



## **TECHNICAL SPECIFICATIONS**

### **MODULE 6 BASE LINER SYSTEM REVISION 0**

### **WESTERN REGIONAL SANITARY LANDFILL Placer County, California**

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PREVIEW

**DIVISION 2**

**SITE WORK**

**SECTION 02110**  
**CLEARING, GRUBBING, AND STRIPPING**

**PART 1: GENERAL**

**1.01 DESCRIPTION**

- A. This section describes the general material and construction requirements for clearing, grubbing, and stripping of vegetation associated with the construction of the Module 6 Base Liner System at WRS�.

**1.02 RELATED SECTIONS**

- A. Section 02200 - Earthwork

**1.03 REFERENCES**

- A. Construction Quality Assurance (CQA) Plan.

**1.04 SUBMITTALS**

- A. Submit written notice of intent to perform clearing, grubbing, or stripping to the Owner at least 7 days in advance of performing these activities.

**PART 2: PRODUCTS**

Not Used

**PART 3: EXECUTION**

**3.01 PROTECTION**

- A. Protect plant growth and features remaining outside of construction areas.
- B. Maintain site access for disposal operations.
- C. Locate and protect any existing utilities and monitoring wells onsite. Damage caused to existing utilities or wells by CONTRACTOR or its subcontractors shall be repaired by the CONTRACTOR at no added cost to the Owner.

**3.02 CLEARING, GRUBBING, AND STRIPPING**

- A. Clearing shall consist of cutting, removing, and disposing of all vegetation including trees, snags, stumps, shrubs, limbs, and other vegetative growth. Coordinate with Owner to confirm Owner has obtained any required tree removal permits.
- B. Grubbing shall consist of the removal and disposal of wood or root matter below the ground surface remaining after clearing and shall include stumps, trunks, roots, or root systems to a minimum depth of 6 inches below the ground surface.
- C. Stripping shall include the removal and disposal of all organic sod, topsoil, plant growth and associated roots. Stripping shall extend to the bottom of the root zone.
- D. Coordinate disposal of clearing and grubbing debris with the Owner. No burning of debris will be permitted.
- E. All cut and fill areas will be cleared, grubbed, and stripped prior to filling or grading to design elevations.
- F. Topsoil from the strippings will be stockpiled at a location designated by the Owner.
- G. Conduct operations and maintain the project site so as to minimize dust creation and dispersion.

**END OF SECTION**

**SECTION 02169**  
**PROTECTIVE PLYWOOD COVER**

**PART 1: GENERAL**

**1.01 DESCRIPTION**

- A. This section describes the furnishing and installation of plywood and “tee”- posts over termination points of geomembrane associated with the construction of the Module 6 Base Liner System at WRS�.

**1.02 RELATED SECTIONS**

- A. Section 02200 – Earthwork  
B. Section 02771 – Geomembrane  
C. Section 02772 – Geotextile

**PART 2: PRODUCTS**

**2.01 PLYWOOD**

- A. New 4' x 8' x ½" CDX plywood, mill reject.

**PART 3: EXECUTION**

**3.01 INSTALLATION**

- A. Install consistent with the details shown on the Construction Drawings.

**END OF SECTION**

## SECTION 02200

### EARTHWORK

#### PART 1: GENERAL

##### 1.01 DESCRIPTION

- A. This section describes the requirements for general earthworks including engineered fill and general earthfill placement, excavation, and subgrade preparation associated with the construction of the Module 6 Base Liner System at WRSL.

##### 1.02 RELATED SECTIONS

- A. Section 02110 – Clearing, Grubbing, and Stripping

##### 1.03 REFERENCES

- A. Latest version of American Society for Testing and Materials (ASTM) standards:
  - 1. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil In Place by the Sand-Cone Method
  - 2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soils using Modified Effort
  - 3. ASTM D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
  - 4. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes
  - 5. ASTM D2937 - Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
  - 6. ASTM D4220 - Standard Practices for Preserving and Transporting Soil Samples
  - 7. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
  - 8. ASTM D4643 - Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
  - 9. ASTM D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
  - 10. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- B. Construction Quality Assurance Plan

##### 1.04 SUBMITTALS

- A. CONTRACTOR shall notify the Owner in writing a minimum of 7 days prior to starting work under this Section.
- B. Submit copies of any permits that may be required to the Owner prior to start of work.
- C. Submit a Health and Safety Plan to the Owner.

##### 1.05 QUALITY ASSURANCE

- A. Observation, sampling and testing will be performed by the CQA Engineer or the Owner's designee to confirm that the materials and construction are in compliance with the requirements of these specifications and the CQA Plan. Make allowances for sampling and testing by the CQA Engineer in both production and scheduling.

##### 1.06 SAFETY

- A. CONTRACTOR is solely responsible for performing work in a safe manner and complying with all applicable local, state, and federal codes, ordinances, laws, and regulations.

## **PART 2: PRODUCTS**

### **2.01 ENGINEERED FILL**

- A. Engineered fill shall consist of soil free from significant amounts of organic materials, loam, wood, trash, or other deleterious materials. Engineered fill shall not contain particles larger than 6 inches in the largest dimension.
- B. Engineered fill shall consist of soil free from organic materials, loam, wood, trash, broken concrete, or other deleterious materials. The engineered fill shall contain a maximum particle size of 3-inches and shall consist of soil classified as SC, SM, or CL in accordance with the Unified Soil Classification System (USCS).
- C. Engineered fill placed within 12 inches of any geosynthetics shall have a maximum particle size of ½-inches.

### **2.02 LINER SUBGRADE**

- A. The upper 6 inches of the finished soil surface in lined areas is considered the liner subgrade. The liner subgrade shall consist of soil free from significant amounts of organic materials, loam, wood, trash, or other deleterious materials, and shall not contain particles larger than 1-inch in the largest dimension. Liner subgrade material shall be classified as SC, SM, or SW in accordance with the Unified Soils Classification System. If the upper six inches does not meet this requirement, the Contractor shall over-excavate and replace with acceptable material at no accost to the Owner.

### **2.03 OTHER SOIL MATERIALS**

- A. Gravel material shall conform to the requirements of Section 02223.
- B. Operations layer material shall conform to the requirements of Section 02225.

## **PART 3: EXECUTION**

### **3.01 EXCAVATION**

- A. Contractor shall take the necessary precautions to maintain the site in a condition that is relatively dry and free of standing water. CONTRACTOR shall be responsible for removing water that accumulates within the footprint of the excavation. The CONTRACTOR will be responsible for dewatering the excavation areas and for directing water encountered during the excavation to drain as directed by the Owner.
- B. Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of the soils below the limits of the excavation. Soils which become soft, loose, or otherwise unsatisfactory for support of structures as a result of inadequate excavation, dewatering, or other construction methods shall be removed and replaced with suitable general fill at no additional cost to the Owner.
- C. Temporary and final slopes in the borrow and/or soil stockpile area(s) shall not be steeper than 2 horizontal to 1 vertical.
- D. If the bottom of any excavation is taken below the limits shown on the Drawings, it shall be refilled by the Contractor, moisture conditioned, and compacted in accordance with the requirements for engineered fill in this Section at no additional cost to the owner.
- E. Excavated soils and rock shall be placed in a stockpile as designated by the Owner. The CONTRACTOR may use this material as general fill if it meets the requirements of Part 2.01 of this specification section.

### **3.02 PREPARATION FOR FILL PLACEMENT**

- A. Before placing fill materials, prepare the area by clearing existing obstructions, vegetation, and debris in accordance with Section 02110 – Site Clearing, Grubbing and Stripping.
- B. Maintain and operate proper and adequate surface drainage to the satisfaction of the CQA Engineer in order to keep the site dry and in such conditions that placement and compaction of fill may proceed unhindered by saturation of the area.
- C. If surface soil in fill placement areas is poorly compacted or excessively soft to a depth of greater than 6 inches, remove affected soil to competent material and replace in

accordance with earthfill placement methods.

### **3.03 ENGINEERED FILL**

- A. Obtain Engineered Fill materials from approved excavation or borrow areas.
- B. The Engineered Fill shall be placed to the lines, grades and elevations shown on the Construction Drawings or as directed in the field by the Engineer.
- C. Prior to Engineered Fill placement, the subgrade shall be lightly scarified, moisture conditioned, and compacted to provide a firm and non-yielding surface. Soft or excessively wet areas shall be over-excavated a minimum of 2 feet to firm material and shall be backfilled and compacted with engineered fill.
- D. The Engineered Fill material shall be placed and compacted in loose lifts that result in a nominal compacted thickness of 6 inches.
- E. All Engineered Fill material placed on slopes steeper than 4H:1V shall be benched. For each 6-inch lift of engineered fill placed against existing or general earthfill slopes, each lift shall be keyed into the existing or general earthfill slopes. Key or Bench heights for the engineered fill shall be equal to compacted lift thickness not to exceed 6 inches for either dimension, or as agreed in the field with the ENGINEER.
- F. Each lift of Engineered Fill shall be compacted to at least 90 percent of the maximum dry density and to a moisture content within -3 to +3 percent of optimum as determined by ASTM D1557. The first lift of anchor trench backfill shall be compacted to at least 85 percent of the maximum dry density according to ASTM D1557 at the moisture content range given above.
- G. The Contractor is responsible for moisture conditioning the borrow soils to the required moisture range. This may include drying for overly wet soils or may include addition of moisture for drier soils.
- H. If new engineered fill is placed next to existing engineered fill, each lift of new engineered fill shall be keyed into the existing engineered fill.
- I. In the event of a failing test, supplemental testing will be performed to define the area that has been inadequately compacted. Material not meeting specified compaction criteria shall be reworked or replaced, at no additional cost to the Owner, and then retested prior to subsequent lift placement over the area.
- J. Grade and restore areas inadvertently disturbed during construction to their original grade and profile.
- K. Water used for moisture conditioning shall be obtained from sources approved by the Owner.
- L. The entire area shall be left in a manner to promote run-off at the end of each day.
- M. Final grading shall be completed to the lines and grades shown on the Construction Drawings and within the specified tolerances. The final surface shall be smooth, firm, non-yielding, and free from debris or other deleterious material.
- N. Where finish grades require seeding, final grades shall be track-walked perpendicular to slope contours so that track marks are parallel to the contours.

### **3.04 LINER SUBGRADE**

- A. The upper six inches of the liner subgrade shall be scarified, moisture conditioned and compacted to the moisture-density requirements specified for general fill. The final surface of the liner subgrade shall not contain particles larger than 1-inch in the largest dimension and no protrusions larger than 3/8-inch. Contractor shall use hand-labor as necessary to remove rocks larger than 1/2-inch from the subgrade surface. Prior to acceptance of the liner subgrade, the CQA Monitor shall inspect the surface and identify areas not meeting this requirement.
- B. If the exposed native soils and/or compacted general fill do not meet the particle-size requirements in Article 2.02A, the upper 6 inches of the subgrade surface shall be over-excavated and replaced with compacted foundation soils meeting the requirements of Article 2.02.A and compacted to the moisture-density requirements specified for general



fill.

### **3.05 TOLERANCES**

- C. All subgrade excavation and fill limits shall be constructed within a tolerance of  $\pm 1.0$  ft for horizontal state plan coordinates, and within +0.1 to -0.1 ft vertical for reference to mean sea level (MSL). All grading shall be performed to maintain slopes and drainage as shown on the Construction Drawings.
- D. A Surveyor licensed in the State of California shall prepare as-built documentation to confirm that the tolerances are as required. The as-built documentation shall be reviewed by the CQA Engineer for approval prior to placement of subsequent layers. As-built documentation is required for finished subgrade.

### **3.06 DUST CONTROL**

- A. The CONTRACTOR is required to implement dust control measures as necessary to minimize dust generation during all construction activities.

### **3.07 EROSION CONTROL**

- A. Throughout the construction period, the CONTRACTOR shall install adequate Best Management Practices (BMPs) whenever a precipitation event is forecast for the site.

### **3.08 STOCKPILING**

- A. Stockpile soils in location designated by Owner.
- B. Final side-slopes shall be inclined no steeper than 2H:1V.
- C. At the completion of the soil stockpiling, the top of the stockpile shall be graded to provide positive drainage.
- D. Track-walk side-slopes to provide a relatively firm and even surface.

**END OF SECTION**

## SECTION 02223

### GRAVEL

#### PART 1: GENERAL

##### 1.01 DESCRIPTION

- A. This section describes the requirements for placement of the LCRS gravel associated with construction of the Module 6 Base Liner System at WRS�.

##### 1.02 RELATED SECTIONS

- A. Section 02200 – Earthwork  
B. Section 02725 – HDPE Pipe and Fittings  
C. Section 02751 – HDPE Geomembranes  
D. Section 02755 – Geocomposites and Geonet

##### 1.03 REFERENCES

- A. Latest Version of American Society for Testing and Materials (ASTM) standards:
1. ASTM C136 - Standard Test Method for Particle-Size Analysis of Fine and Coarse Aggregate
  2. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head)
  3. ASTM D5821 - Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
- B. Construction Quality Assurance (CQA) Plan.

##### 1.04 SUBMITTALS

- A. Submit gravel samples at least 7 days prior to full-scale production for testing by CQA Engineer.

##### 1.05 QUALITY ASSURANCE

- A. Perform in accordance with the CQA Plan.

#### PART 2: PRODUCTS

##### 2.01 LCRS GRAVEL

- A. Gravel shall be comprised of durable, sub-rounded gravel with no more than 25 percent of the 3/4-inch particles having more than one fractured face, as determined by ASTM D5821 and shall meet the following gradation requirements.

US Sieve Size	Percent Passing
3/4"	100
1/2"	50-100
No. 4	0-35
No. 200	0-2

- B. Gravel shall exhibit a permeability of 1.0 cm/sec or greater.

#### PART 3: EXECUTION

##### 3.01 PLACEMENT OF LCRS GRAVEL

- A. Place gravel in LCRS as shown in the Construction Drawings.  
B. Do not operate hauling or spreading equipment on the gravel. Spread and grade gravel using hand equipment to the maximum extent practical.  
C. Take precautions to prevent damage to underlying layers.  
D. Prevent excessive wrinkle development in the geomembrane. Excessive geomembrane

wrinkles shall be cut out and repaired in accordance with procedures described in Section 02751- HDPE Geomembranes at no cost to the Owner. To prevent wrinkles, the Contractor may place material in the early morning hours when the geosynthetic materials are cool and by monitoring and walking out wrinkles in the geosynthetic materials that appear at the face of the placement operations.

