REVISED TECHNICAL SPECIFICATIONS

For the Construction of

Cell 4A Lining System

White Mesa Mill

Blanding, Utah

Prepared for:

Denison Mines (USA) Corporation

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CERTIFICATION PAGE

TECHNICAL SPECIFICATIONS
CELL 4A LINING SYSTEM CONSTRUCTION
DENISON MINES (USA) CORPORATION
WHITE MESA MILL
BLANDING, UTAH

The Engineering material and data contained in these Technical Specifications were prepared under the supervision and direction of the undersigned, whose seal as a registered Professional Engineer is affixed below.

Gregory T. Corcoran, P.E.
Engineer of Record

TABLE OF CONTENTS

Section 01010	**—**	**Summary of Work**
Section 01025	**—**	**Measurement & Payment**
Section 01300	**—**	**Submittals**
Section 01400	**—**	**Quality Control**
Section 01500	**—**	**Construction Facilities**
Section 01505	**—**	**Mobilization / Demobilization**
Section 01560	**—**	**Temporary Controls**
Section 01700	**—**	**Contract Closeout**
Section 02010	**—**	**Demolition**
Section 02220	**—**	**Subgrade Preparation**
Section 02225	**—**	**Drainage Aggregate**
Section 02616	**—**	**PVC Pipe**
Section 02770	**—**	**Geomembrane**
Section 02771	**—**	**Geotextile**
Section 02772	**—**	**Geosynthetic Clay Liner**
Section 02773	**—**	**Geonet**
Section 03400	**—**	**Cast-In-Place Concrete**

SECTION 01010
SUMMARY OF WORK

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The Work generally involves the preparation of subgrade, installation of geosynthetic liner system, and associated piping.

B. The Work will generally consist of:

1. Initial topographic survey;
2. Mass excavation and subgrade preparation;
3. Anchor trench and leak detection system trench excavation;
4. Installation of needle-punched geosynthetic clay liner (GCL) consisting of woven and nonwoven geotextiles;
5. Installation of 60-mil HDPE secondary geomembrane;
6. Installation of leak detection system 4-inch and 18-inch PVC pipe and fittings;
7. Installation of aggregate within leak detection system pipe trench and sump;
8. Installation of 300 mil geonet;
9. Installation of 60-mil HDPE primary geomembrane;
10. Installation of 16 oz./SY nonwoven geotextile cushion;
11. Installation of slimes drain 4-inch and 18-inch PVC pipe and fittings;
12. Installation of aggregate around slimes drain and within sump; and
13. Installation of strip composite drainage layer.

1.02 CONTRACTOR'S RESPONSIBILITIES

A. Start, layout, construct, and complete the Project in accordance with the Technical Specifications, CQA Plan, and Drawings (Contract Documents).

B. Provide a competent Site superintendent, capable of reading and understanding the Construction Documents, who shall receive instructions from the Construction Manager.

C. Establish means, techniques, and procedures for constructing and otherwise executing the Work.

D. Establish and maintain proper Health and Safety practices for the duration of the Project.

E. Except as otherwise specified, furnish the following and pay the cost thereof:

1. Labor, superintendent, and products.
2. Construction supplies, equipment, tools, and machinery.
3. Water, electricity, and other utilities required for construction.
4. Other facilities and services necessary to properly execute and complete the Work.

5. A Registered Land Surveyor, licensed in the State of Utah, to survey and layout the Work, and to certify as-built Record Drawings.

F. Pay cost of legally required sales, consumer, and use taxes and governmental fees.

G. Perform Work in accordance with codes, ordinances, rules, regulations, orders, and other legal requirements of governmental bodies and public agencies bearing on performance of Work.

H. Forward submittals and communications to the Construction Manager. Where applicable, the Construction Manager will coordinate submittals and communications with the representatives who will give approvals and directions through the Construction Manager.

I. Maintain order, safe practices, and proper conduct at all times among Contractor's employees. The Owner, and its authorized representative, may require that disciplinary action be taken against an employee of the Contractor for disorderly, improper, or unsafe conduct. Should an employee of the Contractor be dismissed from his duties for misconduct, incompetence, or unsafe practice, or combination thereof, that employee shall not be rehired for the duration of the Work.

J. Coordinate the Work with the utilities, private utilities, and/or other parties performing work on or adjacent to the Site. Eliminate or minimize delays in the Work and conflicts with those utilities or contractors. Coordinate activities with the Construction Manager. Schedule private utility and public utility Work relying on survey points, lines, and grades established by the Contractor to occur immediately after those points, lines and grades have been established.

K. Coordinate activities of the several trades, suppliers, and subcontractors, if any, performing the Work.

1.03 NOTIFICATION

A. The Contractor shall notify the Construction Manager in writing if he elects to subcontract, sublet, or reassign any portion of the Work. This shall be done at the time the bid is submitted. The written statement shall describe the portion of the Work to be performed by the Subcontractor and shall include an indication, by reference if desired by the Construction Manager, that the Subcontractor is particularly experienced and equipped to perform that portion of the Work. No portion of the Work shall be subcontracted, sublet, or reassigned without written permission of the Construction Manager. Consent to subcontract, sublet, or reassign any portion of the Work by the Construction Manager shall not be considered as a testimony of the Construction Manager as to the qualifications of the Subcontractor and shall not be construed to relieve the Contractor of any responsibilities for completion of the Work.

1.04 CONFORMANCE

A. Work shall conform to the Technical Specifications, CQA Plan, and Drawings that form a part of these Contract Documents.

