moisture content
 - e. Pass/fail assessment
 - f. Test location – wall station number
 - g. Test elevation
 - h. Distance of test location behind the wall face
 5. Verify that all excavated slopes in the vicinity of the retaining wall are bench-cut as required.
 6. Notify the RWIC of any deficiencies in the retaining wall construction and provide the RWIC a reasonable opportunity to correct the deficiency.

7. Notify the General Contractor, Owner and RWDE of any construction deficiencies that have not been corrected in a timely manner.
 8. Document all inspection results and provide reports to Owner, RWDE, and RWIC.
 9. Test compacted density and moisture content of the retained backfill with the following frequency:
 - a. At least once every 500 sq ft (45 sq m) (in plan) per vertical lift, and
 - b. At least once per every 18 in (460 mm) of vertical wall construction.
- D. The General Contractor's engagement of the Inspection Engineer does not relieve the RWIC of responsibility to construct the proposed retaining wall in accordance with the approved construction shop drawings and these specifications.
- E. The RWIC shall inspect the on-site grades and excavations prior to construction and notify the RWDE and General Contractor if on-site conditions differ from the elevations, assumptions, and grading conditions depicted in the retaining wall construction shop drawings.

1.08 DELIVERY, STORAGE AND HANDLING

- A. The RWIC shall inspect the materials upon delivery to ensure that the proper type, grade and color of materials have been delivered.
- B. The RWIC shall store and handle all materials in accordance with the manufacturer's recommendations as specified herein and in a manner that prevents deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, UV exposure or other causes. Damaged materials shall not be incorporated into the work.
- C. Geosynthetics
1. All geosynthetic materials shall be handled in accordance with ASTM D4873. The materials should be stored off the ground and protected from precipitation, sunlight, dirt and physical damage.
- D. Precast Modular Blocks
1. Precast modular blocks shall be stored in an area with positive drainage away from the blocks. Be careful to protect the block from mud and excessive chipping and breakage. Precast modular blocks shall not be stacked more than three (3) units high in the storage area.
- E. Drainage Aggregate and Backfill Stockpiles
1. Drainage aggregate or backfill material shall not be piled over unstable slopes or areas of the project site with buried utilities.
 2. Drainage aggregate and/or reinforced fill material shall not be staged where it may become mixed with or contaminated by poor draining fine-grained soils such as clay or silt.

PART 2 – MATERIALS**2.01 PRECAST MODULAR BLOCK RETAINING WALL UNITS**

- A. All units shall be wet-cast precast modular retaining wall units conforming to ASTM C1776.
- B. All units for the project shall be obtained from a single manufacturer. The manufacturer shall have a minimum of three (3) years experience producing wet-cast precast modular retaining wall units conforming to ASTM C1776 and shall demonstrate compliance with a documented quality control program.
- C. Concrete used in the production of the precast modular block units shall be first-purpose, fresh concrete. It shall not consist of returned, reconstituted, surplus or waste concrete. It shall be an original production mix meeting the requirements of ASTM C94 and exhibit the properties as shown in the following table:

Concrete Mix Properties

| Freeze Thaw Exposure Class ⁽¹⁾ | Minimum 28-Day Compressive Strength ⁽²⁾ | Maximum Water Cement Ratio | Nominal Maximum Aggregate Size | Aggregate Class Designation ⁽³⁾ | Air Content ⁽⁴⁾ |
|---|--|----------------------------|--------------------------------------|--|----------------------------|
| Moderate | 4,000 psi (27.6 MPa) | 0.45 | 1 in (25 mm) | 3M | 4.5% +/- 1.5% |
| Severe | 4,000 psi (27.6 MPa) | 0.45 | 1 in (25 mm) | 3S | 6.0% +/- 1.5% |
| Very Severe | 4,500 psi (30.0 MPa) | 0.40 | 1 in (25 mm) | 4S | 6.0% +/- 1.5% |
| Maximum Water-Soluble Chloride Ion (Cl⁻) Content in Concrete, Percent by Weight of Cement^(5,6) | | | | | 0.15 |
| Maximum Chloride as Cl⁻ Concentration in Mixing Water, Parts Per Million | | | | | 1000 |
| Maximum Percentage of Total Cementitious Materials By Weight^(7,9) (Very Severe Exposure Class Only): | | | | | |
| Fly Ash or Other Pozzolans Conforming to ASTM C618 | | | | | 25 |
| Slag Conforming to ASTM C989 | | | | | 50 |
| Silica Fume Conforming to ASTM C1240 | | | | | 10 |
| Total of Fly Ash or Other Pozzolans, Slag, and Silica Fume ⁽⁸⁾ | | | | | 50 |
| Total of Fly Ash or Other Pozzolans and Silica Fume ⁽⁸⁾ | | | | | 35 |
| Alkali-Aggregate Reactivity Mitigation per ACI 201 | | | | | |
| Slump (Conventional Concrete) per ASTM C143⁽¹⁰⁾ | | | 5 in +/- 1-1/2 in (125 mm +/- 40 mm) | | |
| Slump Flow (Self-Consolidating Concrete) per ASTM C1611 | | | 18 in – 32 in (450 mm – 800 mm) | | |