- E. Protect HDPE pipe from mechanical damage.
- F. The Contractor shall maintain the final surface of the gravel layer free of ruts, and depressions until the overlying materials are placed.
- G. During placement of the gravel, the Contractor shall apply clean water to the gravel surface to help maintain adequate moisture for the electrical leak location survey. Contractor shall apply water as directed by the CQA Engineer.

### **3.02 TOLERANCES**

- A. The final grade of the finished gravel for the LCRS gravel layer shall be within 0.0 to +0.1 ft of the design thickness, and shall be within -0.1 to +0.2 feet of the design elevations.
- B. A surveyor licensed in the State of California shall prepare an as-built, survey record drawing to confirm that the specified tolerances are met. The as-built record drawing shall be reviewed by the CQA Engineer for approval prior to placement of subsequent materials.

**END OF SECTION**

**SECTION 02225**  
**OPERATIONS LAYER**

**PART 1: GENERAL**

**1.01 DESCRIPTION**

- A. This section describes the requirements for placement of the operations layer associated with construction of the Module 6 Base Liner System at WRS�.

**1.02 RELATED SECTIONS**

- A. Section 02221 – Earthwork
- B. Section 02752 – Geotextiles
- C. Section 02755 – Geocomposites

**1.03 REFERENCES**

- A. Latest version of American Society for Testing and Materials (ASTM) standards
- B. Construction Quality Assurance (CQA) Plan

**1.04 SUBMITTALS**

- A. Provide written notice to CQA Engineer at least 7 days in advance of performing work under this section.

**PART 2: PRODUCTS**

**2.01 OPERATIONS LAYER MATERIAL**

- A. Soil Operations Layer: The operations layer material shall consist of clean soil from the adjacent soil stockpile in Modules 7 and 8, free of metal and construction debris, stumps, and other deleterious material. The maximum allowable particle size (largest dimension) is 3/8-inch for material placed on the side slopes
- B. There is no permeability specification requirement for operations layer material placed on the side slopes.
- C. Material shall form a firm, stable base when placed.

**PART 3: EXECUTION**

**3.01 PLACEMENT**

- A. Soil operations layer shall be placed over the side slopes on top of the 60-mil double-sided textured geomembrane. Operations layer shall be placed to the thicknesses shown on the drawings.
- B. Prior to the placement of the operations layer material, final inspection of the geomembrane on the side slopes by the CQA Engineer will be made to verify integrity.
- C. Operations layer shall be pushed and spread using tracked grading equipment. Grading equipment shall have a maximum operating weight of 30 tons and a maximum ground pressure of 11 psi.
- D. Operations layer material placed on the side slopes shall be pushed from the bottom up the slope. In no case shall material be placed down the slope.
- E. The contractor shall take steps to minimize wrinkle generation in the underlying geosynthetic materials during placement of the operations layer. These measures may include placing material in the early morning hours when the geosynthetic materials are cool and monitoring and walking out wrinkles in the geosynthetic materials that appear at the face of the placement operation

**3.02 TOLERANCES**

- A. The final grade of the finished operations layer shall be within +0.1 feet of the design thickness and shall provide positive drainage. At the discretion of the Owner, the thickness may exceed the plus tolerance provided that positive drainage is maintained.

**END OF SECTION**

## SECTION 02230

### TRENCHING

#### PART 1: GENERAL

##### 1.01 DESCRIPTION

- A. This section describes the requirements for trenching, backfilling, and compacting as needed for installation of underground piping and drainage control systems associated with construction of the Module 6 Base Liner System at WRS�.

##### 1.02 RELATED SECTIONS

- A. Section 02221 – Earthwork
- B. Section 02723 – Corrugated Metal Pipe

##### 1.03 REFERENCES

- A. Caltrans Standard Specifications, 2010 Edition, Section 19-3.02E(2), Sand Beddings
- B. Occupational Safety and Health Administration (OSHA)

##### 1.04 SUBMITTALS

- A. Provide written notice to CQA Engineer at least 7 days in advance of performing work under this section.

#### PART 2: PRODUCTS

##### 2.01 BACKFILL MATERIAL

- A. Backfill material shall be free of organic materials, loam, wood, trash, broken concrete, or other deleterious materials.
- B. Backfill material shall be comprised of cohesionless material.
- C. Backfill material shall have a maximum particle size of 1½-inch.

#### PART 3: EXECUTION

##### 3.01 PREPARATION

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely, safe, and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.
- B. Comply with OSHA regulations and permit requirements.
- C. Free standing liquid may be encountered during excavation, especially in trenches. The liquid may be hazardous. Notify the Owner immediately. If free standing liquid is encountered, the Owner will determine how it is to be removed.

##### 3.02 GENERAL PROCEDURES

- A. Contractor shall remove all water, including rainwater, encountered during trench and sub-structure work to an approved location by pumps, drains, and other approved methods.
- B. Contractor shall keep trenches and site construction area free from standing water.

##### 3.03 TRENCHING

- A. Contractor shall comply with pertinent provisions of related sections.
- B. Trenching for pipes:
  - 1. Trench to the minimum width necessary for proper installation of pipe with sides as nearly vertical as possible. Uniformly grade the bottom to provide uniform bearing for the pipe.
  - 2. Where it becomes necessary to excavate beyond the limits of normal excavation lines in order to remove boulders or other interfering objects, backfill the voids remaining after removal of the objects as directed by the CQA monitor.

3. When the void is below the subgrade for the pipe bedding, use select backfill to fill in the void.
  4. When the void is in the side of the trench or open cut, use select backfill to fill in the void.
  5. Remove boulders and other interfering objects, and backfill voids left by such removals, at no additional cost to the Owner.
- C. Depressions:
1. Except where rock is encountered, do not excavate below the depth indicated or specified.
  2. Where rock is encountered, over excavate rock to a minimum over depth of 4 inches below the trench depth indicated or specified.

### **3.04 BACKFILLING**

- A. General:
1. Backfill trenches to the ground surface with materials shown on the Construction Drawings.
  2. Reopen trenches which have been improperly backfilled. Refill and compact as specified, or otherwise correct to the approval of the Engineer.
  3. Do not allow or cause any of the work performed or installed to be covered up or enclosed by work of this Section prior to required inspections, tests, and approvals.
  4. Should any of the work be so enclosed or covered up before it has been approved, uncover all such work and, after approvals have been made, refill and compact as specified, all at no additional cost to the Owner.
- B. Bedding and Backfill Around Pipes:
1. Take special care in bedding and backfilling operations to not damage pipe and pipe coatings.
  2. Place pipe bedding material to the thickness as shown on Construction Drawings. Lightly tamp bedding material under pipe haunches to compact.
  3. Place backfill material to completely surround pipe without voids.
  4. Place backfill material in layers not exceeding 8 inches in thickness, and compact to 90 percent relative compaction of ASTM D1557 at 3 percent below to 3 percent above optimum moisture content.

### **3.05 FIELD QUALITY ASSURANCE**

- A. The CQA Monitor representative will inspect open cuts and trenches before installation of pipes, and will make the following tests:
1. Assure that trenches are not backfilled until all tests have been completed.
  2. Check backfilling for proper layer thickness and compaction.
  3. Verify that test results conform to the specified requirements, and that sufficient tests are performed.
  4. Assure that defective work is removed and properly replaced.

**END OF SECTION**

**SECTION 02373**  
**CORRUGATED METAL PIPE**

**PART 1: GENERAL**

**1.01 DESCRIPTION**

- A. This section describes the requirements for trenching, backfilling, and compacting as needed for installation of underground piping and drainage control systems associated with construction of the Module 6 Base Liner System at WRSL.

**1.02 RELATED SECTIONS**

- A. Section 02221 – Earthwork
- B. Section 02230 – Trenching

**1.03 REFERENCES**

- A. State of California, Department of Transportation, Standard Specifications and Standard Plans, 2018 edition.

**1.04 SUBMITTALS**

- A. Provide written notice to CQA Engineer at least 7 days in advance of performing work under this section.
- B. In accordance with Section 01300, the Contractor shall submit, prior to delivery, manufacturer's specifications stating that the piping meets or exceeds the requirements presented in this Specification and as shown on the Drawings.

**PART 2: PRODUCTS**

**2.01 CORRUGATED METAL PIPE**

- A. Corrugated metal pipe shall comply with Sections 66-1.01, 66-1.02, and either Section 66-2 of the Caltrans Standard Specifications, if aluminum, or Section 66-3 of the Caltrans Standard Specifications, if steel.

**PART 3: EXECUTION**

**3.01 INSTALLATION**

- A. Installation of corrugated metal pipe shall comply with Section 66-1.05 through 66-1.07 of the Caltrans Standard Specifications.

**END OF SECTION**

**SECTION 02721**  
**DRAINAGE FACILITIES**

**PART 1: GENERAL**

**1.01 DESCRIPTION**

- A. This section describes the material and construction requirements for drainage facilities associated with the construction of the Module 6 Base Liner System at WRS�.

**1.02 RELATED SECTIONS**

- A. Section 02110 – Clearing, Grubbing, and Stripping
- B. Section 02200 – Earthworks

**1.03 REFERENCES**

- A. State of California Department of Transportation (CALTRANS), Standard Construction and Material Plans (Standard Plans), latest edition.
- B. State of California Department of Transportation (CALTRANS), Standard Construction and Material Specifications (Standard Specs), latest edition.
- C. American Association of State Highway and Transportation Officials (AASHTO), Standard Specifications for Transportation Materials, latest edition.

**PART 2: PRODUCTS**

**2.01 RIPRAP**

- A. Riprap shall be hard, durable, angular in shape, and resistance to degradation by weathering and abrasion. Unless otherwise specified in this section, it shall meet the requirements specified in the Caltrans Standard Specifications Section 72-2.02 Rock Slope Protection-Materials.
- B. Riprap shall meet the gradation specifications for Riprap as stated in the Caltrans Standard Specifications Section 72-2.02 Rock Slope Protection-Materials.
- C. Riprap materials not meeting the requirements listed herein must be approved by the Engineer prior to placement.
- D. Material used for Riprap shall not be acid producing.
- E. Geotextile to be placed below all riprap shall be 16 oz/sy and conform to Section 02772.

**PART 3: EXECUTION**

**3.01 DRAINAGE CHANNELS**

- A. Excavate drainage channels to the lines and grade indicated on the Drawings.
- B. Install erosion mat lining as required by the drawings and per manufacturer's recommendations.

**3.02 RIPRAP**

- A. Place Riprap as slope protection within channels as shown on the Construction Drawings and in accordance with Caltrans Standard Specifications Section 72.
- B. Place to the thicknesses shown on the Construction Drawings.
- C. Place Riprap with care to reduce segregation of material during placement.
- D. Smooth riprap using excavator or equivalent to provide a uniform surface approximating the designed surface shown on the Construction Drawings.

**3.03 TOLERANCES**

- A. The Contractor shall be responsible for installing all culvert, pipes, and ditches within the following tolerances:
  - 1. Vertical tolerance: 0.15 ft
  - 2. Maintain positive grades - no reverse slopes allowed at any location.



END OF SECTION

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**SECTION 02725**  
**HDPE PIPE AND FITTINGS**

**PART 1: GENERAL**

**1.01 DESCRIPTION**

- A. This section describes the material and construction requirements for the HDPE pipe and fittings associated with the construction of the Module 6 Base Liner System at WRSL.

**1.02 RELATED SECTIONS**

- A. Section 02200 – Earthworks  
B. Section 02223 – Gravel  
C. Section 02751 - HDPE Geomembranes  
D. Section 02755 – Geocomposite  
E. Section 02756 – Geosynthetic Clay Layer

**1.03 REFERENCES**

- A. Latest version of American Society for Testing and Materials (ASTM) standards:
1. ASTM D1505 Density of Plastics by the Density - Gradient Technique.
  2. ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics
  3. ASTM D1693 Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
  4. ASTM D2657 Standard Practices for Heat-Joining for Polyolefin Pipe and Fittings
  5. ASTM D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
  6. ASTM D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Material
  7. ASTM F714 Standard Specification for Polyethylene (PE) Plastics Pipe (SDR-PR) Based on Outside Diameter
- B. Construction Quality Assurance (CQA) Plan.

**1.04 SUBMITTALS**

- A. Submit detailed shop drawings of all HDPE pipe and fittings, pipe bands, a list of materials to be furnished, and the names of the suppliers. Submittals shall be made at least 7 days before the start of work.
- B. Submit manufacturer's quality control certificate for the HDPE pipe product meets the minimum physical property requirements.

**PART 2: PRODUCTS**

**2.01 HDPE MATERIALS**

- A. Specific gravity, as determined by ASTM D1505, shall be at least 0.94.
- B. Carbon black content, as determined by ASTM D1603, shall be at least 2.0 percent.

**2.02 HDPE PIPE, PIPE FITTINGS, AND VALVES**

- A. All HDPE pipe and fittings shall comply with ASTM F714.
- B. All HDPE pipe and fittings shall be comprised of Type IV piping manufactured from resin with a cell classification of 345464C per ASTM D3350. An alternative cell classification may be approved by the Engineer if the Engineer determines the pipe materials are considered functionally equivalent.
- C. HDPE pipe and fittings shall have a maximum Standard Diameter Ratio (SDR) as indicated on the Construction Drawings.
- D. HDPE solid pipe shall be furnished as specified on the Construction Drawings.

- E. HDPE pipe shall be furnished perforated as specified on the Construction Drawings. Perforations shall be drilled into the pipe after manufacture.
- F. HDPE pipes and fittings shall be homogeneous throughout and free of visible cracks, holes, (except as noted on the Construction Drawings), blisters, bubbles, undispersed raw materials, or any foreign inclusions or other deleterious effects.
- G. Fittings at the ends of pipes shall consist of HDPE end caps unless indicated otherwise on the Construction Drawings.
- H. Conveyance pipe shall be manufactured as double contained pipe with centralizers to center the inner pipe within the outer pipe.
- I. Valves shall have wetted parts that are resistant to corrosion by leachate. Valves shall be either ball valves or butterfly valves unless otherwise called out on the construction drawings.