B. Omissions from the Technical Specifications, CQA Plan, and Drawings or the misdescription of details of Work which are necessary to carry out the intent of the Contract Documents are customarily performed, shall not relieve the Contractor from performing such omitted or misdescribed details of the Work, but they shall be performed as if fully and correctly set forth and described in the Technical Specifications, CQA Plan, and Drawings.

1.05 DEFINITIONS

A. **OWNER** - The term Owner means the Denison Mines (USA) Corporation for whom the Work is to be provided.

B. **CONSTRUCTION MANAGER** – The term Construction Manager means the firm responsible for project administration and project documentation control. All formal documents will be submitted to the Construction Manager for proper distribution and/or review. During the period of Work the Construction Manager will act as an authorized representative of the Owner.

C. **DESIGN ENGINEER** - The term Design Engineer means the firm responsible for the design and preparation of the Construction Documents. The Engineer is responsible for approving all design changes, modifications, or clarifications encountered during construction. The Design Engineer reports directly to the Owner.

D. **CQA ENGINEER** – The term CQA Engineer refers to the firm responsible for CQA related monitoring and testing activities. The CQA Engineer's authorized personnel will include CQA Engineer-of-Record and Lead CQA Monitor. The CQA Engineer may also perform CQC work as appropriate. The CQA Engineer reports directly to the Owner.

E. **CONTRACTOR** - The term Contractor means the firm that is responsible for the Work. The Contractor's responsibilities include the Work of any and all of subcontractors and suppliers. The Contractor reports directly to the Construction Manager. All subcontractors report directly to the Contractor.

F. **SURVEYOR** – The term Surveyor means the firm that will perform survey and provide as-built Record Drawings for the Work. The Surveyor shall be a Registered Land Surveyor, licensed to practice in the State of Utah. The Surveyor is employed by and reports directly to the Contractor.

G. **SITE** - The term Site refers to all approved staging areas, and all areas where the Work is to be performed, both public and privately owned.

H. **WORK** - The term Work means the entire completed construction, or various separately identifiable parts thereof, required to be furnished under the Contract Documents. Work includes any and all labor, services, materials, equipment, tools, supplies, and facilities required by the Contract Documents and necessary for the completion of the project. Work is the result of performing services, furnishing labor, and furnishing and incorporating materials and equipment into the construction, all as required by the Contract Documents.

I. **DAY** - A calendar day on which weather and other conditions not under the control of the Contractor will permit construction operations to proceed for the major part of the day with the normal working force engaged in performing the controlling item or items of Work which would be in progress at that time.

J. **CONTRACT DOCUMENTS** - Contract Documents consist of the Technical Specifications, CQA Plan, and Drawings.

1.06 CONTRACT TIMES

A. The time stated for completion and substantial completion shall be in accordance with the Contract Times specified in the Agreement. Extensions to the Contract Time of performance shall be granted for those days when the Contractor is unable to work due to adverse weather conditions or as a result of abnormal conditions. Extension of time of performance based on adverse weather conditions shall be granted when requested by the Contractor and reviewed

in writing by the Construction Manager. All requests for extensions of time by the Contractor based on adverse weather conditions must be submitted in writing to the Construction Manager within five (5) working days of the time in question. No claims for damages shall be made by the Contractor for delays.

B. Contractor shall adhere to the schedule provided in the Contract. Unapproved extensions to the schedule will result in the Contractor paying liquidated damages in the amount of $4,000 per day to cover costs associated with Construction Management and construction oversight.

1.07 CONTRACTOR USE OF WORK SITE

A. Confine Site operations to areas permitted by law, ordinances, permits, and the Contract Documents. The Contractor shall ensure that all persons under his control (including Subcontractors and their workers and agents) are kept within the boundaries of the Site and shall be responsible for any acts of trespass or damage to property by persons who are under his control. Consider the safety of the Work, and that of people and property on and adjacent to work Site, when determining amount, location, movement, and use of materials and equipment on work Site.

B. The Contractor shall be responsible for protecting private and public property including pavements, drainage culverts, electricity, highway, telephone, and similar property and shall make good of, or pay for, all damage caused thereto. Control of erosion throughout the project is of prime importance and is the responsibility of the Contractor. The Contractor shall provide and maintain all necessary measures to control erosion during progress of the Work to the satisfaction of the Construction Manager and all applicable laws and regulations, and shall remove such measures and collected debris upon completion of the project. All provisions for erosion and sedimentation control apply equally to all areas of the Work.

C. Contractor shall promptly notify the Construction Manager in writing of any subsurface or latent physical conditions at the Site that differ materially from those indicated or referred to in the Contract Documents. Construction Manager will promptly review those conditions and advise Owner in writing if further investigations or tests are necessary. If the Construction Manager finds that the results of such investigations or tests indicate that there are subsurface and latent physical conditions which differ materially from those intended in the Contract Documents, and which could not reasonably have been anticipated by Contractor, a Change Order shall be issued incorporating the necessary revisions.

D. At no time shall Contractor interfere with operations of businesses on or in the vicinity of the Site. Should the Contractor need to work outside the regular working hours, the Contractor is required to submit a written request and obtain approval by the Construction Manager.

1.08 PRESERVATION OF SCIENTIFIC INFORMATION

A. Federal and State legislation provides for the protection, preservation, and collection of data having scientific, prehistoric, historical, or archaeological value (including relics and specimens) that might otherwise be lost due to alteration of the terrain as a result of any construction work. If evidence of such information is discovered during the course of the Work, the Contractor shall notify the Construction Manager immediately, giving the location and nature of the findings. Written confirmation shall be forwarded within two (2) working days.