⁽¹⁾Exposure class is as described in ACI 318. “Moderate” describes concrete that is exposed to freezing and thawing cycles and occasional exposure to moisture. “Severe” describes concrete that is exposed to freezing and thawing cycles and in continuous contact with moisture. “Very Severe” describes concrete that is exposed to freezing and thawing cycles and in continuous contact with moisture and exposed to deicing chemicals. Exposure class should be specified by owner/purchaser prior to order placement.

⁽²⁾Test method ASTM C39.

⁽³⁾Defined in ASTM C33 Table 3 *Limits for Deleterious Substances and Physical Property Requirements of Coarse Aggregates for Concrete*.

⁽⁴⁾Test method ASTM C231.

⁽⁵⁾Test method ASTM C1218 at age between 28 and 42 days.

⁽⁶⁾Where used in high sulfate environments or where alkali-silica reactivity is an issue, water soluble chloride shall be limited to no more than trace amounts (from impurities in concrete-making components, not intended constituents.)

⁽⁷⁾The total cementitious material also includes ASTM C150, C595, C845, C1157 cement. The maximum percentages shall include:

- (a) Fly ash or other pozzolans in type IP, blended cement, ASTM C595, or ASTM C1157.
- (b) Slag used in the manufacture of an IS blended cement, ASTM C595, or ASTM C1157.
- (c) Silica fume, ASTM C1240, present in a blended cement.

- ⁽⁸⁾Fly ash or other pozzolans and silica fume shall constitute no more than 25 and 10 percent, respectively, of the total weight of the cementitious materials.
- ⁽⁹⁾Prescriptive limits shown may be waived for concrete mixes that demonstrate excellent freeze/thaw durability in a detailed and current testing program.
- ⁽¹⁰⁾Slump may be increased by a high-range water-reducing admixture.
- D. Concrete reinforcing steel, when required for the specified block, shall conform to ASTM A615 and have a minimum yield strength of 60,000 psi. When required by the Owner to be galvanized or epoxy-coated, reinforcing steel shall conform to ASTM A767 or ASTM A775, respectively, and have a minimum yield strength of 60,000 psi.
- E. At least 1 in of concrete cover shall be maintained over all reinforcing steel bars.
- F. Facing unit dimensions shall be as required by the manufacturer's system and design. Units shall be sized to meet structural and constructability requirements.
- G. Facing units shall provide a consistent horizontal setback between courses as required to achieve the design batter indicated in the construction drawings.
- H. The 28-in (710 mm) and 41-in (1030 mm) precast modular block units may be cast with a continuous vertical core slot that will permit the insertion of a 12-in (305 mm) wide strip of geogrid reinforcement to pass completely through the block. When installed in this manner, the geogrid reinforcement shall form a non-normal load dependent, positive connection between the block unit and the reinforcement strip. The use of steel for the purposes of creating the geogrid-to-block connection is not acceptable.
- I. Without field cutting or special modification, the precast modular block units shall be capable of achieving a minimum radius of 14 ft - 6 in (4.42 m).
- J. Facing units shall provide a consistent horizontal setback between courses as required to achieve the design batter indicated in the construction drawings. The method of achieving setback shall be inherent to the manufacturer's system.
- K. The precast modular block unit face texture shall be selected by the owner from the available range of textures available from the precast modular block manufacturer. Each textured block facing unit shall be a minimum of 5.76 sq ft (0.54 sq m) with a unique texture pattern that repeats with a maximum frequency of once in any 15 sq ft (1.4 sq m) of wall face.
- L. The block color shall be selected by the owner from the available range of colors available from the precast modular block manufacturer.
- M. All precast modular block units shall be sound and free of cracks or other defects that would interfere with the proper installation of the unit, impair the strength or performance of the constructed wall. PMB units to be used in exposed wall construction shall not exhibit chips