### **PART 3: EXECUTION**

#### **3.01 INSTALLATION**

- A. HDPE Pipe, Pipe Fittings, and Valves
  - 1. All HDPE pipe and fittings shall be installed in accordance with the manufacturer's recommendations.
  - 2. Foreign material shall be removed from the interior of all pipe and fittings prior to welding.
  - 3. All joining or coupling of new pipe sections shall be accomplished by thermal butt fusion in accordance with ASTM D2657. No solvent or adhesive welding will be allowed. Field-cutting of pipes, where required, shall be made with a machine specifically designed for cutting pipe. Cuts shall be carefully made, without damage to pipe or lining, so as to leave a smooth end at right angles to the axis of the pipe.
  - 4. Joining of new pipe to existing pipe shall be completed through mechanical joining with blind flanges secured with stainless steel nuts and bolts or with thermal fusion couplers.
  - 5. Grind off the inner fusion weld beads for the LCRS sump riser pipes.
  - 6. All pipe and fittings shall be laid or placed to the lines, grades and elevations, with bedding and backfill, as shown on the Construction Drawings.
  - 7. Blocking under piping shall not be permitted.

#### **3.02 TOLERANCES**

- A. The CONTRACTOR shall be responsible for installing all HDPE piping within the following tolerances:
  - 1. Horizontal tolerance: 0.5 ft maximum
  - 2. Vertical tolerance: 0.15 ft maximum
  - 3. Maintain positive grades - no reverse slopes allowed at any location.

**END OF SECTION**

**SECTION 02751**  
**HDPE GEOMEMBRANES**

**PART 1: GENERAL**

**1.01 DESCRIPTION**

- A. This section describes the requirements for the manufacture, supply, installation, and quality control (QC) of High Density Polyethylene (HDPE) geomembranes associated with the construction of the Module 6 Base Liner System at WRSL.

**1.02 RELATED SECTIONS**

- A. Section 02200 – Earthwork  
B. Section 02223 – Gravel  
C. Section 02725 - HDPE Pipe and Fittings  
D. Section 02755 – Geocomposites and Geonet  
E. Section 02756 – Geosynthetic Clay Layer

**1.03 REFERENCES**

- A. Latest version of American Society for Testing and Materials (ASTM) standards:
1. ASTM D638 Test Method for Tensile Properties of Plastics
  2. ASTM D746 Test Method for Determination of Low Temperature Brittleness Properties
  3. ASTM D1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting
  4. ASTM D1204 Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature
  5. ASTM D1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
  6. ASTM D1505 Standard Test Method for Density of Plastics by Density-Gradient Technique
  7. ASTM D1603 Test Method for Carbon Black in Olefin Plastics
  8. ASTM D1693 Test Method for Environmental Stress Crack Resistance
  9. ASTM D4833 Test Method for Puncture Resistance of Geotextiles, Geomembranes, and Related Products
  10. ASTM D5199 Standard Test Method for Measuring the Nominal Thickness of Geomembranes
  11. ASTM D5321 Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
  12. ASTM D5596 Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
  13. ASTM D5994 Standard Test Method for Measuring the Core Thickness of Textured Geomembrane
  14. ASTM D6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using the Thermo-Fusion Methods
  15. ASTM D7002 Standard Practice for Leak Location on Exposed Geomembranes Using the Water Puddle System
  16. ASTM D7007 Standard Practice Standard Practices for Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earth Materials
- B. Latest version of Geosynthetics Research Institute (GRI) testing methods:
1. GRI-GM10 The Stress Crack Resistance of HDPE Geomembrane Sheet

2. GRI-GM13 Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
3. GRI-GM19 Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

C. Construction Quality Assurance (CQA) Plan

**1.04 SUBMITTALS**

- A. Production Data: Furnish the following in writing to the CQA Engineer a minimum of seven calendar days prior to geomembrane shipment to the site:
1. Resin:
    - a. Statement of production dates and origin of resin used to manufacture the geomembrane for the project.
    - b. Copies of the quality control certificates issued by the manufacturer and resin supplier indicating that the resin used to manufacture the geomembrane meets these specifications.
  2. Quality Control: A copy of the manufacturer's quality control program shall be submitted to the CQA Engineer a minimum of seven calendar days prior to geomembrane shipment to the site. Quality control testing shall be performed by the manufacturer in accordance with the test procedures, and frequency listed in the Quality Control Program and as approved by the CQA Engineer. Prior to delivery the following shall be submitted to the CQA Engineer for Review:
    - a. Certificates for each shift's production of geomembrane, statements of production dates.
    - b. Certification stating all geomembrane rolls are furnished by one manufacturer, and all rolls are manufactured from one resin type obtained from one resin supplier.
    - c. Copies of quality control certificates issued by the Manufacturer. The quality control certificates shall include:
      - i. Roll numbers and identification;
      - ii. Sampling procedures; and
      - iii. Results of quality control tests, including descriptions of the test methods used.
    - d. The results of the manufacturing quality control tests shall meet or exceed the property values listed in Table 02751-1.
    - e. Geomembrane delivery, storage, handling and installation instructions.
  3. Extrudate Beads and/or Rod:
    - a. Statement of production dates.
    - b. Certification stating all extrudate is from one manufacturer, is the same resin type, and was obtained from the same resin supplier as the resin used to manufacture the geomembrane rolls.
    - c. Copies of quality control certificates issued by the Manufacturer.
- B. Prior to mobilization of the Installer to the site, the INSTALLER shall submit the following information:
1. Shop drawings indicating panel layout and field seams 14 calendar days prior to installation of geomembrane.
  2. Installation schedule.
  3. Copy of Installer's letter of approval or license by the Geomembrane Manufacturer.
  4. Installation capabilities, including:
    - a. Information on equipment proposed for this project;

- b. Average daily production anticipated for this project; and
  - c. Quality control procedures.
- 5. Provide copies of the quality control/quality assurance program for the manufacturer of the geomembrane liner.
- 6. Resume of the superintendent to be assigned to this project, including dates and duration of employment.
- 7. Resumes of all personnel who will perform seaming operations on this project, including dates and duration of employment.
- 8. The installation crew shall have the following experience.
  - a. The superintendent shall have supervised the installation of a minimum of 2,000,000 ft<sup>2</sup> of polyethylene geomembrane and 500,000 ft<sup>2</sup> of geotextile.
  - b. The master seamer shall have experience seaming a minimum of 1,000,000 ft<sup>2</sup> of polyethylene geomembrane using the same type of seaming apparatus to be used at this site.
  - c. All other seaming personnel shall have seamed at least 100,000 ft<sup>2</sup> of polyethylene geomembrane using the same type of seaming apparatus to be used at this site. Personnel who have seamed less than 100,000 ft<sup>2</sup> of polyethylene geomembrane shall be allowed to seam only under the direct supervision of the master seamer or Superintendent.
- C. During the installation, the Installer shall be responsible for the timely submission to the CQA Engineer of subgrade acceptance certificates, signed by the Installer, for each area to be covered by geomembrane.
- D. The following shall be furnished to the Owner upon completion of the project:
  - 1. A 20-year written warranty provided by the manufacturer against defects in material. Warranty conditions concerning limits of liability will be evaluated and must be acceptable to the Owner.
  - 2. A 1-year warranty provided by the Geosynthetics Installer against defects in workmanship. Warranty conditions concerning limits of liability will be evaluated and must be acceptable to the Owner.
  - 3. As-built Panel Drawings provided by the Geosynthetics Installer.

## **1.05 QUALITY ASSURANCE**

- A. Perform work in accordance with the Installer's Quality Control Program and the Construction Quality Assurance Plan.
- B. Attend a pre-installation conference one week prior to commencing work of this section. Require attendance of parties directly affecting the work of this section.

## **PART 2: PRODUCTS**

### **2.01 DELIVERY, STORAGE AND HANDLING**

- A. Conform to the manufacturer's requirements to prevent damage to geomembrane.
- B. Delivery:
  - 1. Deliver materials to the site only after the CQA Engineer and the Owner approve required submittals.
  - 2. All rolls of geomembrane delivered to the site shall be identified at the factory with the following:
    - a. Manufacturer's name
    - b. Product identification
    - c. Lot number
    - d. Roll number

- e. Roll dimensions
- 3. Separate damaged rolls from undamaged rolls and store at locations designated by the Owner until proper disposition of material is determined by the Owner and the CQA Engineer.
- 4. The Owner will be the final authority regarding damage.
- 5. Separate rolls without proper documentation and store until the CQA Engineer approval is received.
- 6. The Contractor shall be responsible for offloading all geosynthetic materials
- C. On-Site Storage:
  - 1. Store in space allocated by the Owner.
  - 2. Protect from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat or other damage.
  - 3. Store on level prepared surface (not on wooden pallets).
  - 4. Stack per Manufacturer's recommendation but no more than three rolls high.
- D. On-Site Handling:
  - 1. Use appropriate handling equipment to load, move or deploy geomembrane rolls. Appropriate handling equipment includes cloth chokers and spreader bar for loading, spreader and roll bars for deployment. Dragging panels on ground surface will not be permitted.
  - 2. Do not fold geomembrane material; folded material shall be rejected.
  - 3. The installer is responsible for storage, and transporting material from storage area to liner facility.
- E. Damaged Geomembrane:
  - 1. Geomembrane damage will be documented by the CQA Engineer.
  - 2. Damaged geomembrane shall be repaired, if possible, in accordance with these specifications or shall be replaced at no additional cost to the Owner.

## 2.02 MATERIALS

- A. The geomembrane shall be comprised of high density polyethylene (HDPE) material as indicated on the Construction Drawings, manufactured of new, first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures.
- B. The geomembrane shall be produced free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter. Any such defect shall be repaired in accordance with the repair procedures in Article 3.06.
- C. The geomembrane shall be manufactured with a minimum of 20.0 feet seamless width. There shall be no factory seams.
- D. The geomembrane liner shall be 60 mil HDPE and shall be textured as shown in the Construction Drawings.
- E. The geomembrane shall be supplied in rolls; folds will not be permitted. Identify each roll with labels indicating lot number, roll number, thickness, length, width, manufacturer, and plant location.
- F. Specifications for HDPE geomembrane properties are presented in Table 02751-1 included at the end of this section. Supplied material shall conform to these properties based upon the manufacturer's QC testing and CQA conformance testing.
- G. The geomembrane shall meet the interface shear strength requirements of Table 02751-2 and be tested at a frequency of one test per test configuration (3 samples under different normal loads as specified).
- H. Resin:



1. Shall be HDPE and manufactured specifically for producing HDPE geomembrane.
  2. Do not intermix resin types.
- I. Extrudate Rod or Bead:
1. Shall be made from same resin as the geomembrane.
  2. Additives shall be thoroughly dispersed.
  3. Shall be free of contamination by moisture or foreign matter.

## **2.03 EQUIPMENT**

- A. Welding equipment and accessories shall meet the following requirements:
1. Equipped with gauges showing temperatures both in apparatus and at nozzle (extrusion welder) or at wedge (fusion welder).
  2. All welding equipment shall be capable of welding conductive geomembrane.
  3. Maintain adequate number of welding apparatus to avoid delaying work.
  4. Use power source capable of providing constant voltage under combined-line load.
  5. Provide secondary containment to catch spilled fuel under electric generator, if located on geomembrane.
- B. Provide calibrated tensiometer capable of quantitatively measuring geomembrane strength:
1. Equipped with gauge accurate to +2 lbs per inch of geomembrane width and capable of pulling at 2 inches per minute and 20 inches per minute.
  2. Provide one inch die for cutting sample specimens.
  3. Provide certificate of tensiometer calibration within the past 12-months.
- C. Provide calibrated air pressure gauges or new, factory calibrated air pressure gauges.

## **2.04 CONFORMANCE TESTING**

- A. Material that arrives at the site will be sampled and conformance tested by the CQA Engineer at a minimum frequency of one per 100,000 square feet of material continuously produced and supplied to the project, with a minimum of one sample per production lot. The Manufacturer shall pay for shipping the conformance samples by the CQA Engineer. Materials may be sampled at the plant at the option of the Owner.
- B. As a minimum, the following tests will be performed by a geosynthetics CQA laboratory and shall meet the requirements outlined in Table 02751-1.
1. Thickness (ASTM D5994)
  2. Specific Gravity (ASTM D1505)
  3. Carbon Black Content (ASTM D1603)
  4. Carbon Black Dispersion (ASTM D5596)
  5. Tensile Properties (ASTM D6693)
  6. Puncture Resistance (ASTM D4833)
- C. If a test result is in non-conformance with the specifications, all material from that production lot represented by the failed test shall be rejected. Rejected material may be minimized by bounding the nonconformance material with additional passing tests conducted by the geosynthetics CQA laboratory. Additional tests shall be conducted at no additional cost to the Owner.
- D. Rejected material shall be replaced at no additional cost to Owner.

## **PART 3: EXECUTION**

### **3.01 EXAMINATION**

- A. Verify in writing that the surface on which the geomembrane will be installed is



acceptable. In so doing the Installer shall assume full liability for the accepted surface.

- B. The beginning of installation means acceptance of existing conditions. The Installer shall be responsible for maintenance of the geomembrane covered subgrade once installation of geomembrane begins.

### **3.02 PREPARATION**

- A. Maintain the surface suitability and integrity until the lining installation is completed and accepted.
- B. Repair rough areas and any damage to the subgrade caused by installation of the liner.
- C. To avoid sharp bends in the geomembrane, bevel the leading edges of the anchor trench.
- D. Subgrade shall be smooth, uniform, firm and free from rocks or other debris. For deployment over soil subgrade, no rocks or protrusions greater than 3/8-inch in diameter shall be exposed at the subgrade surface.