B. The Contractor shall exercise care so as not to damage artifacts uncovered during excavation operations, and shall provide such cooperation and assistance as may be necessary to preserve the findings for removal or other disposition by the Construction Manager or Government agency.

C. Where appropriate, by reason of a discovery, the Construction Manager may order delays in the time of performance, or changes in the Work, or both. If such delays, or changes, or both, are ordered, the time of performance and contract price shall be adjusted in accordance with the applicable clauses of the Contract.

1.09 MEASUREMENT AND PAYMENT

A. Measurement for Work will be according to the work items listed in Section 01025 of these Specifications.

1.10 EXISTING UTILITIES

A. The Contractor shall be responsible for locating, uncovering, protecting, flagging, and identifying all existing utilities encountered while performing the Work. The Contractor shall request that Underground Service Alert (USA) locate and identify the existing utilities. The request shall be made 48 hours in advance.

B. Costs resulting from damage to utilities shall be borne by the Contractor. Costs of damage shall include repair and compensation for incidental costs resulting from the unscheduled loss of utility service to affected parties.

C. The Contractor shall immediately stop work and notify the Construction Manager of all utilities encountered and damaged. The Contractor shall also Survey the exact location of any utilities encountered during construction.

1.11 CONTRACTOR QUALIFICATIONS

A. The Contractor, and all subcontractors, shall be licensed at the time of bidding, and throughout the period of the Contract, by the State of Utah to do the type of work required under terms of these Contract Documents. By submitting a bid, the Contractor certifies that he is skilled, competent, and knowledgeable on the nature, extent and inherent conditions of the Work to be performed and has been regularly engaged in the general class and type of work called for in these Contract Documents and meets the qualifications required in these Specifications.

B. The Construction Manager shall disqualify a bidder that either cannot provide references, or if the references cannot substantiate the Contractor's qualifications.

C. By submission of a bid for this Project, the Contractor acknowledges that he is thoroughly familiar with the Site conditions.

1.12 INTERPRETATION OF TECHNICAL SPECIFICATIONS, CQA PLAN, AND DRAWINGS

A. Should it appear that the Work to be done or any matters relative thereto are not sufficiently detailed or explained in the Technical Specifications, CQA Plan, and/or Drawings, the Design Engineer will further explain or clarify, as may be necessary. In the event of any questions arising respecting the true meaning of the Contract Documents, the matter shall be referred to the Design Engineer, whose decision thereon shall be final.

1.13 HEALTH AND SAFETY

A. The Contractor shall be responsible for health and safety of its own crew, subcontractors, suppliers, and visitors. Contractor shall adhere to the Contractor Safety Rules for the site.

1.14 GENERAL REQUIREMENTS

A. SURVEYING - The Surveyor shall be responsible for all surveying required to layout and control the Work. Surveying shall be conducted such that all applicable standards required by the State of California.

B. PERMITS - The Contractor shall be required to obtain permits in accordance with construction of the facility.

C. SEDIMENTATION, EROSION CONTROL, AND DEWATERING - Contractor shall comply with all laws, ordinances, and permits for controlling erosion, water pollution, and dust emissions resulting from construction activities; the Contractor shall be responsible for any fines imposed due to noncompliance. The Contractor shall perform work in accordance with the Storm Water Pollution Prevention Plan (SWPPP) provided by the Owner. The Contractor shall pump all water generated from dewatering into Cell 3, as directed by the Construction Manager.

D. PROTECTION OF EXISTING SERVICES AND WELLS - The Contractor shall exercise care to avoid disturbing or damaging the existing monitor wells, electrical poles and lines, permanent below-ground utilities, permanent drainage structures, and temporary utilities and structures. When the Work requires the Contractor to be near or to cross locations of known utilities, the Contractor shall carefully uncover, support and protect these utilities and shall not cut, damage, or otherwise disturb them without prior authorization from the Construction Manager. All utilities or wells damaged by the Contractor shall be immediately repaired by the Contractor to the satisfaction of the Construction Manager at no additional cost.

E. BURNING - The use of open fires for any reason is prohibited.

F. TEMPORARY ROADS - The Contractor shall be responsible for constructing and maintaining all temporary roads and lay down areas that the Contractor may require in the execution of the Work.

G. CONSTRUCTION WATER - The Contractor shall obtain for water from the Owner for construction and dust control. The Contractor shall not add substances (such as soap) to construction water. The Contractor shall utilize measuring devices that allow him to track the volume of water used. Such usage records shall be maintained and provided to the Construction Manager.

H. COOPERATION - The Contractor shall cooperate with all other parties engaged in project-related activities to the greatest extent possible. Disputes or problems should be referred to the Construction Manager for resolution.

I. FAMILIARIZATION - The Contractor is responsible for becoming familiar with all aspects of the Work prior to performing the Work.

J. SAFEGUARDS - The Contractor shall provide and use all personnel safety equipment, barricades, guardrails, signs, lights, flares, and flagmen as required by OSHA, state, or local codes and ordinances. No excavations deeper than 4 feet with side slopes steeper than 2:1 (horizontal:vertical) shall be made without the prior approval of the Design Engineer and the Construction Manager. When shoring is required, the design and inspection of such shoring shall be the Contractor's responsibility and shall be subject to the review of the Design

Engineer and Construction Manager prior to use. No personnel shall Work within or next to an excavation requiring shoring until such shoring has been installed, inspected, and approved by an engineer registered in the State of Utah. The Contractor shall be responsible for any fines imposed due to violation of any laws and regulations relating to the safety of the Contractor's personnel.