or cracks in the exposed face or faces of the unit that are not otherwise permitted. Chips smaller than 1.5 in (38 mm) in its largest dimension and cracks not wider than 0.012 in (0.3 mm) and not longer than 25% of the nominal height of the PMB unit shall be permitted. PMB units with bug holes in the exposed architectural face smaller than 0.75 in (19 mm) in its largest dimension shall be permitted. Bug holes, water marks, and color variation on non-architectural faces are acceptable. PMB units that exhibit cracks that are continuous through any solid element of the PMB unit shall not be incorporated in the work regardless of the width or length of the crack.

- N. Preapproved Manufacturers:
 1. Redi-Rock Retaining Wall Systems
 2. Or approved equal

- O. Substitutions: Alternative precast modular block retaining wall systems may be submitted for approval provided they demonstrate compliance with this specification, including material properties, connection capacity, durability, and design methodology.

- P. Value Engineering Alternatives. The owner may evaluate and accept systems that meet the requirements of this specification after the bid date that provide a minimum cost savings of 20% to the Owner. Construction expediency will not be considered as a contributing portion of the cost savings total.

2.02 GEOGRID REINFORCEMENT

- A. Geogrid reinforcement shall be a woven or knitted PVC coated geogrid manufactured from high-tenacity PET polyester fiber with an average molecular weight greater than 25,000 ($M_n > 25,000$) and a carboxyl end group less than 30 ($CEG < 30$). The geogrid shall be furnished in prefabricated roll widths of certified tensile strength by the manufacturer. The prefabricated roll width of the geogrid shall be 12 in (300 mm) +/- 1/2 in (13 mm). Geogrid shall be installed in accordance with manufacturer recommendations and approved design.

- B. The ultimate tensile strength (T_{ult}) of the geogrid reinforcement shall be measured in accordance with ASTM D6637.

- C. Geogrid – Soil Friction Properties
 1. Friction factor, F^* , shall be equal to $2/3 \tan \phi$, where ϕ is the effective angle of internal friction of the reinforced fill soil.
 2. Linear Scale Correction Factor, α , shall equal 0.8.

- D. Long-Term Tensile Strength (T_{at}) of the geogrid reinforcement shall be calculated in accordance with Section 3.5.2 of FHWA-NHI-10-024 and as provided in this specification.
 1. The creep reduction factor (RF_{CR}) shall be determined in accordance with Appendix D of FHWA-NHI-10-025 for a minimum 75 year design life.

2. Minimum installation damage reduction factor (RF_{ID}) shall be 1.25. The value of RF_{ID} shall be based upon documented full-scale tests in a soil that is comparable to the material proposed for use as reinforced backfill in accordance with ASTM D5818.
 3. Minimum durability reduction factor (RF_D) shall be 1.3 for a soil pH range of 3 to 9.
- E. Connection between the PMB retaining wall unit and the geogrid reinforcement shall be determined from short-term testing per the requirements of FHWA NHI-10-025, Appendix B.4 for a minimum 75-year design life.
- F. The minimum value of T_{al} for geogrid used in design of a reinforced precast modular block retaining wall shall be 2,000 lb/ft (29 kN/m) or greater.
- G. The minimum length of geogrid reinforcement shall be the greater of the following:
1. 0.7 times the wall design height, H.
 2. 6 ft (1.83 m).
 3. The length required by design to meet internal stability requirements, soil bearing pressure requirements and constructability requirements.
- H. Constructability Requirements. Geogrid design embedment length shall be measured from the back of the precast modular block facing unit and shall be consistent for the entire height of a given retaining wall section.
- I. Geogrid shall be positively connected to every precast modular block unit. Design coverage ratio, R_c , as calculated in accordance with AASHTO LRFD Bridge Design Specifications Figure 11.10.6.4.1-2 shall not exceed 0.50.
- J. Preapproved Geogrid Reinforcement Products.
1. Miragrid XT Geogrids as manufactured by TenCate Geosynthetics of Pendergrass, Georgia USA and distributed by Manufacturers of the Redi-Rock Retaining Wall System.
- K. Substitutions: Geogrid reinforcement shall meet the design requirements specified herein and conform to ASTM D6637. Alternative products may be submitted for approval.