### **3.03 DEPLOYMENT**

- A. Geomembrane shall not be deployed:
  - 1. During precipitation
  - 2. In the presence of excessive moisture
  - 3. In areas of ponded water
  - 4. In the presence of excessive winds
  - 5. In excessive heat or cold
- B. Each panel shall be marked with an "identification code" (number or letter) consistent with the layout plan. The identification code shall be simple and logical. The number of panels deployed in one day shall be limited by the number of panels which can be seamed on the same day. All deployed panels shall be seamed to adjacent panels by the end of each day.
- C. The following is the acceptable method of deployment:
  - 1. Use equipment which will not damage geomembrane by handling, trafficking, leakage of hydrocarbons or other means.
  - 2. Do not allow personnel working on geomembrane to wear damaging shoes, or engage in activities that could damage geomembrane.
  - 3. Smoking on the liner is prohibited.
  - 4. Round sharp corners of clamps and other metal tools used in the work area.
  - 5. Do not allow clamps and other metal tools to be tossed or thrown.
  - 6. Unroll panels with a method that protects geomembrane from scratches and crimps and protects soil surface and underlying geotextile from damage.
  - 7. Use a method to minimize wrinkles, especially differential wrinkles between adjacent panels.
  - 8. Place adequate hold-downs to prevent uplift by wind.
  - 9. Use hold-downs that will not damage geomembrane such as sandbags.
  - 10. Use continuous hold-downs along leading edges to minimize risk of wind flow under panels.
  - 11. Panels shall be deployed perpendicular to slope elevation contours and the generation of seams shall be minimized.
  - 12. Protect geomembrane in heavy traffic areas by geotextile, extra geomembrane or other suitable materials.
  - 13. Do not allow vehicular traffic on geomembrane surface.

14. Panels deployed on grades steeper than 12% shall extend a minimum of 3 feet beyond the crest or toe of that grade.
- D. Visually inspect sheet surface during unrolling of geomembrane and mark faulty or suspect areas for repair or test. Replace faulty (requires more than one patch per 200 square feet) geomembrane stock at no additional cost to the Owner.
- E. Deploy geomembrane in ambient temperatures less than 104°F (40°C) and greater than 32° F (0°C), measured 6 inches above geomembrane surface. In prevailing warm or cold weather conditions deployment may be acceptable if the provisions for sampling in such conditions is satisfied (see Section 3.5 below). The geomembrane shall not be deployed during precipitation, in the presence of excessive moisture, in area of ponded water, or in the presence of excessive winds.

### 3.04 FIELD SEAMING

- A. Orient seams perpendicular to slope elevation contours, i.e., orient down (not across) slope and use seam numbering system compatible with panel number system.
- B. Minimize the number of field seams in corners, odd-shaped geometric locations and outside corners.
- C. Overlap panels by a minimum of 3 inches for extrusion welding and 4 inches for fusion welding. Use procedures to temporarily bond adjacent panels together that do not damage the geomembrane and that are not detrimental to seam weld material for extrusion welding.
- D. Do not use solvent or adhesive unless product is approved in writing by the Owner.
- E. No horizontal seams shall be allowed on grades steeper than 12% or within 3 feet of the crest or toe of slopes. A horizontal seam is defined as more than half of the panel width.
- F. Clean surface of grease, moisture, dust, dirt, debris or other foreign material.
- G. Prior to any extrusion welding, the geomembrane seam or repair shall be prepared as follows:
  1. Clean surface of oxidation by disc grinder or equivalent not more than one hour before seaming; use number 80 grit sandpaper for the disc grinder. Bevel edges of geomembrane before bonding and provide continuous tacking in repair areas.
  2. Repair area where excessive grinding substantially reduces sheet thickness by more than 4 mils beyond extents of weld.
  3. Clean grinding dust around weld area after grinding.
  4. The following procedure shall be followed for wrinkles and fishmouths.
    - a. Cut along the ridge of the wrinkle or fishmouth.
    - b. Overlap a minimum of 3 inches and seam.
    - c. Any portion where the overlap is less than 3 inches shall be patched with an oval or round patch of geomembrane that extends a minimum of 6 inches beyond the cut in all directions.
  5. If required, a firm, dry substrate (piece of geomembrane or other material) may be placed directly under the seam overlap to achieve proper support.
  6. Keep water from intercepting the weld during and immediately after welding the seam.
  7. For existing welds, or welds that are over 3 minutes old, grind the existing weld two inches back from point of termination and restart welding on ground weld.
- H. At least one spare operable seaming apparatus shall be maintained for every three seaming teams. Place protective fabric or piece of geomembrane beneath hot welding apparatus when resting on geomembrane lining and use an electric generator capable of providing constant voltage under combined line load. The electric generator shall generally be located outside of liner. Provide protective lining and secondary containment large enough to catch spilled fuel under electric generators when located on the liner. The welding apparatus shall be equipped with gauges giving temperatures in apparatus and at nozzle.

- I. For extrusion welding, purge welding apparatus of heat-degraded extrudate before welding if extruder is stopped for longer than five minutes. All purged extrudate shall be disposed of off the geomembrane. Each extruder shoe shall be inspected daily for wear to assure that its offset is the same as the geomembrane thickness. Repair or replace worn shores, damaged or misaligned armature brushes, nozzle contamination, or other worn or damaged parts. Avoid stop-start welding. Remove extrudate rod from welder when not using welder for long period (over two hours). No welding may commence on the liner until the field trial seam sample, made by that equipment and seamer, passes destructive testing.
- J. Test and set "hot air system" using scrap material at least each day prior to commencing seaming and adjust hot air velocity to preclude wind effects. Adjust contact pressure rollers to prevent surface ripples in sheet. No equipment shall be used for welding the geomembrane until a field trial seam sample made by that equipment has passed destructive testing.
- K. In performing hot wedge welding, the welding apparatus shall be automated vehicular mounted devices equipped with gauges giving applicable temperatures and pressures. The edge of cross seams shall be ground to smooth incline (top and bottom) prior to welding. A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after usage. Protect against moisture buildup between sheets. If welding across cross seams, conduct field test seams at least every two hours, otherwise once prior to start of work and once at mid-day. No equipment is allowed to commence welding on geomembrane until the field trial seam sample made by that equipment has passed destructive testing.
- L. Field trial seams shall be conducted, per seaming apparatus and per seamer, on pieces of geomembrane liner to verify adequate seaming conditions at the following frequency:
1. At beginning of each seaming period.
  2. At least once every five hours.
  3. At the discretion of the CQA Engineer.
- M. Make the trial seams at area of seaming and in contact with subgrade or GCL (same condition as the liner to be seamed). The seam sample shall be at least 42 inches long and 12 inches wide with the seam centered lengthwise. A one foot length of each trial seam sample shall be submitted to the CQA Engineer for archive. Cut three 1-inch wide specimens and test two for peel adhesion, and one for bonded seam strength (shear). Each double wedge fusion seam specimens shall be tested for peel on both sides of the weld. A specimen passes when:
1. The locus-of-break is not one of the following failing modes as defined by ASTM D6392:
    - a. An adhesion failure (code AD, AD1 or AD2),
    - b. Greater than 25% adhesion failure on an adhesion-break (code AD-BRK), or
    - c. An adhesion-weld break through an extrusion weld which exhibits a strength less than required by Table 02751-3
  2. The break is ductile.
  3. The strength of breaks for the trial seam testing shall conform to the values listed in Table 02751-3, included at the end of this section.
- N. A trial seam sample passes when all specimens have passing results in peel and shear tests. If a specimen fails (one of the specimens fails in either peel or shear mode), the trial seam procedure shall be repeated in its entirety. If the repeated trial seam fails, the seaming apparatus or operator may not weld until the deficiencies or conditions are corrected and two consecutive passing field trial seams are achieved.
- O. The following procedures shall be followed during cold weather conditions.
1. Geomembrane surface temperatures shall be determined by the CQA Engineer at intervals of at least once per 100 feet of seam length to determine if preheating is

required. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32° F (0° C).

2. For fusion welding, preheating may be waived by the Owner based upon a recommendation by the CQA Engineer, if the installer demonstrates to the CQA Engineer's satisfaction that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.
3. If preheating is required, the CQA Engineer will observe all areas of geomembrane that have been preheated by a hot air device prior to seaming, to ensure that they have not been overheated.
4. Care shall be taken to confirm that the surface temperatures are not lowered below the minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for the seam area.
5. All preheating devices shall receive approval by the CQA Engineer prior to use.
6. Additional destructive tests will be taken at an interval between 250 and 500 feet of seam length, at the discretion of the CQA Engineer.
7. Sheet grinding may be performed before preheating, if applicable.
8. Trial seaming shall be conducted under the same ambient temperature and preheating conditions as the production seams. Under cold weather conditions, new trial seams shall be conducted if the ambient temperature drops by more than 10o F from the initial trial seam test conditions. Such new trial seams shall be conducted upon completion of seams in progress during the temperature drop.

P. The following procedures shall be followed during warm weather conditions.

1. At ambient temperatures above 104o F (40o C), no seaming of the geomembrane shall be permitted unless the Installer can demonstrate to the satisfaction of the CQA Engineer that the geomembrane seam quality is not compromised. Trial seaming shall be conducted under the same ambient temperature conditions as the production seams. At the option of the CQA Engineer, additional destructive testing may be required for any suspected areas.

### **3.05 FIELD QUALITY CONTROL**

- A. The Installer shall designate a full-time quality control (QC) technician who shall be responsible for supervising and/or conducting the field quality control program. The QC technician may not be replaced without written authorization by the Owner.
- B. Non-Destructive Seam Testing
  1. The Installer shall non-destructively test field welds for continuity over their full length. The non-destructive testing shall be performed concurrently with seaming work progress, not at the completion of all seaming. Any defects located in the seam shall be repaired in accordance with Article 3.06. The following non-destructive testing procedures shall be used to test the field seams for continuity.
    - a. Vacuum box testing for extrusion welds.
    - b. Air pressure testing for double fusion seams.
  2. Vacuum Box Testing
    - a. The vacuum box testing equipment shall comprise the following.
      - i. Rigid housing; transparent viewing window, a soft rubber gasket attached to bottom of housing; porthole or valve assembly, and a vacuum gauge.
      - ii. A vacuum pump capable of applying 5 psi gage pressure of vacuum to the box.
      - iii. A bucket of soapy solution and applicator.
    - b. The procedure for vacuum testing is as follows:

- i. Clean window, gasket surfaces, and check for leaks.
- ii. Energize vacuum pump and reduce tank pressure to approximately 5 psi.
- iii. Wet a strip of geomembrane approximately 12 inches by 30 inches (or length of box) with soapy solution .
- iv. Place box over wetted area and compress.
- v. Close bleed valve and open vacuum valve.
- vi. Ensure that a leak tight seal is created.
- vii. Examine length of weld through viewing window for presence of soap bubbles for a period of not less than 10 seconds,
- viii. If no bubbles appear after 10 seconds, close vacuum valve and open bleed valve, move box over next adjoining area with minimum three inches overlap and repeat process.
- ix. Areas where soap bubbles appear will be marked by the CQA Engineer with a defect code. The Installer shall then repair the area in accordance with Article 3.06 and retest the repaired area.

### 3. Air Pressure Testing (Double Fusion Seams Only)

#### a. The air pressure testing equipment shall comprise the following:

- i. An air pump, equipped with a calibrated pressure gauge with an accuracy of 1 psi, capable of generating and sustaining a pressure between 25 to 30 psi and mounted on a cushion to protect geomembrane.
- ii. Rubber hose with fittings and connections.
- iii. Sharp hollow needle or other pressure feed device approved by the Owner.

#### b. To perform the test:

- i. Seal both ends of the seam to be tested.
- ii. Insert a needle or other approved pressure feed device into tunnel created by double hot wedge seaming and insert a protective cushion between air pump and geomembrane.
- iii. Energize air pump to 25 to 30 psi, close valve, and sustain pressure for a minimum of five minutes.
- iv. If loss of pressure exceeds 2 psi or does not stabilize, locate faulty area and repair in accordance with Article 3.06.
- v. Release pressure at opposite end of seam from gauge to verify that the seam is not blocked.
- vi. Remove approved pressure feed device and seal penetration holes by extrusion welding.

### C. Destructive Seam Testing

1. For destructive seam testing, the CQA Engineer shall be provided with a minimum of one sample per 500 feet of seam length by each welding apparatus. The location will be selected by the CQA Engineer and the installer will not be informed of the sample location in advance. The Installer shall visually observe, mark and repair suspect welds before release of a section to the CQA Engineer for destructive sample marking. Cut destructive samples as seaming and nondestructive testing progresses, prior to completion of liner installation. The CQA Engineer will mark destructive samples with consecutive numbering, location, apparatus I.D., technician I.D., Engineer I.D., and apparatus settings and date. Record, in written form, weld and test date, time, location, seam number, ambient temperatures, machine settings, technician I.D., apparatus I.D., and pass or fail description. The installer shall



immediately repair holes in geomembrane resulting from obtaining destructive samples and vacuum test patches. The size of destructive samples shall be 12 inches wide by 48 inches long with seam centered lengthwise.

2. The sample shall be cut into three 14-inch long pieces and distributed as follows:
    - a. To the CQA Engineer for destructive testing.
    - b. To the CQA Engineer for archive.
    - c. To the Installer for its use.
  3. Ten 1-inch wide specimens shall be taken from one piece. Five specimens shall be tested for peel and five for shear strengths in accordance with the CQA Plan, with test results meeting the requirements of Table 02751-3, included at the end of this section. Four out of five specimens must meet Table 02751-3 and the requirements of Paragraph 3.04.M.1 of this section. In the event of failure, the procedures for failed seam tracking are:
    - a. Retrace welding path a minimum of 10 feet in both directions from the failed test location and remove (at these locations) a one inch wide specimen for testing. Repeat tracking procedures until the Installer is confident of seam quality.
    - b. Obtain destructive samples from each side of the welding path and give samples to the CQA Engineer for destructive testing.
    - c. Repeat process if additional tests fail.
    - d. Reconstruct seam between passing test locations to satisfaction of the CQA Engineer.
    - e. Reconstruction may be one of the following:
      - f. Cut out old seam, reposition panel and re-seam.
      - g. Add cap strip.
      - h. Cut additional destructive samples from reconstruction at discretion of CQA Engineer.
    - i. If additional destructive sample results are not acceptable, repeat process until reconstructed seam is judged satisfactory by the CQA Engineer.
- D. For final seaming inspection, check the seams and surface of geomembrane for defects, holes, blisters, undispersed raw materials, or signs of contamination by foreign matter. Brush, blow, or wash geomembrane surface if dirt inhibits inspection. The CQA Engineer shall decide if cleaning of geomembrane surface and welds is needed to facilitate inspection. Distinctively mark repair areas and indicate required type of repair.