K. CLEAN-UP - The Contractor shall be responsible for general housekeeping during construction. Upon completion of the Work, the Contractor shall remove all of his equipment, facilities, construction materials, and trash. All disturbed surface areas shall be re-paved, re-vegetated, or otherwise put into the pre-existing condition before performing the Work, or a condition satisfactory to the Construction Manager.

L. SECURITY - The Contractor is responsible for the safety and condition of all of his tools and equipment.

M. ACCEPTANCE OF WORK - The Contractor shall retain ownership and responsibility for all Work until accepted by Construction Manager. Construction Manager will accept ownership and responsibility for the Work: (i) when all Work is completed; and (ii) after the Contractor has submitted all required documentation, including manufacturing quality control documentation and manufacturing certifications.

PART 2 – PRODUCTS

NOT USED.

PART 3 – EXECUTION

NOT USED.

PART 4 – MEASUREMENT AND PAYMENT

NOT USED.

[END OF SECTION]

SECTION 01025
MEASUREMENT AND PAYMENT

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. This section covers measurement and payment criteria applicable to the Work performed under lump sum and unit price payment methods, and non-payment for rejected work.

1.02 RELATED SECTIONS

A. This section relates to all other sections of the contract.

1.03 AUTHORITY

A. Measurement methods delineated in the individual specification sections are intended to complement the criteria of this section. In the event of conflict, the requirements of the individual specification section shall govern.

B. A surveyor, licensed in the State of Utah, hired by the Contractor will take all measurements and compute quantities accordingly. All measurements, cross-sections and quantities shall be stamped and certified by the licensed surveyor and submitted to the Construction Manager. The Construction Manager maintains the right to provide additional measurements and calculation of quantities to verify measurements and quantities submitted by the Contractor.

1.04 UNIT QUANTITIES SPECIFIED

A. Quantities and measurements indicated in the Bid Schedule are for bidding and contract purposes only. Quantities and measurements supplied or placed in the Work and verified by the Construction Manager shall determine payment. If the actual work requires more or fewer quantities than those quantities indicated, the Contractor shall provide the required quantities at the lump sum and unit prices contracted unless modified elsewhere in these Contract Documents.

B. Utah sales tax shall be included in each bid item as appropriate.

1.05 MEASUREMENT OF QUANTITIES

A. Measurement by Volume: Measurement shall be by the cubic dimension using mean lengths, widths and heights or thickness, or by average end area method as measured by the surveyor. All measurement shall be the difference between the original ground surface and the design ("neat-line") dimensions and grades.

B. Measurement by Area: Measurement shall be by the square dimension using mean lengths and widths and/or radius as measured by the surveyor. All measurement shall be the difference between the original ground surface and the design ("neat-line") dimensions and grades.

C. Linear Measurement: Measurement shall be by the linear dimension, at the item centerline or mean chord. All measurement shall be the difference between the original ground surface and the design ("neat-line") dimensions and grades.

D. Stipulated Lump Sum Measurement: Items shall be measured as a percentage by weight, volume, area, or linear means or combination, as appropriate, of a completed item or unit of Work.

1.06 PAYMENT

A. Payment includes full compensation for all required labor, products, tools, equipment, transportation, services and incidentals; erection, application or installation of an item of the Work; and all overhead and profit. Final payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities accepted by the Construction Manager multiplied by the unit price for Work which is incorporated in or made necessary by the Work.

B. A monthly progress payment schedule will be used to compensate the Contractor for the Work. The monthly amount to be paid to the Contractor is calculated as the percent of completed work for each bid item multiplied by the total anticipated work for that bid item minus a 10 percent retainer.

C. When the Contractor has completed all Work associated with completion of the project, the remaining 10 percent retainer of the contract amount will be paid to the Contractor after filing the Notice of Completion.

1.07 NON-PAYMENT FOR REJECTED PRODUCTS

A. Payment shall not be made for any of the following:

1. Products wasted or disposed of in a manner that is not acceptable.
2. Products determined as unacceptable before or after placement.
3. Products not completely unloaded from the transporting vehicle.
4. Products placed beyond the design lines, dimensions, grades and levels of the required Work.
5. Products remaining on hand after completion of the Work.
6. Loading, hauling, and disposing of rejected Products.
7. Products rejected because of contamination (i.e. soil residues, fuel spills, solvents, etc.).

1.08 BID ITEMS

A. The following bid items shall be used by the Owner and by the Contractor to bid the Work described in these bid documents.

BID ITEM	SECTION	DESCRIPTION	UNITS
1	01500	Construction Facilities	LS
2	01505	Mobilization / Demobilization	LS
3	02220	Subgrade Preparation	SF
4	02220	Anchor Trench	LF
5	02616	4-inch PVC Pipe and Fittings	LF
6	02616	18-inch PVC Pipe and Fittings	LF
7	02616	Strip Drain Composite	LF
8	02770	60-mil Smooth HDPE Geomembrane	SF
9	02772	Geosynthetic Clay Liner	SF

BID ITEM	SECTION	DESCRIPTION	UNITS
10	02773	300-mil Geonet	SF
11	03400	Cast-In-Place Concrete	LS

PART 2 – PRODUCTS

NOT USED.

PART 3 – EXECUTION

NOT USED.

PART 4 – MEASUREMENT AND PAYMENT

NOT USED.

[END OF SECTION]

SECTION 01300
SUBMITTALS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. This section contains requirements for administrative and work-related submittals such as construction progress schedules, Shop Drawings, test results, operation and maintenance data, and other submittals required by Contract Documents.