2.03 GEOTEXTILE

- A. Nonwoven geotextile fabric shall be placed as indicated on the retaining wall construction shop drawings. Additionally, the nonwoven geotextile fabric shall be placed in the v-shaped joint between adjacent block units on the same course. The nonwoven geotextile fabric shall meet the requirements Class 3 construction survivability in accordance with AASHTO M 288.
- B. Preapproved Nonwoven Geotextile Products
1. Mirafi 140N
 2. Propex Geotex 451

3. Skaps GT-142
4. Thrace-Linq 140EX
5. Carthage Mills FX-40HS
6. Stratatex ST 142

2.04 DRAINAGE AGGREGATE AND WALL INFILL

- A. Drainage aggregate (and wall infill for retaining walls designed as modular gravity structures) shall be a durable crushed stone conforming to No. 57 size per ASTM C33 with the following particle-size distribution requirements per ASTM D6913:

| U.S. Standard <u>Sieve Size</u> | <u>% Passing</u> |
|------------------------------------|------------------|
| 1-1/2 in (38 mm) | 100 |
| 1 in (25 mm) | 95-100 |
| 1/2 in (13 mm) | 25-60 |
| No. 4 (4.76 mm) | 0-10 |
| No. 8 (2.38 mm) | 0-5 |

2.05 REINFORCED FILL

- A. Material used as reinforced backfill material in the reinforced zone (if applicable) shall be a granular fill material meeting the requirements of USCS soil type GW, GP, SW or SP per ASTM D2487 or alternatively by AASHTO Group Classification A-1-a or A-3 per AASHTO M 145. The backfill shall exhibit a minimum effective internal angle of friction, $\phi = 34$ degrees at a maximum 2% shear strain and meet the following particle-size distribution requirements per ASTM D6913.

| U.S. Standard <u>Sieve Size</u> | <u>% Passing</u> |
|------------------------------------|------------------|
| 3/4 in (19 mm) | 100 |
| No. 4 (4.76 mm) | 0-100 |
| No. 40 (0.42 mm) | 0-60 |
| No. 200 (0.07 mm) | 0-15 |

- B. The reinforced backfill material shall be free of sod, peat, roots or other organic or deleterious matter including, but not limited to, ice, snow or frozen soils. Materials passing the No. 40 (0.42 mm) sieve shall have a liquid limit less than 25 and plasticity index less than 6 per ASTM D4318. Organic content in the backfill material shall be less than 1% per AASHTO T-267 and the pH of the backfill material shall be between 5 and 8.
- C. Soundness. The reinforced backfill material shall exhibit a magnesium sulfate soundness loss of less than 30% after four (4) cycles, or sodium sulfate soundness loss of less than 15% after five (5) cycles as measured in accordance with AASHTO T-104.

- D. Reinforced backfill shall not be comprised of crushed or recycled concrete, recycled asphalt, bottom ash, shale or any other material that may degrade, creep or experience a loss in shear strength or a change in pH over time.

2.06 LEVELING PAD

- A. The precast modular block units shall be placed on a leveling pad constructed from crushed stone or unreinforced concrete. The leveling pad shall be constructed to the dimensions and limits shown on the retaining wall design drawings prepared by the RWDE.
- B. Crushed stone used for construction of a granular leveling pad shall meet the requirements of the drainage aggregate and wall infill in section 2.04 or a preapproved alternate material.
- C. Concrete used for construction of an unreinforced concrete leveling pad shall satisfy the criteria for AASHTO Class B. The concrete should be cured a minimum of 12 hours prior to placement of the precast modular block wall retaining units and exhibit a minimum 28-day compressive strength of 2,500 psi (17.2 MPa).