### **3.06 REPAIR PROCEDURES**

- A. The geomembrane will be inspected before and after seaming for evidence of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of inspection. The geomembrane surface shall be swept or washed by the Installer if surface contamination inhibits inspection. The Installer shall ensure that an inspection of the geomembrane precedes any seaming of that section.
- B. Remove damaged geomembrane and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.
- C. Repair, removal, and replacement shall be at the Installer's expense if the damage results from the Installer's activities.
- D. Repair any portion of the geomembrane exhibiting a flaw, or failing a destructive or non-destructive test. The Installer shall be responsible for repair of damaged or defective areas. Agreement upon the appropriate repair method shall be decided between the CQA Engineer and the Installer. Procedures available include:

1. Patching: Used to repair holes (over 1/4-inch diameter), tears (over 1/4 inch long), undispersed raw materials, and contamination by foreign matter.
  2. Grinding and welding: Used to repair pinholes, blemishes and over-grinding.
  3. Capping: Used to repair large lengths of failed seams.
  4. Removing the seam and replacing with a strip of new material.
- E. In addition, the following procedures shall be observed.
1. Geomembrane surfaces to be repaired shall be abraded (extrusion welds only) no more than 1/2 hour prior to the repair.
  2. All geomembrane surfaces shall be clean and dry at the time of repair.
  3. The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the CQA Engineer.
  4. Extend patches or caps at least 6 inches beyond the edge of the defect, i.e., be a minimum of 12 inches in diameter, and round all corners of material to be patched.
  5. Bevel the edge of the patch and do not cut patch with repair sheet in contact with geomembrane. Temporarily bond the patch to the geomembrane with an approved method, extrusion weld the patch, and then vacuum test the repair.
- F. Repair Verification:
1. Number and log each patch repair (performed by the CQA Engineer).
  2. Non-destructively test each repair using methods specified in this Section.
  3. Provide daily documentation of non-destructive and destructive testing to the CQA Engineer. The documentation shall identify seams that initially failed the test and include the evidence that these seams were repaired and retested successfully.

### **3.07 GEOELECTRICAL LEAK LOCATION SURVEY**

- A. The CQA Engineer shall complete a geoelectric leak location survey on liner at the following phases of construction:
1. A geoelectric leak survey on the exposed sideslope geomembrane in accordance with ASTM D7002.
  2. A geoelectric leak survey on the base liner geomembrane after completion of the soil operations layer and underlying LCRS gravel in accordance with ASTM D7007.
  3. CONTRACTOR will leave a small strip of operations layer uncompleted at the upper edge of the access ramp to provide electrical isolation of the liner system. Completion of the operations layer soil placement will follow successful completion of the geoelectric leak survey.
  4. The CONTRACTOR shall furnish and install the permanent electrodes beneath the geomembrane on the floor (12 gauge bare copper wire).
  5. The CONTRACTOR shall supply an AC power source for the geoelectric leak survey (110V, 5A) for the geoelectric leak survey.
  6. The CONTRACTOR shall supply two supervised laborers with equipment to assist with laying out the survey string lines.
  7. The geoelectric leak survey is expected to take up to 2 working days to complete for each layer. The CONTRACTOR shall allow for time necessary to complete the survey.
- B. If the geoelectric leak survey identifies potential damages and/or leaks in the liner, the CONTRACTOR is responsible for all work and costs necessary to expose the liner, repair the damage or leaks in the liner, and reconstruct the necessary layers of the liner system.

### **3.08 ACCEPTANCE**

- A. The INSTALLER shall retain ownership and responsibility for the geomembrane until acceptance by the Owner.

B. Acceptance Criteria: The following shall be completed:

1. Verification of adequacy of field seams, repairs and testing by the CQA Engineer.
2. Successful completion of the geoelectric leak survey and completion of the repair of all defects identified by the survey.
3. All submittals.
4. "As-built" Drawings, approved and final Construction Drawings submitted.
5. Construction area cleaned.
6. Final field inspection.
7. Warranty signed over to the Owner.
8. Field Inspections: Inspect the completed work with the Owner; defects, wrinkles, suspicious looking welds shall be noted and marked; document, correct and arrange further field inspections until no corrective action is necessary.



**TABLE 02751-1**  
**HDPE GEOMEMBRANE PROPERTIES**

Property	Qualifier	Units	60-mil Specification	Test Method
Thickness	min. avg. min.	mils mils	60 54	ASTM D5994 ASTM D5199 <sup>(1)</sup>
Specific Gravity	min.		0.940	ASTM D1505
Carbon Black Content	range	%	2 - 3	ASTM D1603
Carbon Black Dispersion	rating	-	Note 2	ASTM D5596 <sup>(2)</sup>
Tensile Properties				
1. Yield Strength	min. avg.	lb/in	126	ASTM D6693 <sup>(3)</sup>
2. Break Strength	min. avg.	lb/in	90	
3. Elongation at Yield	min. avg.	%	12	
4. Elongation at Break	min. avg.	%	100	
Tear Resistance	min. avg.	lb	42	ASTM D1004 <sup>(4)</sup>
Puncture Resistance	min. avg.	lb	90	ASTM D4833
Oxidative Induction Time				
1. Standard, or	min. avg.	min.	100	ASTM D3895
2. High Pressure	min. avg.	min.	400	ASTM D5885
Stress Crack Resistance	min. avg.	hours	300	ASTM D5397 <sup>(5)</sup>

1. 10 measurements across the width of the roll (perpendicular to the machine direction) and report average and lowest individual readings.
2. At least 9 specimens will be Category 1 or 2. No more than one specimen shall be Category 3. No specimen shall be Category 4 or 5.
3. Type IV die. ASTM D638 test specimen shall be used.
  - a) The grip separation shall be 2.5 inches. This test does not require the use of extensometers. The rate of grip separation will be 2 inches per minute.
  - b) Machine Direction (MD) and Transverse Direction (TD) average values should be on the basis of 5 test specimens in each direction.
  - c) Yield elongation is based on a gauge length of 1.3 inches. Break elongation is based on a gauge length of 2.0 inches.
4. Die C
5.
  - a) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
  - b) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

TABLE 02751-2

## HDPE GEOMEMBRANE MINIMUM RESIDUAL INTERFACE SHEAR STRENGTH

Test Configuration	ASTM Standard	Test Condition	Hydration Time Required Prior to Shearing	Strain Rate	Min. Shear Displmt.	Normal Stress	Large Displ. <sup>1</sup> Shear Strength Required
				inch/min	(inches)	(psf)	(psf)
Upper Surface of Secondary GCL–Lower Surface of Secondary HDPE Geomembrane <sup>2,3</sup>	D6243	Submerged	48 hours under corresponding normal load	0.04	3.0	4,000 8,000 12,000 16,000	850 1,700 2,550 3,400
Upper surface of Secondary HDPE Geomembrane– Lower Surface of Geocomposite Drain <sup>4</sup>	D5321	Submerged	N/A	0.2	3.0	4,000 8,000 12,000 16,000	850 1,700 2,550 3,400
Upper Surface of Geocomposite Drain–Lower Surface of Primary GCL <sup>3,4</sup>	D6243	Submerged	48 hours under corresponding normal load	0.04	3.0	4,000 8,000 12,000 16,000	850 1,700 2,550 3,400
Upper Surface of Primary GCL–Lower of Surface of Primary HDPE geomembrane	D5321	Submerged	48 hours under corresponding normal load	0.04	3.0	4,000 8,000 12,000 16,000	850 1,700 2,550 3,400

1. Large displacement shear strength as measured at a shear displacement of 3 inches; the listed values correspond to a large-displacement friction angle of 12 degrees.
2. Both primary and secondary GCLs and HDPE Geomembrane interfaces should be tested separately.
3. The internal shear strength of the GCL should be tested simultaneously by allowing the required gap for internal shearing of GCL.
4. The internal shear strength of the geocomposite drain should be tested simultaneously by allowing the required gap for internal shearing.

TABLE 02751-3

HDPE GEOMEMBRANE SEAM PROPERTIES  
FOR SMOOTH AND TEXTURED MATERIAL

PROPERTY	QUALIFIER	UNITS	60-mil Specification	METHOD
Thickness	nominal	mils	60	
Shear Seam Strength	minimum	lb/in.	120	ASTM D6392 <sup>(1)</sup>
Shear Seam Elongation	minimum	%	50	ASTM D6392 <sup>(1)</sup>
Peel Adhesion Fusion	minimum	lb/in.	91	ASTM D6392 <sup>(1)</sup>
Extrusion	minimum	lb/in.	78	ASTM D6392 <sup>(1)</sup>

1. For shear tests, the sheet shall yield before failure of the seam. For peel adhesion, seam separation shall not extend more than 25% into the seam. For either test, testing shall be discontinued when the sample has visually yielded. Sample break shall conform to a passing locus-of-break as described in paragraph 3.04.M.1 this Section.

END OF SECTION

**SECTION 02755**  
**GEOCOMPOSITE**

**PART 1: GENERAL**

**1.01 DESCRIPTION**

- A. This section describes the requirements for the manufacture, supply, installation, and quality control (QC) of geocomposites and geonet associated with the construction of the Module 6 Base Liner System at WRSL.

**1.02 RELATED SECTIONS**

- A. Section 02221 - Earthwork  
B. Section 02223 - Gravel  
C. Section 02751 - HDPE Geomembranes  
D. Section 02756 – Geosynthetic Clay Layer

**1.03 REFERENCES**

- A. Latest version of the American Society of Testing and Materials (ASTM) standards:
1. ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
  2. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
  3. ASTM D1505 - Standard Test Method for Density of Plastics by Density - Gradient Technique
  4. ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics
  5. ASTM D3786 - Standard Test Method for Bursting Strength of Textile Fabrics- Diaphragm Bursting Strength Tester Method
  6. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc Type Apparatus
  7. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity
  8. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles
  9. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
  10. ASTM D4716 - Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
  11. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile
  12. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
  13. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
  14. ASTM D5261 - Standard Test Method for Measuring Mass Per Unit Area of Geotextiles
  15. ASTM D6241 - Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products using a 50-mm Probe.
  16. ASTM D7005 - Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites
- B. Construction Quality Assurance Plan

**1.04 SUBMITTALS**

- A. Geocomposite Manufacturer shall submit to the CQA Engineer the following documentation on the raw materials used to manufacture the geocomposite:
  - 1. Quality control certificates issued by the raw material supplier including the production dates of the raw material used to manufacture geocomposite for the project.
  - 2. Results of tests conducted by the Geocomposite Manufacturer to verify the quality of the resin used to manufacture the geocomposite rolls assigned to the project and the origin of the resin and quality control certificates issued by the resin supplier.
- B. A copy of the Geocomposite Manufacturer's Quality Control Program.
- C. Quality control certificates for test results at the sampling frequency indicated by the Manufacturer's QC Plan shall be submitted.
  - 1. Manufacturing quality control certificates for each shift's production shall be signed by responsible parties employed by the Manufacturer (such as the production manager).
  - 2. The quality control certificates shall include:
    - a. Roll numbers and identification
    - b. Sampling procedures
    - c. Results of the quality control tests verifying each of the properties listed in Table 02755-1
    - d. Transmissivity tests do not need to be completed as routine QC tests. However, manufacturer shall include a written statement that the product has been tested and meets or exceeds the transmissivity requirements. Tests results for the product shall be included.
- D. Manufacturer's certification that the geotextile products meet or exceed specified requirements and are 100% free of needles.

#### **1.05 QUALITY ASSURANCE**

- A. Perform work in accordance with Manufacturer's instructions and the CQA Plan.

#### **1.06 QUALIFICATIONS**

- A. Geocomposite Manufacturer shall be a well-established firm with more than two years of experience in the manufacture of geocomposites.
- B. GEOSYNTHETIC INSTALLER shall meet the requirements of the CQA Plan.

### **PART 2: PRODUCTS**

#### **2.01 MATERIALS**

- A. The geocomposite to be used on the project shall comprise HDPE geonet drainage material with non-woven, needle-punched geotextiles bonded on the upper and lower surfaces. The geotextile component shall be triple-punched, needle-punched non-woven 8 oz/sy geotextile meeting the requirements of Geotextile Filters in Section 02752. The geotextile will be thermally bonded to the geonet component of the geocomposite. Chemical bonding is not allowed.
- B. Geocomposite shall meet the minimum properties listed in Table 02755-1.
- C. For the LCRS, the geonet shall meet the requirements for geonet list in Table 02755-1.

#### **2.02 CONFORMANCE TESTING**

- A. Material arriving at the site will be sampled and conformance tested by the CQA Engineer at a minimum frequency of one per 250,000 square feet of material supplied to the project with a minimum of one sample per production lot (geocomposite production lot). Materials may be sampled at the plant at the discretion of the Owner. The Geosynthetic Manufacturer shall pay for shipping the conformance samples to the geosynthetics CQA Laboratory specified by the CQA Engineer. If so, the geonet and geotextile samples should be sampled prior to bonding. As a minimum, conformance tests shall include:

1. Geonet:
  - a. Density - ASTM D 1505
  - b. Thickness - ASTM D 5199
2. Geotextile:
  - a. Mass Per Unit Area - ASTM D 5261
  - b. Permittivity - ASTM D 4491
3. Geocomposite
  - a. Peel Strength - ASTM D 7005
- B. If a test result is in nonconformance with the specifications, all material from that production lot presented by the failed test shall be rejected. Rejected material may be minimized by bounding the nonconformance material with additional passing tests conducted by the geosynthetic CQA laboratory. Additional tests will be conducted at no additional cost to the Owner.
- C. Rejected material shall be replaced at no cost to Owner.

## **2.03 DELIVERY, STORAGE, AND HANDLING**

- A. The GEOSYNTHETIC INSTALLER shall be responsible for handling, storage, and care of the geocomposites following transportation to the site. The GEOSYNTHETIC INSTALLER shall be liable for all damage to the materials incurred prior to final acceptance of the liner system by the CQA Consultant.
- B. The geocomposite and geonet shall be stored off the ground and out of direct sunlight, and shall be protected from mud, dirt, dust, and any additional storage procedures required by the Geocomposite/Geonet Manufacturer.
- C. All rolls of geocomposite shall be identified at the factory with the following:
  1. Manufacturer's name
  2. Product identification
  3. Lot Number
  4. Roll number
  5. Roll dimensions
- D. The Contractor shall be responsible for offloading all geosynthetic materials
- E. The geocomposites and geonets shall be handled in such a manner as to ensure they are not damaged in any way.
- F. Precautions shall be taken to prevent damage to underlying layers during placement of the geocomposite and geonet.
- G. After unwrapping the geocomposite from its cover, the geocomposite shall not be left exposed for a period in excess of 45 days.