B. Submit required materials to the Construction Manager for proper distribution and review in accordance with requirements of the Contract Documents**.**

1.02 CONSTRUCTION PROGRESS SCHEDULES

A. The Contractor shall prepare and submit two (2) copies of the construction progress Schedule to the Construction Manager for review within 5 days after the effective date of Contract.

B. Schedules shall be prepared in the form of a horizontal bar chart. The schedule shall include the following items.

1. A separate horizontal bar for each operation.
2. A horizontal time scale, which identifies the first workday of each week.
3. A scale with spacing to allow space for notations and future revisions.
4. Listings arranged in order of start for each item of the Work.

C. The Construction Progress Schedule for construction of the Work shall include the following items where applicable.

1. Submittals: dates for beginning and completion of each major element of construction and installation dates for major items. Elements shall include, but not be limited to, the following items which are applicable:

    a. Mobilization schedule
    b. Demobilization schedule.
    c. Final site clean-up.
    d. Show projected percentage of completion for each item as of first day of each week.
    e. Show each individual Bid Item.

D. Schedule Revisions:

1. Bi-weekly to reflect changes in progress of Work.
2. Indicate progress of each activity at submittal date.
3. Show changes occurring since the previous schedule submittal. Changes shall include the following.

    a. Major changes in scope.
    b. Activities modified since previous submittal.

c. Revised projections of progress and completion.

d. Other identifiable changes.

4. Provide narrative report as needed to define:

a. Problem areas, anticipated delays, and impact on schedule.

b. Recommended corrective action and its effect.

1.03 CONSTRUCTION WORK SCHEDULE

A. The Contractor shall submit an updated 14-day work schedule at the beginning of each week by Monday morning at 8:00 a.m. The schedule shall address applicable line items from the construction project schedule with a refined level of detail for special activities.

1.04 SHOP DRAWINGS AND SAMPLES

A. Shop Drawings, product data, and samples shall be submitted as required in individual Sections of the Specifications.

B. The Contractor's Responsibilities:

1. Review Shop Drawings, product data, and samples prior to submittal.

2. Determine and verify:

a. Field measurements.

b. Field construction criteria.

c. Catalog numbers and similar data.

d. Conformance with Specifications.

3. Coordinate each submittal with requirements of the Work and Contract Documents.

4. Notify the Construction Manager in writing, at the time of the submittal, of deviations from requirements of Contract Documents.

5. Begin no fabrication or Work pertaining to required submittals until return of the submittals with appropriate approval.

6. Designate dates for submittal and receipt of reviewed Shop Drawings and samples in the construction progress schedule.

C. Submittals shall contain:

1. Date of submittal and dates of previous submittals.

2. Project title and number.

3. Contract identification.

4. Names of:

a. The Contractor.

b. Supplier.

c. Manufacturer.

5. Summary of items contained in the submittal.

6. Identification of the product with identification numbers, and the Drawing and Specification section numbers.
7. Clearly identified field dimensions.
8. Details required on the Drawings and in the Specifications.
9. Manufacturer, model number, dimensions, and clearances, where applicable.
10. Relation to adjacent or critical features of the Work or materials.
11. Applicable standards, such as ASTM or Federal Specification numbers.
12. Identification of deviations from Contract Documents.
13. Identification of revisions on re-submittals.
14. 8-in. by 3-in. blank space for the Contractor's and proper approval stamp.
15. The Contractor's stamp, signed, certifying to review of the submittal, verification of the products, field measurements, field construction criteria, and coordination of information within the submittal with requirements of Work and Contract Documents.

D. Re-submittal Requirements:

1. Re-submittal is required when corrections or changes in submittals are required by the Construction Manager, Design Engineer, or CQA Engineer. Re-submittals are required until all comments by the Construction Manager, Design Engineer, or CQA Engineer is addressed and the submittal is approved.
2. Shop Drawings and Product Data:
    a. Revise initial drawings or data and resubmit as specified for initial submittal.
    b. Indicate changes made other than those requested by the Construction Manager, Design Engineer, or CQA Engineer.

E. Distribute reproductions of Shop Drawings and copies of product data which have been accepted by the Construction Manager to:

1. Job site file.
2. Record documents file.

F. Construction Manager's Duties:

1. Verify that review comments are technically correct and are consistent with technical and contractual requirements of the work.
2. Return submittals to the Contractor for distribution or re-submittal.

G. Design Engineer's Duties:

1. Review submittals promptly for compliance with contract documents and in accordance with the schedule.
2. Affix stamp and signature, and indicate either the requirements for re-submittal or no comments.
3. Return submittals to the Construction Manager.

H. CQA Engineer's Duties:

1. Review submittals promptly for compliance with contract documents and in accordance with the schedule.
2. Affix stamp and signature, and indicate either the requirements for re-submittal or no comments.
3. Return submittals to the Construction Manager.

1.05 TEST RESULTS AND CERTIFICATION

A. Results of tests conducted by the Contractor on materials or products shall be submitted for review.

B. Certification of products shall be submitted for review.

1.06 SUBMITTAL REQUIREMENTS

A. Provide complete copies of required submittals as follows.

1. Construction Work Schedule:
   a. Two copies of initial schedule.
   b. Two copies of each revision.
2. Construction Progress Schedule:
   a. Two copies of initial schedule.
   b. Two copies of each revision.
3. Shop Drawings: Two copies.
4. Certification Test Results: Two copies.
5. Other Required Submittals:
   a. Two copies if required for review.
   b. Two copies if required for record.

B. Deliver the required copies of the submittals to the Construction Manager.

PART 2 – PRODUCTS

NOT USED.

PART 3 – EXECUTION

NOT USED.