2.07 DRAINAGE

- A. Drainage Pipe
 - 1. Drainage collection pipe shall be a 4 in (100 mm) diameter, 3-hole perforated, HDPE pipe with a minimum pipe stiffness of 22 psi (152 kPa) per ASTM D2412.
 - 2. The drainage pipe shall be manufactured in accordance with ASTM D1248 for HDPE pipe and fittings.
- B. Preapproved Drainage Pipe Products
 - 1. ADS 3000 Triple Wall pipe as manufactured by Advanced Drainage Systems, or Equal.

PART 3 – EXECUTION

3.01 GENERAL

- A. All work shall be performed in accordance with OSHA safety standards, state and local building codes and manufacturer's requirements.
- B. The General Contractor is responsible for the location and protection of all existing underground utilities. Any new utilities proposed for installation in the vicinity of the retaining wall, shall be installed concurrent with retaining wall construction. The General Contractor shall coordinate the work of subcontractors affected by this requirement.

- C. New utilities installed below the retaining wall shall be backfilled and compacted to a minimum of 98% maximum dry density per ASTM D698 standard proctor.
- D. The General Contractor is responsible to ensure that safe excavations and embankments are maintained throughout the course of the project.
- E. All work shall be inspected by the Inspection Engineer as directed by the Owner.

3.02 EXAMINATION

- A. Prior to construction, the General Contractor, Grading Contractor, RWIC and Inspection Engineer shall examine the areas in which the retaining wall will be constructed to evaluate compliance with the requirements for installation tolerances, worker safety and any site conditions affecting performance of the completed structure. Installation shall proceed only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

- A. Fill Soil.
 - 1. The Inspection Engineer shall verify that reinforced backfill placed in the reinforced soil zone satisfies the criteria of this section.
 - 2. The Inspection Engineer shall verify that any fill soil installed in the foundation and retained soil zones of the retaining wall satisfies the specification of the RWDE as shown on the construction drawings.
- B. Excavation.
 - 1. The Grading Contractor shall excavate to the lines and grades required for construction of the precast modular block retaining wall as shown on the construction drawings. The Grading Contractor shall minimize over-excavation. Excavation support, if required, shall be the responsibility of the Grading Contractor.
 - 2. Over-excavated soil shall be replaced with compacted fill in conformance with the specifications of the RWDE and "Division 31, Section 31 20 00 – Earthmoving" of these project specifications.
 - 3. Embankment excavations shall be bench cut as directed by the project Geotechnical Engineer and inspected by the Inspection Engineer for compliance.
- C. Foundation Preparation.
 - 1. Prior to construction of the precast modular block retaining wall, the leveling pad area and undercut zone (if applicable) shall be cleared and grubbed. All topsoil, brush, frozen soil and organic material shall be removed. Additional foundation soils found to be unsatisfactory beyond the specified undercut limits shall be undercut and replaced with approved fill as directed by the project Geotechnical Engineer. The Inspection Engineer shall ensure that the undercut limits are consistent with the requirements of the project

Geotechnical Engineer and that all soil fill material is properly compacted in accordance with project specifications. The Inspection Engineer shall document the volume of undercut and replacement.

2. Following excavation for the leveling pad and undercut zone (if applicable), the Inspection Engineer shall evaluate the in-situ soil in the foundation and retained soil zones.
 - a. The Inspection Engineer shall verify that the shear strength of the in-situ soil assumed by the RWDE is appropriate. The Inspection Engineer shall immediately stop work and notify the Owner if the in-situ shear strength is found to be inconsistent with the retaining wall design assumptions.
 - b. The Inspection Engineer shall verify that the foundation soil exhibits sufficient ultimate bearing capacity to satisfy the requirements indicated on the retaining wall construction shop drawings per paragraph 1.06 I of this section.
- D. Leveling Pad.
1. The leveling pad shall be constructed to provide a level, hard surface on which to place the first course of precast modular block units. The leveling pad shall be placed in the dimensions shown on the retaining wall construction drawings and extend to the limits indicated.
 2. Crushed Stone Leveling Pad. Crushed stone shall be placed in uniform maximum lifts of 6 in (150 mm). The crushed stone shall be compacted by a minimum of 3 passes of a vibratory compactor capable of exerting 2,000 lb (8.9 kN) of centrifugal force and to the satisfaction of the Inspection Engineer.
 3. Unreinforced Concrete Leveling Pad. The concrete shall be placed in the same dimensions as those required for the crushed stone leveling pad. The RWIC shall erect proper forms as required to ensure the accurate placement of the concrete leveling pad according to the retaining wall construction drawings.