## **PART 3: EXECUTION**

### **3.01 EXAMINATION**

- A. Verify that other work is complete over the areas where the geocomposite or geonet is to be deployed.

### **3.02 PREPARATION**

- A. Protect elements surrounding the work of this section from damage.

### **3.03 INSTALLATION**

- A. The geocomposite and geonet shall be installed in accordance with the Manufacturer's recommended procedures and the CQA Plan.
- B. The CQA Engineer shall verify that all geocomposite and geonet rolls and underlying layers are free from deleterious material or debris prior to the geocomposite or geonet

deployment. Dirt entrapped in the geocomposite following deployment shall be cleaned or affected geocomposite or geonet removed and replaced prior to placement of successive layers.

- C. On side-slopes, the geocomposite and geonet shall be secured in the anchor trench and shall be deployed parallel to the dip of the slope. On the base, the geocomposite and geonet shall be orientated parallel to the flow direction to the sump. The geocomposite panels shall be positioned to minimize wrinkles.
- D. The Installer is responsible for anchoring exposed geocomposite and geonet to protect against wind damage until subsequent layers are placed.
- E. The geocomposite or geonet shall not be welded to the geomembrane unless specified otherwise.
- F. The geocomposite or geonet shall only be cut utilizing methods and tools (i.e., a hooked utility blade) which will not damage the geocomposite.
- G. The geonet and geonet component of the geocomposite shall be overlapped a minimum of 4 inches between adjacent panels and shall be fastened by nylon ties. Ties shall be yellow or white for easy inspection. No metallic materials are allowed. Ties shall be placed every 5 feet along the lengths of adjacent panels, every 1 ft across butt-seams, and every 6 in. in any anchor trench.
- H. Butt-seams will only be allowed on grades less than 15%.
- I. The bottom geotextile component of the geocomposite shall be overlapped. The top geotextile component shall overlapped a minimum of 6 in. and shall be continuously sewn.
- J. Polymeric thread, with chemical resistance properties equal to or exceeding those of the geotextile, shall be used for all sewing. The seams shall be sewn using Stitch Type 401. The seam type shall be Federal Standard Type SSa-1.
- K. The Geosynthetic Installer shall be responsible for field handling, storing, deploying, seaming or joining, temporary restraining (against wind), anchoring, and other aspects of geocomposite installation.
- L. The Installer shall accept and retain full responsibility for all materials and installation and shall be held responsible for any defects in the completed systems.

### **3.04 REPAIRS**

- A. Any defects observed in the geocomposite shall be brought to the attention of the CQA Engineer.
- B. Holes or tears in the geocomposite shall be repaired with geocomposite patches extending 2 feet beyond the edges of the hole or tear. The patch shall be secured in place by using approved ties spaced at 6 inches. The ties shall extend through the geonet component of the patch and through the geotextile and geonet components of the geocomposite requiring repair. The upper geotextile component of the patch shall be heat bonded to the geotextile component of the geocomposite requiring repair.

### **3.05 FIELD QUALITY CONTROL**

- A. Field inspection and testing shall be performed in accordance with the CQA Plan.

### **3.06 PROTECTION**

- A. Do not permit traffic over any of the Products related to this Section.
- B. The CONTRACTOR or Geosynthetics Installer shall place all soil materials in such a manner as to ensure that:
  - 1. The geocomposite and underlying materials are not damaged
  - 2. Minimal slippage occurs between the geocomposite and the underlying geosynthetic layers
  - 3. Excess tensile stresses are not developed in the geocomposite



**TABLE 02755-1**  
**GEOCOMPOSITE AND GEONET PROPERTY VALUES**

PROPERTIES	QUALIFIER	UNITS	SPECIFIED VALUES	TEST METHOD
<b>Geonet Component:</b> Polymer Composition Polymer Density Carbon Black Content Foaming Agents Nominal Thickness Transmissivity <sup>1,2</sup>	minimum min. avg. range  maximum min. avg. minimum	% g/cc %  % mils m <sup>2</sup> /s	95% polyethylene by weight 0.94 2-3  0.0 250 3.0x10 <sup>-3</sup>	ASTM D1505 ASTM D1603  N/A ASTM D5199 ASTM D4716
<b>Geotextile Component:</b> Polymer Composition  Mass per Unit Area  <u>Filter Requirements</u> Apparent Opening Size Permittivity  <u>Mechanical Requirements</u> Grab Strength Tear Strength Puncture Strength UV Stability, 500 hrs	minimum  min. avg.  maximum  min. avg.  min. avg. min. avg. min. avg. min. avg.	%  oz/yd <sup>2</sup>  mm  s <sup>-1</sup>  lb lb lb % retained	95% polyester or polypropylene 8  0.21  1.26  200 90 600 50	ASTM D5261   ASTM D4751 ASTM D4491  ASTM D4632 ASTM D4533 ASTM D6241 ASTM D4355
<b>Geocomposites:</b> Transmissivity <sup>1,2</sup>  Peel Strength <sup>3</sup>	minimum  min. avg.	m <sup>2</sup> /s  lb/in.	5.0x10 <sup>-4</sup>  1.0 lb/in avg (0.5 lb/in min.)	ASTM D4716  ASTM D7005

Notes:

- (1) Transmissivity of the geonet component only required for the LCRS geonet.
- (2) The design transmissivity is the hydraulic transmissivity of the geonet or geocomposite using water at 68°F ± 3°F with a gradient of 0.1 under a compressive stress of not less than 1,000 psf. For the test, the geocomposite shall be sandwiched between steel plates. The minimum test duration will be 24 hours and the report for the test results shall include measurements at intervals over the entire test duration.
- (3) The average peel strength of all geocomposite specimens tested shall be 1.0 lb/in or greater and no single specimen shall have peel strength less than 0.5 lb/in.

**END OF SECTION**

## SECTION 02772

### GEOTEXTILE

#### PART 1: GENERAL

##### 1.01 DESCRIPTION OF WORK

- A. This section includes furnishing and installing geotextile fabric in accordance with the construction of the Module 6 Base Liner System at WRSL.

##### 1.02 RELATED SECTIONS

- A. Section 02200 –Earthwork
- B. Section 02750 – HDPE Pipe and Fittings
- C. Section 02751 –HDPE Geomembrane
- D. Section 02755 – Geocomposites and Geonet

##### 1.03 REFERENCES

- A. ASTM International, latest version:
  - 1. D4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles
  - 2. D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
  - 3. D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
  - 4. D5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles
  - 5. D6241 Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

##### 1.04 SUBMITTALS

- A. The CONTRACTOR shall submit samples and a complete description of geotextile fabric and thread proposed for use to the CQA Engineer a minimum of seven days prior to geotextile shipment. The geotextile fabric and thread shall meet or exceed requirements of this Section.
- B. The CONTRACTOR shall furnish written instructions for storage and handling of the geotextile a minimum of seven days prior to geotextile shipment.
- C. The CONTRACTOR shall submit, prior to shipping, manufacturer's specifications, quality control certificates, and a certification that geotextile fabric and thread stating materials meet or exceed parameters provided in this Section and as shown on the Construction Drawings.
- D. The CONTRACTOR shall submit Manufacturer and Installer's warranties to the Owner upon installation completion.

##### 1.05 DELIVERY, STORAGE AND HANDLING

- A. The geotextile shall be labeled, delivered and stored in accordance with ASTM D4873 unless otherwise agreed upon by the CQA Engineer. The protective wrapping shall be maintained during periods of shipment and storage.
- B. Roll numbers, Manufacturer's name, product identification, lot number and roll dimensions shall be marked on protective covering.
- C. During shipment and storage, the geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following:
  - 1. Site construction
  - 2. Damage precipitation
  - 3. Extended ultraviolet radiation including sunlight
  - 4. Chemicals that are strong acids or strong bases



5. Flames including welding sparks
  6. Temperatures in excess of 160°F (71°C)
  7. Any other environmental condition that may damage the property values of the geotextile.
- D. Manufacturer shall provide unloading straps with rolls delivered to the site.
  - E. If the CQA Monitor determines material is damaged or has excessive sunlight (UV) exposure, the CONTRACTOR shall immediately make all repairs and replacements at no additional cost to the Owner.
  - F. Geotextile damaged during transportation, loading, unloading, delivery, and storage shall be documented by the CQA Monitor and the CONTRACTOR.
  - G. Damaged geotextile shall be repaired, if possible, to the satisfaction of the CQA Engineer.
  - H. Damaged geotextile rejected by the CQA Engineer shall be replaced at no cost to the Owner.
  - I. The Contractor shall be responsible for offloading all of the geosynthetic materials delivered to the site.

#### **1.06 QUALITY CONTROL**

- A. Use adequate numbers of skilled workman who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Render assistance as necessary for CQA Monitor to collect product samples for Quality Assurance testing.

#### **1.07 WARRANTY**

- A. Geotextile and thread shall be provided with Manufacturer and Installer's warranties and the material and workmanship shall meet the warranty provisions of this Contract.

### **PART 2: PRODUCTS**

#### **2.01 GEOTEXTILE**

- A. The non-woven geotextile shall have the following minimum properties:

**Table 02772-1  
Geotextile Minimum Properties**

<b>Property</b>	<b>Test Designation</b>	<b>8 oz. Non –Woven</b>
Mass per Unit Area	ASTM D5261	8oz/yd <sup>2</sup>
Grab Tensile Strength <sup>1</sup>	ASTM D4632	200 lbs
CBR Puncture Resistance	ASTM D6241	580 lbs
AOS (Maximum Value) <sup>3</sup>	ASTM D4751	0.21 mm
AOS (Average Value) <sup>3</sup>	ASTM D4751	0.18 mm

*Notes:*

1. *Measured in weakest direction.*
2. *Non-woven, geotextile shall be continuous-filament needle-punched polypropylene or polyester, or staple-filament needle-punched polyester; yarn oriented into a stable network that maintains its structure during handling, placement, and long-term service.*
3. **Geotextile Filter Material Properties**
  - B. The geotextiles shall be manufactured in North America, unless otherwise approved in writing by the CQA Engineer.

## **2.02 MANUFACTURER SOURCE QUALITY CONTROL**

- A. The Manufacturer shall certify that quality control tests have been performed on the geotextile, at a minimum frequency of one per 100,000 square feet of material continuously produced and supplied to the project with a minimum of one sample per production lot.
- B. The Manufacturer shall provide the CQA Monitor with quality control certificates from the Manufacturer for each lot and each shift's production of geotextile. The quality control certificates shall include:
  1. Roll numbers and identification.
  2. Sampling procedures.
  3. Results of quality control tests, including a description of test methods used.

## **2.03 CONFORMANCE TESTING**

- A. Conformance Testing (Performed by the CQA Monitor or a representative of the Third-Party Laboratory):
  1. Conformance samples shall be obtained at a frequency of one sample every 200,000 sf. The CQA Monitor shall obtain samples and forward the samples to the Third Party Laboratory. Samples shall be obtained across the entire roll width, excluding the first 2 feet of the roll. Sample size shall be 3-feet long by the roll width. The CQA Monitor shall mark the machine direction on the sample. The Geosynthetic Manufacturer shall pay for shipping the conformance samples to the geosynthetics CQA Laboratory specified by the CQA Engineer.
  2. The following tests shall be performed on the conformance samples to determine geotextile characteristics and results shall be evaluated according to ASTM D4759.
    - a. Mass per unit area (ASTM D5261)
    - b. Grab tensile strength (ASTM D4632)
    - c. Puncture resistance (ASTM D6241)

## **2.04 EQUIPMENT**

- A. Sewing equipment and accessories shall meet the following requirements:
  1. Maintained in adequate number in order to avoid delaying work.
  2. Supplied by a power source capable of providing constant voltage under a combined-line load.
  3. Provided with a protective lining and splash pad large enough to catch spilled fuel under an electric generator, if used on geotextile.

## **PART 3: EXECUTION**

### **3.01 SURFACE CONDITIONS**

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Notify the CQA Engineer of such conditions and proposed corrective actions before correcting unsatisfactory conditions. Do not proceed until unsatisfactory conditions are corrected.

### **3.02 APPROVAL TO DEPLOY**

- A. Prior to installation of geotextile, approval from the CQA Monitor shall be obtained. If required, deficiencies in the underlying materials shall be corrected as applicable.

### **3.03 DEPLOYMENT**

- A. The geotextile shall be secured during deployment by placing sandbags as ballast. Ballast shall be left in place until the geotextile is covered. Installer shall be responsible for the geotextile until the geotextile is covered. Material used to fill sandbags shall be the same as the material to be placed over the geotextile. The CONTRACTOR shall be responsible for removing the sandbags. No separate payment will be provided for this work.
- B. Care shall be taken to protect other in-place geosynthetic materials when cutting geotextile. Installer shall repair, or replace, at the CQA Engineer's discretion, underlying geosynthetic components damaged during geotextile installation at no cost to the Owner.
- C. During deployment, the Installer shall not entrap excessive dust, stones, or moisture in geotextile that could damage or clog drains or filters, or hamper subsequent seaming.
- D. The geotextile shall be examined over its entire surface to ensure that no potentially harmful foreign objects, such as needles, are present. Foreign objects, if encountered, shall be removed.
- E. Unless ultraviolet-light stabilized, geotextiles shall be covered within a time frame acceptable to the Manufacturer or within 48 hours.

### **3.04 SEAMS AND OVERLAPS**

- A. Seam geotextile by sewing. Geotextile shall be overlapped 6 inches prior to seaming. The Installer shall not seam horizontally on slopes greater than 10 horizontal to 1 vertical (i.e., seam up and down, not across slopes).
- B. The Installer shall ensure that no soil materials are present within the seams.
- C. Polymeric thread with chemical resistance properties equal to or exceeding those of the geotextile, shall be used if the geotextile is joined by sewing. The geotextile shall be sewn with a 401 two-thread chain stitch, or CQA Engineer approved equivalent.