PART 4 – MEASUREMENT AND PAYMENT

NOT USED.

[END OF SECTION]

SECTION 01400
QUALITY CONTROL

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Monitor quality control over suppliers, Manufacturers, products, services, Site conditions, and workmanship, to produce Work of specified quality.

B. Comply with Manufacturers' instructions, including each step in sequence.

C. Should Manufacturers' instructions conflict with Technical Specifications, request clarification from Design Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce workmanship of specified quality.

1.02 TOLERANCES

A. Monitor tolerance control of installed products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with Manufacturers' tolerances. Should Manufacturers' tolerances conflict with Technical Specifications, request clarification from Design Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.03 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, complies with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of current issue on date of Notice to Proceed with construction, except where a specific date is established by code.

C. Obtain copies of standards where required by product Specification sections.

1.04 INSPECTING AND TESTING SERVICES

A. The CQA Engineer will perform construction quality assurance (CQA) inspections, tests, and other services specified in individual Sections of the Specification.

B. The Contractor shall cooperate with CQA Engineer; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.

C. CQA testing or inspecting does not relieve Contractor, subcontractors, and suppliers from their requirements to perform quality control Work as indicated in the Technical Specifications.

PART 2 – PRODUCTS

NOT USED.

PART 3 – EXECUTION

NOT USED.

PART 4 – MEASUREMENT AND PAYMENT

NOT USED.

[END OF SECTION]

SECTION 01500
CONSTRUCTION FACILITIES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Construction facilities include furnishing of all equipment, materials, tools, accessories, incidentals, labor, and performing all work for the installation of equipment and for construction of facilities, including their maintenance, operation, and removal, if required, at the completion of the Work under the Contract.

1.02 DESCRIPTION OF WORK

A. Construction facilities include, but are not limited to, the following equipment, materials, facilities, areas, and services:

1. Parking Areas.
2. Temporary Roads.
3. Storage of Materials and Equipment.
4. Construction Equipment.
5. Temporary Sanitary Facilities.
6. Temporary Water.
7. First Aid Facilities.
8. Health and Safety.
9. Security.

B. Construct/install, maintain, and operate construction facilities in accordance with the applicable federal, state, and local laws, rules, and regulations, and the Contract Documents.

1.03 GENERAL REQUIREMENTS

A. Contractor is responsible for furnishing, installing, constructing, operating, maintaining, removing and disposing of the construction facilities, as specified in this Section, and as required for the completion of the Work under the Contract.

B. Contractor shall maintain construction facilities in a clean, safe and sanitary condition at all times until completion of the Work.

C. Contractor shall minimize land disturbances related to the construction facilities to the greatest extent possible and restore land, to the extent reasonable and practical, to its original contours by grading to provide positive drainage and by seeding the area to match with existing vegetation or as specified elsewhere.

1.04 TEMPORARY ROADS AND PARKING AREAS

A. Temporary roads and parking areas are existing roads that are improved, or new roads constructed by Contractor for convenience of Contractor in the performance of the Work under the Contract.

B. Contractor shall coordinate construction with Construction Manager.

C. If applicable, coordinate all road construction activities with local utilities, fire, and police departments.

D. Keep erosion to a minimum and maintain suitable grade and radii of curves to facilitate ease of movement of vehicles and equipment.

E. Furnish and install longitudinal and cross drainage facilities, including, but not limited to, ditches, structures, pipes and the like.

F. Clean equipment so that mud or dirt is not carried onto public roads. Clean up any mud or dirt transported by equipment on paved roads both on-site and off-site.

1.05 STORAGE OF MATERIALS AND EQUIPMENT

A. Make arrangements for material and equipment storage areas. Locations and configurations of approved facilities are subject to the acceptance of the Construction Manager.

B. Confine all operations, including storage of materials, to approved areas. Store materials in accordance with these Technical Specifications and the Construction Drawings.

C. Store construction materials and equipment within boundaries of designated areas. Storage of gasoline or similar fuels must conform to state and local regulations and be limited to the areas approved for this purpose by the Construction Manager.

1.06 CONSTRUCTION EQUIPMENT

A. Erect, equip, and maintain all construction equipment in accordance with all applicable statutes, laws, ordinances, rules, and regulations or other authority having jurisdiction.

B. Provide and maintain scaffolding, staging, hoists, barricades, and similar equipment required for performance of the Work. Provide hoists or similar equipment with operators and signals, as required.

C. Provide, maintain, and remove upon completion of the Work, all temporary rigging, scaffolding, hoisting equipment, debris boxes, barricades around openings and excavations, fences, ladders, and all other temporary work, as required for all Work hereunder.

D. Construction equipment and temporary work must conform to all the requirements of state, county, and local authorities, OSHA, and underwriters that pertain to operation, safety, and fire hazard. Furnish and install all items necessary for conformity with such requirements, whether or not called for under separate Sections of these Technical Specifications.

1.07 TEMPORARY SANITARY FACILITIES

A. Provide temporary sanitary facilities for use by all employees and persons engaged in the Work, including subcontractors, their employees and authorized visitors, and the Construction Manager.

B. Sanitary facilities include enclosed chemical toilets and washing facilities. These facilities must meet the requirements of local public health standards.

C. Locate sanitary facilities as approved by Construction Manager, and maintain in a sanitary condition during the entire course of the Work.

1.08 TEMPORARY WATER

A. Make all arrangements for water needs from the Owner.

B. Provide drinking water for all personnel at the site.

1.09 FIRST AID FACILITIES

A. Provide first aid equipment and supplies to serve all Contractor personnel at the Site.

1.10 HEALTH AND SAFETY

A. Provide necessary monitoring equipment and personal protective equipment in accordance with Contractor prepared Site Health and Safety Plan.