3.04 PRECAST MODULAR BLOCK WALL SYSTEM INSTALLATION

- A. The precast modular block structure shall be constructed in accordance with the construction drawings, these specifications and the recommendations of the retaining wall system component manufacturers. Where conflicts exist between the manufacturer's recommendations and these specifications, these specifications shall prevail.
- B. Drainage components. Pipe, geotextile and drainage aggregate shall be installed as shown on the construction shop drawings.
- C. Precast Modular Block Installation
 1. The first course of block units shall be placed with the front face edges tightly abutted together on the prepared leveling pad at the locations and elevations shown on the construction drawings. The RWIC shall take special care to ensure that the bottom course of block units are in full contact with the leveling pad, are set level and true and are properly aligned according to the locations shown on the construction drawings.

2. Backfill shall be placed in front of the bottom course of blocks prior to placement of subsequent block courses. Nonwoven geotextile fabric shall be placed in the V-shaped joints between adjacent blocks. Drainage aggregate shall be placed in the V-shaped joints between adjacent blocks to a minimum distance of 12 in (300 mm) behind the block unit. If stone infill of hollow core blocks exceeds 45% of the block design volume, drainage aggregate will not be required to extend beyond the back of the blocks, with the approval of the RWDE.
 3. Drainage aggregate shall be placed in 9 in (230 mm) maximum lifts and compacted by a minimum of three (3) passes of a vibratory plate compactor capable exerting a minimum of 2,000 lb (8.9 kN) of centrifugal force.
 4. Unit core fill shall be placed in the precast modular block unit vertical core slot. The core fill shall completely fill the slot to the level of the top of the block unit. The top of the block unit shall be broom-cleaned prior to placement of subsequent block courses. No additional courses of precast modular blocks may be stacked before the unit core fill is installed in the blocks on the course below.
 5. Base course blocks for gravity wall designs (without geosynthetic soil reinforcement) may be furnished without vertical core slots. If so, disregard item 4 above, for the base course blocks in this application.
 6. Nonwoven geotextile fabric shall be placed between the drainage aggregate and the retained soil (gravity wall design) or between the drainage aggregate and the reinforced fill (reinforced wall design) as required on the retaining wall construction drawings.
 7. Subsequent courses of block units shall be installed with a running bond (half block horizontal course-to-course offset). With the exception of 90-degree corner units, the shear channel of the upper block shall be fully engaged with the shear knobs of the block course below. The upper block course shall be pushed forward to fully engage the interface shear key between the blocks and to ensure consistent face batter and wall alignment. Geogrid, drainage aggregate, unit core fill, geotextile and properly compacted backfill shall be complete and in-place for each course of block units before the next course of blocks is stacked.
 8. The elevation of retained soil fill shall not be less than 1 block course (18 in (457 mm)) below the elevation of the reinforced backfill throughout the construction of the retaining wall.
 9. If included as part of the precast modular block wall design, cap units shall be secured with an adhesive in accordance with the precast modular block manufacturer's recommendation.
- D. Geogrid Reinforcement Installation (if required)
1. Geogrid reinforcement shall be installed at the locations and elevations shown on the construction drawings on level fill compacted to the requirements of this specification.
 2. Continuous 12 in (300 mm) wide strips of geogrid reinforcement shall be passed completely through the vertical core slot of the precast modular block unit and extended to the embedment length shown on the construction plans. The strips shall be staked or anchored as necessary to maintain a taut condition.