### **3.05 REPAIRS**

- A. Holes or tears in geotextiles shall be repaired as follows:
  - 1. On 10 horizontal to 1 vertical (10:1) or steeper slopes: patch from the same geotextile material and continuously sew or heat bond in place.
  - 2. Remove all sheets with tears exceeding 20 percent of the roll width and replace with new material.
  - 3. On slopes flatter than 10:1 patch from the same geotextile material, spot-seam in place with a minimum overlap of 24 inches in all directions.
- B. Remove soil and other material which may have penetrated through the torn geotextile before repairing.

### **3.06 FIELD QUALITY ASSURANCE**

- A. General:
  - 1. The Manufacturer and Installer shall participate in and conform with all terms and requirements of the Owner's quality assurance program. The INSTALLER shall be responsible for assuring this participation. Quality assurance requirements are as specified in this Section.

### **3.07 ACCEPTANCE**

- A. INSTALLER shall retain Ownership and responsibility for geotextile until acceptance by the Owner.
- B. The Owner will accept the geotextile installation when:
  - 1. The installation is finished.
  - 2. All required documentation from the Manufacturer and Installer has been received and approved.
  - 3. Verification of the adequacy of all field seams and repairs, including associated testing, is complete.
  - 4. Written certification documents have been received by the Owner from the CQA Officer.

**END OF SECTION**

**SECTION 02756**  
**GEOSYNTHETIC CLAY LINER**

**PART 1: GENERAL**

**1.01 DESCRIPTION**

- A. This section describes the requirements for the manufacture, supply, installation, and quality control of the geosynthetic clay liner (GCL) associated with the construction of the Module 6 Base Liner System at WRSL.

**1.02 RELATED SECTIONS**

- A. Section 02200 - Earthwork  
B. Section 02751 - HDPE Geomembranes  
C. Section 02755 - Geocomposites and Geonet

**1.03 REFERENCES**

- A. American Society of Testing and Materials (ASTM), latest edition:
1. ASTM D4632 - Grab Breaking Load and Elongation of Geotextiles
  2. ASTM D5084 - Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter
  3. ASTM D5888 - Standard Guide for Storage and handling of Geosynthetic Clay Liners
  4. ASTM D5889 - Standard Practice for Quality Control of Geosynthetic Clay Liners
  5. ASTM D5890 - Swell Index of Mineral Component of Geosynthetic Clay Liners
  6. ASTM D5993 - Measuring Mass per Unit of Geosynthetic Clay Liners
- B. Latest version of Geosynthetics Research Institute (GRI) testing methods:
1. GRI-GCL3 - Test Methods, Required Properties, and Testing Frequencies for Geosynthetic Clay Liners (GCLs)

**1.04 SUBMITTALS**

- A. Quality Control Submittals:
1. A copy of the Manufacturer's quality control plan.
  2. Quality control (QC) certificates containing the Manufacturer's QC testing results. At a minimum, QC certifications shall include the requirements listed in Part 2.01 B of this section. QC certificates shall be submitted at the frequency indicated in the Manufacturer's QC Plan for GCL continuously produced and supplied to the project and at least one per lot.
  3. Manufacturer's certificate that products meet or exceed specified requirements.
- B. As-built GCL Panel Drawings

**1.05 QUALITY ASSURANCE**

- A. Perform work in accordance to the Construction Quality Assurance Plan.

**1.06 QUALIFICATIONS**

- A. The GEOSYNTHETIC INSTALLER shall be experienced in this installation of geosynthetic clay liners. In the event the GEOSYNTHETIC INSTALLER is not experienced, a Representative of the Geosynthetic Clay Liner Manufacturer shall be on site to train the GEOSYNTHETIC INSTALLER, at no additional cost to the Owner.

**PART 2: PRODUCTS**

**2.01 GEOSYNTHETIC CLAY LINER (GCL)**

- A. GCL Materials. The GCL shall consist of Bentomat DN or equivalent and shall include

internal stitching reinforcement through the material that joins the backing fabrics.

- B. The GCL shall meet or exceed the product specifications below:
1. Maximum moisture content of 12% at the time of manufacture per ASTM D4643. The GCL shall not be installed with a moisture content greater than 35%.
  2. Maximum fluid loss of 18 ml per ASTM D5891.
  3. Nominal Thickness: 0.25 inches.
  4. Maximum permeability of  $5 \times 10^{-9}$  cm/sec per ASTM D5084.
  5. Bentonite mass per unit area of 0.75 lbs/ft<sup>2</sup> at 0% moisture (0.95 lbs/ft<sup>2</sup> at 20% moisture) per ASTM D5993.

## **2.02 DELIVERY, STORAGE, AND HANDLING**

- A. Handling, storage, and care of the geosynthetic clay liner, prior to and following installation, is the responsibility of the GEOSYNTHETIC INSTALLER, until Final Acceptance of the liner system by the Owner.
- B. Store and protect the geosynthetic clay liner. GCL shall be protected from ultraviolet light exposure, moisture, puncture, cutting, or other damaging or deleterious conditions. Any additional storage procedures required by the Manufacturer shall be the GEOSYNTHETIC INSTALLER's responsibility.
- C. Protect GCL from rain and moisture at all times.
- D. All rolls of GCL shall be identified at the factory with the following:
1. Manufacturer's name
  2. Product identification
  3. Lot number
  4. Roll number
  5. Roll dimensions
- E. GCL rolls shall be shipped and stored in relatively opaque and water tight wrappings.
- F. The Contractor shall be responsible for offloading all of the geosynthetic materials delivered to the site.

## **2.03 CONFORMANCE TESTING**

- A. Conformance testing shall be completed at a frequency of 1 test per 100,000 square feet of material delivered to the site, and a minimum of 1 test per lot. The Geosynthetic Manufacturer shall pay for shipping the conformance samples by the CQA Engineer.
- B. Conformance tests shall include permeability (ASTM D 5084) and mass per unit area (ASTM D 5993).

## **PART 3: EXECUTION**

### **3.01 INSTALLATION**

- A. Repair rough areas and any damage to the subgrade caused by installation of the lining and fill any ruts caused by equipment prior to overlying geomembrane deployment.
- B. Install the GCL so that panel seams are parallel to the dip of the slope.
- C. Pull GCL panels from roll suspended at the crest of the slope and install with the non-woven geotextile side up or as recommended by the Manufacturer.
- D. Do not install the GCL over wet subgrade, in standing water, or during precipitation events. Geomembrane shall not be placed on a GCL that is hydrated.
- E. The GCL shall be overlapped in accordance with the Manufacturer's recommended procedures. As a minimum, the overlap shall be a minimum of 6 inches (12 inches maximum) along the length of the GCL panel and 12 inches along the ends of the GCL panel.

- F. Place only as much GCL each day as can be covered with HDPE liner. The GCL shall be covered by HDPE liner at the end of each working day.
- G. Use single panels of bentonite mat from anchor trench over crest of slope down to lower limit of mat on an intermediate bench or cell floor.
- H. End-to-end seams only allowed on slopes of 10 percent or less.
- I. Do not drag textured geomembranes across previously installed bentonite mat. Use a smooth rub sheet between mat and geomembrane, or other methods, to prevent damage. Remove rub sheet when geomembrane is in position.
- J. All hydrated GCL shall be removed and replaced by the GEOSYNTHETIC INSTALLER at no additional cost to the Owner.

### **3.02 GCL SEAMING**

- A. Pull GCL panel tight to smooth out creases or irregularities in the panels.
- B. Remove all dirt and debris from the overlap area.
- C. Bentonite seam enhancement, consisting of the placement of 0.50 lbs/ft<sup>2</sup> of dry bentonite between overlapped panels, shall be completed for all seams except for the following conditions:
  - 1. The edge-to-edge panel seams consist of Bentomat DN with super groove seams.
- D. Seams shall consist of overlap and bentonite only. Do not staple.

### **3.03 REPAIR**

- A. Repair cuts, tears, or holes in the GCL by covering with a geosynthetic clay liner patch. On slopes greater than 5 percent, the patch shall overlap the edges of the hole or tear by a minimum of 2 ft in all directions. On slopes 5 percent or flatter, the patch shall overlap the edges of the hole by a minimum of 1 ft in all directions and 0.50 lbs. / ft<sup>2</sup> of raw bentonite.
- B. Attach patch to panel using either non-hazardous, non-toxic adhesive as recommended by GCL manufacturer or by spot welding with hot air apparatus ("Leistering"). Attachment method shall be approved by Construction Manager (based on recommendations of the CQA Engineer) prior to use.
- C. All repairs shall be made at no additional cost to the Owner.

**END OF SECTION**



**SECTION 02820**  
**EROSION CONTROL**

**PART 1: GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. This section describes the requirements for erosion control, including supply and installation of hydroseeding and turf reinforcement mats, associated with the construction of the Module 6 Base Liner System at WRSL.

**1.02 RELATED SECTIONS**

- A. Section 02200 – Earthwork

**1.02 REFERENCES**

- A. NOT APPLICABLE

**1.03 SUBMITTALS**

- A. Product data, within 30 days after CONTRACTOR has received the Owner's notice to proceed, submit:
1. Complete materials list of items proposed to be provided under this section
  2. Complete data on source, size, and quality
  3. Sufficient data to demonstrate compliance with the specified requirements
    - a. Certificate of compliance for seed mix
    - b. Certificate of seed inoculation

**1.04 WARRANTY**

- A. Hydroseed warranty period is 1 year.
1. The CONTRACTOR shall replant areas that do not produce cover within the warranty period at no expense to Owner. Replanting shall conform to the provisions of this Section, except as may be modified upon approval by the CQA Engineer.

**PART 2: PRODUCTS**

**2.01 HYDROSEEDING**

- A. WATER
1. Shall be clear and suitable for agricultural use.
  2. Reclaimed water may be used; however, it must be tested by a certified laboratory and found suitable for plant growth before it is applied.
  3. If water is obtained at the site, it shall be done so only under authorization from the CQA Engineer.
  4. Shall be added to the slurry mixture in sufficient quantity to ensure uniform distribution of hydromulch solids.
- B. SEED
1. Submit seed mix to owner for approval. Seed mix shall have demonstrated success at the WRSL or other similar project sites.
  2. All seeds shall be in conformance with the California State Seed Law of the Department of Food and Agriculture.
  3. Each bag shall be delivered to the site sealed and clearly marked as to species, purity, percent germination, dealer's guarantee, and dates of test.

4. Seed containers shall be labeled to clearly reflect the amount of Pure Live Seed (PLS) contained.
5. Prior to seeding at the request of the CQA Engineer, the CONTRACTOR shall provide a letter of certification, original Association of Official Seed Analysts (AOSA)-certified seed test results, and calculation of PLS content.
6. The CQA Engineer may at the time of delivery examine the seed and sample the seed using methods recognized by the AOSA. Contact the local County Agricultural Commissioner for procedures or assistance.
7. All legume seed shall be pellet-inoculated as provided in Bulletin AXT-280 of the University of California Cooperative Extension, "Pellet Inoculation of Legume Seed". Inoculant sources shall be species-specific and shall be applied at a rate of 2 pounds of inoculant per one hundred pounds of seed.

**C. FERTILIZER**

1. Shall conform to the requirements of the California Food and Agricultural Code.
2. Shall be pelleted or granular form.
3. Shall have a minimum guaranteed analysis of 16-20-0+S (Sulfur).
4. Shall be applied at the rate of 300 pounds per acre.

**D. MULCH**

1. Mulch shall be fibrous wood cellulose material capable of uniform suspension when added to water and agitated in a slurry tank.
2. Water content of the fiber before mixing into the slurry shall not exceed 15% (percent) of the dry weight of the fiber, which is determined by California Test 226. Commercially packaged fiber shall have the moisture content marked on the package. A certificate of compliance may be required by the CQA Engineer. Application rates for the mulch products with moisture contents greater than 15% shall be increased by the following factor, c:

$$c = \frac{85}{\text{percent fiber (solids) in product}}$$

3. Other agents, such as photo-chemical dyes, water penetrants, and water retention agents, may be added at the discretion of the CONTRACTOR, with approval of the CQA Engineer.

**2.02 TURF REINFORCEMENT MAT**

- A. UV stability minimum tensile strength (retained after 1000 hrs) (mod. ASTM D4355) at least 80%.
- B. Minimum tensile strength (ASTM D6818) at least 100 lb/ft (18 lbs/in.).

**2.03 STRAW WATTLES**

- A. Straw Wattles shall be North American Green SediMax-SW Straw Wattles or an equivalent product accepted by the Engineer.

**PART 3: EXECUTION**

**3.01 HYDROSEEDING**

**A. PREPARATION OF SEEDING AREAS**

1. Hydroseed shall be applied to a freshly-graded surface while soil remains friable and weed-free.
2. If seeding area is compacted, loosen top ½ inch of soil to create favorable conditions for germination. Method to be approved by the CQA Engineer.

3. Remove soil lumps, ridges, and depressions.
4. Remove deleterious material.
5. Track walk with dozer.

**B. WEATHER LIMITATIONS**

1. Apply during the following months: October or November, unless otherwise approved by the CQA Engineer.
2. Do not apply in wind conditions which would not allow uniform application of hydroseed mix.
3. Apply on soil that is surface moist.

**C. EQUIPMENT**

1. Hydraulic-type pressure spray distribution system.
2. Provide tank large enough to mix grass seed, fertilizer, mulch, and water into a slurry and provide continuous mixing and agitating.

**D. MIXING AND PLACING**

1. Hydroseeding shall be made in the following single application:
2. All seed, fertilizer, and stabilizing emulsion with 2,000 pounds of mulch per acre.
3. The seed shall be applied within 60 minutes of being added to the slurry tank.
4. The hydroseeding slurry components shall be discharged from the tank within 4 hours to prevent destruction of the seed.
5. The CONTRACTOR shall add 50% more of the originally-specified seed mix to any slurry mixture which has not been applied within 4 hours after mixing. The CONTRACTOR shall add 75% more of the original seed mix after 12 hours and recharge the mix completely after 36 hours without discharge.

**E. PROTECTION**

1. Protect hydroseeding area from damage.
2. Repair damaged areas.

**3.02 STRAW WATTLES**

- B.** Install straw wattles as required by the Construction Drawings and manufacturer's recommendations.