1.11 SECURITY

A. Make all necessary provisions and be responsible for the security of the Work and the Site until final inspection and acceptance of the Work, unless otherwise directed by the Construction Manager.

1.12 SHUT-DOWN TIME OF SERVICE

A. Do not disconnect or shut down any part of the existing utilities and services, except by express permission of Construction Manager.

1.13 MAINTENANCE

A. Maintain all construction facilities, utilities, temporary roads, and the like in good working condition as required by the Construction Manager during the term of the Work.

1.14 STATUS AT COMPLETION

A. Upon completion of the Work, or prior thereto, when so required by Construction Manager:

1. Repair damage to roads caused by or resulting from the Contractor's work or operations.
2. Remove and dispose of all construction facilities. Similarly, all areas utilized for temporary facilities shall be returned to near original, natural state, or as otherwise indicated or directed by the Construction Manager.

PART 2 – PRODUCTS

NOT USED**.**

PART 3 – EXECUTION

NOT USED.

PART 4 – MEASUREMENT AND PAYMENT

A. Providing for and complying with the requirements set forth in this Section for Construction Facilities as lump sum (LS) and payment will be based on the unit price provided on the Bid Schedule.

B. The following are considered incidental to the Work:

1. Mobilization.
2. Temporary roadways and parking areas.
3. Temporary sanitary facilities.
4. Decontamination of equipment.
5. Security.
6. Demobilization.

[END OF SECTION]

SECTION 01505
MOBILIZATION / DEMOBILIZATION

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Mobilization consists of preparatory work and operations, including but not limited to those necessary for the movement of personnel and project safety; including: adequate personnel, equipment, supplies, and incidentals to the project Site; establishment of facilities necessary for work on the project; premiums on bond and insurance for the project and for other work and operations the Contractor must perform or costs the Contractor must incur before beginning work on the project, which are not covered in other bid items.

B. Demobilization consists of work and operations including, but not limited to, movement of personnel, equipment, supplies, and incidentals off-site.

PART 2 – PRODUCTS

NOT USED.

PART 3 – EXECUTION

NOT USED.

PART 4 – MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Providing for and complying with the requirements set forth in this Section as lump sum (LS) and payment will be based on the unit price provided on the Bid Schedule.

B. The Contract Price for Mobilization / Demobilization shall include the provision for movement of equipment onto the job site; removal of all facilities and equipment at the completion of the project; cost of bonds, both prime and subcontractors; permits; preparation of a Health and Safety Plan; all necessary safety measures; and all other related mobilization and demobilization costs. Price bid for mobilization shall not exceed 10 percent of the total bid for the Project. Fifty percent of the mobilization bid price, less retention, will be paid on the initial billing provided all equipment and temporary facilities are in place and bond fees paid. The remaining 50 percent of the mobilization bid price will be paid on satisfactory removal of all facilities and equipment on completion of the project.

[END OF SECTION]

SECTION 01560
TEMPORARY CONTROLS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Temporary Controls required during the term of the Contract for the protection of the environment and the health and safety of workers and general public.

B. Furnishing all equipment, materials, tools, accessories, incidentals, and labor, and performing all work for the installation of equipment and construction of facilities, including their maintenance and operation during the term of the Contract.

C. Temporary Controls include:

1. Dust Control.
2. Pollution Control.
3. Traffic and Safety Controls.

D. Perform Work as specified in the Technical Specifications and as required by the Construction Manager. Maintain equipment and accessories in clean, safe and sanitary condition at all times until completion of the Work.

1.02 DUST CONTROL

A. Provide dust control measures in-accordance with the Technical Specifications. Dust control measures must meet requirements of applicable laws, codes, ordinances, and permits.

B. Dust control consists of transporting water, furnishing required equipment, testing of equipment, additives, accessories and incidentals, and carrying out proper and efficient measures wherever and as often as necessary to reduce dust nuisance, and to prevent dust originating from construction operations throughout the duration of the Work.

1.03 POLLUTION CONTROL

A. Pollution of Waterways:

1. Perform Work using methods that prevent entrance or accidental spillage of solid or liquid matter, contaminants, debris, and other objectionable pollutants and wastes into watercourses, flowing or dry, and underground water sources.
2. Such pollutants and wastes will include, but will not be limited to, refuse, earth and earth products, garbage, cement, concrete, sewage effluent, industrial waste, hazardous chemicals, oil and other petroleum products, aggregate processing tailings, and mineral salts.

B. Dispose of pollutants and wastes in accordance with applicable permit provisions or in a manner acceptable to and approved by the Construction Manager.

C. Storage and Disposal of Petroleum Product:

1. Petroleum products covered by this Section include gasoline, diesel fuel, lubricants, and refined and used oil. During project construction, store all petroleum products in such a way as to prevent contamination of all ground and surface waters and in accordance with local, state, and federal regulations.

2. Lubricating oil may be brought into the project area in steel drums or other means, as the Contractor elects. Store used lubricating oil in steel drums, or other approved means, and return them to the supplier for disposal. Do not burn or otherwise dispose of at the Site.

3. Secondary containment shall be provided for products stored on site, in accordance with the Owner provided Storm Water Pollution Prevention Plan.

1.04 TRAFFIC AND SAFETY CONTROLS

A. Post construction areas and roads with traffic control signs or devices used for protection of workmen, the public, and equipment. Signs and devices must conform to the American National Standards Institute (ANSI) Manual on Uniform Traffic Control Devices for Streets and Highways.