3. Reinforcement length (L) of the geogrid reinforcement is measured from the back of the precast modular block unit. The cut length (L_c) is two times the reinforcement length plus additional length through the block facing unit. The cut length is calculated as follows:

$$L_c = 2*L + 3 \text{ ft } (2*L + 0.9 \text{ m}) \text{ (28 in (710 mm) block unit)}$$

$$L_c = 2*L + 5 \text{ ft } (2*L + 1.5 \text{ m}) \text{ (41 in (1030 mm) block unit)}$$

4. The geogrid strip shall be continuous throughout its entire length and may not be spliced. The geogrid shall be furnished in nominal, prefabricated roll widths of 12 in (300 mm)+/- 1/2 in (13 mm). No field modification of the geogrid roll width shall be permitted.
5. Neither rubber tire nor track vehicles may operate directly on the geogrid. Construction vehicle traffic in the reinforced zone shall be limited to speeds of less than 5 mph (8 km/hr) once a minimum of 9 in (230 mm) of compacted fill has been placed over the geogrid reinforcement. Sudden braking and turning of construction vehicles in the reinforced zone shall be avoided.
- E. Construction Tolerance. Allowable construction tolerance of the retaining wall shall be as follows:
1. Deviation from the horizontal alignment of the wall face shall not exceed a 1/200 ratio when measured along straight wall section and shall not exceed 2 in (50 mm) from staked location.
 2. The maximum allowable offset (horizontal bulge) of the face in any precast modular block joint shall be 1/2 in (13 mm).
 3. The base of the precast modular block wall excavation shall be within 2 in (50 mm) of the staked elevations, unless otherwise approved by the Inspection Engineer.
 4. Differential vertical settlement of the face shall not exceed a 1/100 ratio of wall length and shall not exceed 3 in (75 mm).
 5. The maximum allowable vertical displacement of the face in any precast modular block joint shall be 1/2 in (13 mm).
 6. Deviation from the overall design batter shall not exceed 1° from vertical.
 7. Refer to local project requirements for additional allowable construction tolerances.

3.05 WALL INFILL AND REINFORCED BACKFILL PLACEMENT

- A. Backfill material placed immediately behind the drainage aggregate shall be compacted as follows:
1. 98% of maximum dry density at $\pm 2\%$ optimum moisture content per ASTM D698 standard proctor or 85% relative density per ASTM D4254.
- B. Compactive effort within 3 ft (0.9 m) of the back of the precast modular blocks should be accomplished with walk-behind compactors. Compaction in this zone shall be within 95% of maximum dry density as measured in accordance with ASTM D698 standard proctor or 80%

- relative density per ASTM D 4254. Heavy equipment should not be operated within 3 ft (0.9 m) of the back of the precast modular blocks.
- C. Backfill material shall be installed in lifts that do not exceed a compacted thickness of 9 in (230 mm).
 - D. At the end of each work day, the RWIC shall grade the surface of the last lift of the granular wall infill to a $3\% \pm 1\%$ slope away from the precast modular block wall face and compact it.
 - E. The General Contractor shall direct the Grading Contractor to protect the precast modular block wall structure against surface water runoff at all times through the use of berms, diversion ditches, silt fence, temporary drains and/or any other necessary measures to prevent soil staining of the wall face, scour of the retaining wall foundation or erosion of the reinforced backfill or wall infill.

3.06 OBSTRUCTIONS IN THE INFILL AND REINFORCED FILL ZONE

- A. The RWIC shall make all required allowances for obstructions behind and through the wall face in accordance with the approved construction shop drawings.
- B. Should unplanned obstructions become apparent for which the approved construction shop drawings do not account, the affected portion of the wall shall not be constructed until the RWDE can appropriately address the required procedures for construction of the wall section in question.

3.07 COMPLETION

- A. For walls supporting unpaved areas, a minimum of 12 in (300 mm) of compacted, low-permeability fill shall be placed over the granular wall infill zone of the precast modular block retaining wall structure. The adjacent retained soil shall be graded to prevent ponding of water behind the completed retaining wall.
- B. For retaining walls with crest slopes of 5H:1V or steeper, silt fence shall be installed along the wall crest immediately following construction. The silt fence shall be located 3 ft to 4 ft (0.9 m to 1.2 m) behind the uppermost precast modular block unit. The crest slope above the wall shall be immediately seeded to establish vegetation. The General Contractor shall ensure that the seeded slope receives adequate irrigation and erosion protection to support germination and growth.
- C. The General Contractor shall confirm that the as-built precast modular block wall geometries conform to the requirements of this section. The General Contractor shall notify the Owner of any deviations.

END OF SECTION 02832