**END OF SECTION**

**SECTION 02950  
REVEGETATION**

**PART 1: GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. This section describes the requirements for revegetation associated with the construction of the Module 6 Base Liner System at WRSL.

**1.02 RELATED SECTIONS**

- A. Section 02200 – Earthwork

**1.02 REFERENCES**

- A. NOT APPLICABLE

**1.03 SUBMITTALS**

- A. Product data: within 30 days after Contractor has received the Owner's notice to proceed, submit:
1. Complete materials list of items proposed to be provided under this section.
  2. Complete data on source, size, and quality.
  3. Sufficient data to demonstrate compliance with the specified requirements.

**1.04 WARRANTY**

- A. Warranty period is 1 year.
- B. Replant areas that do not produce ground cover within the warrantee period at no expense to the Owner.

**PART 2: PRODUCTS**

**2.01 GRASS SEED**

- A. General: Provide grass seed which is:
1. Free from noxious weed seeds and re-cleaned.
  2. Grade A recent crop seed.
  3. Treated with appropriate fungicide at time of mixing.
  4. Delivered to site in sealed containers with dealers guaranteed analysis.
- B. The Contractor shall use the seed mix shown in Table 02950-1

**Table 02950-1  
Seed Mix**

Grass shall be:	lbs/acre
Blando Brome	10
Annual Rye	10
Rose Clover	5
Zorro Fescue	5
Arroyo Lupine	3

## **2.02 FERTILIZER**

- A. 16-20-0 mix at 500 lbs per acre.

## **2.03 MULCH**

- A. Hay Mulch – Shall consist of mowed and properly cured grass, clover or other acceptable plants, no salt hay shall be used.
- B. Straw Mulch – Shall consist of stalks, or stems of grain after threshing.
- C. Wood Fibre Mulch – Shall consist of wood fibre produced from clean, whole uncooked wood, formed into resilient bundles having a high degree of internal friction and shall be dry when delivered on the project site.

## **PART 3: EXECUTION**

### **3.01 PREPARATION OF SEEDING AREA**

- A. Contractor shall loosen the top ½-inch of soil to create favorable conditions for germination. Method to be approved by the Engineer.
- B. Remove soil lumps, ridges, and depressions.
- C. Remove deleterious material.

### **3.02 SEEDING**

- A. Seeding shall be done between September 21 and October 30, unless otherwise approved by the Engineer.
- B. If there is a delay in seeding, during which weeds grow or soil is washed out, the Contractor shall remove the weeds or replace the soil before sowing the seed, without additional compensation.
- C. Contractor shall lightly rake soil immediately before seeding is begun.
- D. Seed shall be sown in the stockpile by machine. Water seeding (hydroseeding) will be permitted after approval by the Engineer.
- E. Application rate as specified in Table 02950-1.

### **3.03 APPLYING FERTILIZER**

- A. Apply at 500 pounds per acre.
- B. Apply organic stabilizing emulsion at 100 pounds per acre.

### **3.04 PLACING MULCH**

- A. Hay or Straw Mulch: Loosely spread to a uniform depth over all areas designated on the plans, at the rate 1,500 pounds per acre, or as otherwise directed.
- B. Hay or Straw Mulch: Apply by mechanical apparatus, if in the judgment of the Engineer the apparatus spreads the mulch uniformly and forms a suitable mat to control slope erosion. The apparatus shall be capable of spreading at least 80% of the hay or straw in lengths of 6-inches or more, otherwise it shall be spread by hand without additional compensation.
- C. Wood Fibre Mulch: Spread uniformly over certain selected seeded areas at the minimum rate of 1,500 pounds per acre unless otherwise directed. It shall be placed by spraying from an approved spraying machine having pressure sufficient to cover the entire area in one operation.

### **3.05 SEEDING AND MULCHING BY SPRAY MACHINE**

- A. Application of fertilizer, grass seed, and mulch may be accomplished in one operation by the use of an approved spraying machine. The materials shall be mixed with water in the machine and kept in an agitated state in order that the materials may be uniformly suspended in the water. The spraying equipment shall be so designed that when the

solution is sprayed over an area, the resulting deposits of fertilizer, grass seed, and mulch shall be equal in quantity to those quantities specified.

**3.06 PROTECTION**

- A. Protect seeding area from damage.
- B. Repair damaged areas at no additional cost to the Owner.

**END OF SECTION**

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**PREVIEW**

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**PREVIEW**

**DIVISION 3**

**CONCRETE**



**SECTION 03300**  
**CAST-IN-PLACE CONCRETE**

**PART 1: GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. This section describes the requirements for the cast-in-place concrete for concrete pads associated with the construction of the Module 6 Base Liner System at WRS�.
- B. Technical Specifications for the cast-in-place concrete for the solidification basins can be found in the Construction Drawings.

**1.02 REFERENCES**

- A. American Concrete Institute (ACI):
  - 1. 301 Specifications for Structural Concrete for Buildings
  - 2. 308 Standard Practice for Curing Concrete
  - 3. 318 Building Code Requirements for Reinforced Concrete
- B. American Society for Testing and Materials (ASTM):
  - 1. A185 Specification for Welded Steel Wire Fabric for Concrete Reinforcement
  - 2. A615 Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement
  - 3. C33 Specification for Concrete Aggregates
  - 4. C39 Test Method for Compressive Strength of Cylindrical Concrete Specimens
  - 5. C42 Drilled Cores and Sawed Beams of Concrete
  - 6. C94 Standard specification for Ready-Mixed Concrete
  - 7. C143 Test Method for Slump of Portland Cement Concrete
  - 8. C150 Specification for Portland Cement

**1.03 QUALITY ASSURANCE**

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Comply with ACI 301, except as may be modified herein.
- C. Provide access for, and cooperate with, the Monitor and testing laboratory.
  - 1. Do not commence placement of concrete until mix designs have been reviewed and approved by the CQA Engineer, and until copies of the approved mix designs are at the Site and the batch plant.
  - 2. Three concrete test cylinders will be taken by an independent testing laboratory for every 150 cubic yards of concrete placed, but not less than one set per day. One of the test cylinders shall be tested at 7 days for 70 percent of design strength and the remaining two shall be tested at 28 days for full design strength.

**1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with pertinent provisions of ACI 301.

**1.05 SUBMITTALS**

- A. Submit the following to the CQA Engineer for review and approval at least 14 days before intended placement.
  - 1. Concrete mix designs.
  - 2. Materials list of items proposed to be provided under this Section.

3. Manufacturer's specifications and other data needed to prove conformance with the specified requirements.
  4. Manufacturer's recommended installation procedures which, when approved by the CQA Engineer, will become the basis for accepting or rejecting actual installation procedures used for the Work.
- B. Distribute approved mix designs to testing laboratory, batch plant, the Site, the Owner, and the CQA Engineer.

## **PART 2: PRODUCTS**

### **2.01 FORMWORK**

- A. Design, erect, support, brace, and maintain formwork so it will safely support vertical and lateral loads which might be applied until such loads can be supported safely by the concrete structure.
- B. Construct formwork to the exact sizes, shapes, lines, and dimensions shown on the Construction Drawings, and as required to obtain accurate alignment, location, grades, and level and plumb work in the finished structure.

### **2.02 REINFORCEMENT**

- A. Comply with the Following as Minimums:
1. Bars: ASTM A615, grade 60 unless otherwise shown on the Construction Drawings, using deformed bars for number 3 and larger,
  2. Welded Wire Fabric: ASTM A185,
  3. Bending: ACI 318.
- B. Fabricate reinforcement to the required shapes and dimensions, within fabrication tolerances stated in the CRSI "Manual of Standard Practices."
- C. Do not use reinforcement having any of the following defects:
1. Bar lengths, depths, or bends exceeding the specified fabricating tolerances,
  2. Bends or kinks not indicated on the Drawings or required for this Work,
  3. Bars with cross-section reduced due to excessive rust or other causes.

### **2.03 CONCRETE**

- A. The class, strength, mix, curing and testing of concrete shall conform to provisions of ACI 308 unless otherwise specified in plans or in these specifications. Comply with what is shown on the Construction Drawings as Minimums:
- B. Provide concrete with the compressive strengths shown on the Construction Drawings.

### **2.04 OTHER MATERIALS**

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the CONTRACTOR subject to the approval of the CQA Engineer.

## **PART 3: EXECUTION**

### **3.01 SURFACE CONDITIONS**

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completions of the Work. Notify the Owner and the CQA Engineer of such conditions and proposed corrective action before correcting unsatisfactory conditions. Do not proceed until unsatisfactory conditions are corrected.

### **3.02 REINFORCING**

- A. Comply with the following, as well as the specified standards, for details and methods of reinforcing placement and supports.

1. Clean reinforcement and remove loose dust and mill scale, earth, and other materials which reduce bond or destroy bond with concrete.
2. Position, support, and secure reinforcement to prevent displacement by forms, construction, and the concrete placement operations.
3. Place reinforcement to obtain the required coverage for concrete protection.
4. Install welded wire fabric in as long lengths as practicable, overlapping adjoining pieces one full mesh minimum.
5. Unless otherwise shown on the Construction Drawings, or required by governmental agencies having jurisdiction, overlap bars 32 diameters minimum.

### **3.03 EMBEDDED ITEMS**

- A. Do not embed piping or conduit in structural concrete.
- B. Embedded items shall be set in concrete as indicated on the Construction Drawings.
- C. Set bolts, inserts, and other required items in the concrete, secured so they will not be displaced, and in the precise locations needed. Set anchor bolts within tolerances recommended by manufacturer.
- D. Do not cut in place concrete to place work left out through oversight, except by approval of the Owner/ CQA Engineer.

### **3.04 MIXING CONCRETE**

- A. Transit mix the concrete in accordance with provisions of ASTM C94.
- B. Mixing Water
  1. At the batch plant, withhold 2 1/2 gallons of water per cu yd of concrete.
  2. Upon arrival at the job site, add all or part of the withheld water (as required for proper slump) before the concrete is discharged from the mixer.
    - a) Slump allowance shall be between 2 and 4 inches as determined using ASTM C143.
  3. Supply test cone and all other required materials to perform test.
  4. Mix not less than five minutes after the withheld water has been added, and not less than one minute of that time immediately prior to discharge of the batch.
  5. Unless otherwise directed provide 15 minutes total mixing time per batch after the first additions of the withheld water.
- C. Do not use concrete that has stood for over 30 minutes after leaving the mixer, or concrete that is not placed within 60 minutes after water is first introduced into the mix.

### **3.05 TESTING**

- A. Testing to be performed by the Owner's CQA Engineer.

### **3.06 PLACING CONCRETE**

- A. Preparation:
  1. Remove foreign matter accumulated in the forms and footing excavations.
  2. Rigidly close openings left in the formwork.
  3. Wet wooden form work sufficiently to tighten up cracks; wet other material sufficiently to maintain workability of the concrete.
  4. Use only clean tools.
  5. Do not place concrete in weather conditions which may be detrimental to the quality of the final product, including:
    - a) Temperature below 32°F
  6. During precipitation:

- a) In the presence of excessive moisture (fog, dew, mist, etc.)
- B. Conveying:
  - 1. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic.
  - 2. Deposit concrete in its final location, as practicable, so as to avoid separation due to rehandling and flowing.
  - 3. Do not use concrete which becomes non-plastic and unworkable, or does not meet required quality control limits, or has been contaminated by foreign materials.
  - 4. Remove rejected concrete from the job site.
- C. Placing Concrete in Forms:
  - 1. Deposit concrete in horizontal layers not deeper than 24 inches, and avoid inclined construction joints.
  - 2. Remove temporary spreaders in forms when concrete has reached the elevation of the spreaders.
- D. Placing Concrete Slabs:
  - 1. Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or Section is completed.
  - 2. Bring slab surfaces to the correct level and slope with a straightedge, and then strike off.
  - 3. Use bullfloats or darbies to smooth the surface, leaving the surface free from bumps and hollows.
  - 4. Do not sprinkle water on the plastic surface. Do not disturb the slab surface prior to start of finishing operations.

### 3.07 CONSOLIDATION

- A. General:
  - 1. Consolidate each layer of concrete immediately after placing, by use of internal concrete vibrators supplemented by hand spading, rodding, or tamping.
  - 2. Do not vibrate forms or reinforcement.
  - 3. Do not use vibrators to transport concrete inside the forms.

### 3.08 JOINTS

- A. Construction Joints:
  - 1. Do not use horizontal construction joints except as may be shown on the Drawings.
  - 2. If additional construction joints are found to be required, secure the Owner/ CQA Engineer's approval of joint design and location prior to start of concrete placement.
- B. Expansion Joints:
  - 1. Do not permit reinforcement or other embedded metal items that are being bonded with concrete to extend continuously through any expansion joint.
  - 2. Fill expansion joints full depth with expansion joint material approved by the Owner/ CQA Engineer.

### 3.09 CONCRETE FINISHING

- A. Except as may be shown otherwise on the Drawings, provide the following finishes at the indicated locations.
  - 1. Class I Trowel Finish: Apply to exposed vertical surfaces above finished ground

and to at least 1 foot below finished ground.

2. Non-slip Broom Finish: Apply to horizontal surfaces of slabs and bases.
- B. Finished work shall contact a 10 foot straight edge in any direction with a 1/8-inch maximum tolerance.
- C. Provide finished concrete surfaces conforming to the following tolerances:
  1. Maximum Variation from Plumb in all Vertical Lines and Surfaces: 1/4 inch in 10 feet.
  2. Maximum Variation from Level or Grades Indicated: 1/4 inch in 10 feet.
  3. Maximum Variation in Cross-Sectional Dimensions and Slab Thickness: minus 1/4 inch, plus 1/4 inch.

### **3.10 CURING**

- A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Cure surfaces in accordance with ACI 308.
- D. Ponding: Maintain 100 percent coverage of water over floor slab areas continuously for 4 days minimum.
- E. Spraying: Spray water over floor slab areas and maintain wet for 7 days minimum.

### **3.11 PROTECTION OF WORK**

- A. Protect all concrete pours from damage or premature loadings prior to complete curing of the concrete.

### **3.12 REMEDIAL WORK**

- A. Repair or replace deficient or damaged work as directed by the Owner/ CQA Engineer and at no additional cost to the Owner.

**END OF SECTION**