B. Remove signs or traffic control devices after they have finished serving their purpose. It is particularly important to remove any markings on road surfaces that under conditions of poor visibility could cause a driver to turn off the road or into traffic moving in the opposite direction.

C. Provide flag persons, properly equipped with International Orange protective clothing and flags, as necessary, to direct or divert pedestrian or vehicular traffic. A full-time flag person shall be required for the duration of importation of fill.

D. Barricades for protection of employees must conform to the portions of the ANSI Manual on Uniform Traffic Control Devices for Streets and Highways, relating to barricades.

E. Guard and protect all workers, pedestrians, and the public from excavations, construction equipment, all obstructions, and other dangerous items or areas by means of adequate railings, guard rails, temporary walks, barricades, warning signs, sirens, directional signs, overhead protection, planking, decking, danger lights, etc.

F. Construct and maintain fences, planking, barricades, lights, shoring, and warning signs as required by local authorities and federal and state safety ordinances, and as required to protect all property from injury or loss and as necessary for the protection of the public, and provide walks around any obstructions made in a public place for carrying out the Work covered in this Contract. Leave all such protection in place and maintained until removal is authorized by the Construction Manager.

1.05 MAINTENANCE

A. Maintain all temporary controls in good working conditions during the term of the Contract for the safe and efficient transport of equipment and supplies, and for construction of permanent works.

1.06 STATUS AT COMPLETION

A. Upon completion of the Work, or prior thereto as approved by the Construction Manager, remove all temporary controls and restore disturbed areas.

PART 2 – PRODUCTS

NOT USED.

PART 3 – EXECUTION

NOT USED.

PART 4 – MEASUREMENT AND PAYMENT

4.01 TEMPORARY CONTROLS

A. Temporary Controls: the measurement and payment of temporary controls shall be in accordance with and as a part of Mobilization / Demobilization, as outlined in Section 01505.

[END OF SECTION]

SECTION 01700
CONTRACT CLOSEOUT

PART 1 – GENERAL

1.01 CLOSEOUT PROCEDURES

A. Contractor shall submit written certification that the Technical Specifications, CQA Plan, and Drawings have been reviewed, Work has been inspected, and that Work is complete and in-accordance with the Technical Specifications, CQA Plan, and Drawings and ready for Owner's inspection.

1.02 FINAL CLEANING

A. Contractor shall execute final cleaning prior to final inspection.

B. Contractor shall clean equipment and fixtures to a sanitary condition.

C. Contractor shall remove waste and surplus materials, rubbish, and construction facilities from the construction Site.

1.03 PROJECT RECORD DOCUMENTS

A. Maintain on Site, one set of the following record documents and record actual revisions to the Work.

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other Modifications to the Contract.
5. Reviewed Shop Drawings, product data, and samples.

B. Store Record Documents separate from documents used for construction.

C. Record information concurrent with construction progress.

D. Specifications: Legibly mark and record at each product Section a description of actual products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates utilized.
3. Changes made by Addenda and Modifications.

E. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:

1. Measured horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface features.
2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible, accessible, and permanent features of the Work.

3. Field changes of dimension and detail.
4. Details not shown on original Construction Drawings.

F. Submit record documents to the Construction Manager.

PART 2 – PRODUCTS

NOT USED.

PART 3 – EXECUTION

NOT USED.

PART 4 – MEASUREMENT AND PAYMENT

4.01 CONTRACT CLOSEOUT

A. Contract Closeout: the measurement and payment of contract close out shall be in accordance with and as part of Mobilization / Demobilization, as outlined in Section 01505.

[END OF SECTION]

SECTION 02220
SUBGRADE PREPARATION

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, equipment, and incidentals necessary to perform all Earthwork. The Work shall be carried out as specified herein and in accordance with the Drawings and the Construction Quality Assurance (CQA) Plan.

B. The Work shall include, but not be limited to vegetation removal, re-conditioning, and grading of subgrade soil and construction of geosynthetics anchor trench. Earthwork shall conform to the dimensions, lines, grades, and sections shown on the Drawings or as directed by the Engineer.

1.02 RELATED SECTIONS

Section 02770 – Geomembrane

Section 02771 – Geotextile

Section 02772 – Geosynthetic Clay Liner

Section 02773 – Geonet

1.03 REFERENCES

A. Drawings

B. Site CQA Plan

1.04 QUALIFICATIONS

A. The Contractor's Site Superintendent for the earthworks operations shall have supervised the construction of at least two civil construction and earthworks projects in the last 5 years, including grading and trenching.

1.05 QUALITY ASSURANCE

A. The Contractor shall ensure that the materials and methods used for subgrade preparation meet the requirements of the Drawings and this Section. Any material or method that does not conform to these documents, or to alternatives approved in writing by the Design Engineer will be rejected and shall be repaired, or removed and replaced, by the Contractor at no additional expense to the Owner.

PART 2 – PRODUCTS

2.01 SUBGRADE SOIL

A. Subgrade surface be free of protrusions larger than 0.5 inches. Any such observed particles shall be removed prior to placement of geosynthetics.

B. Subgrade surface shall be free of large desiccation cracks at the time of geosynthetics placement.

C. Additional subgrade soil, if needed, shall consist of on-site soils that are free of deleterious, organic, and/or other soil impacts that can damage the overlying liner system.

2.02 ANCHOR TRENCH BACKFILL

A. Anchor trench backfill is the soil material that is placed in the anchor trench, as shown on the Drawings. Rocks greater than 6-in. in any dimension shall not be permitted in anchor trench backfill material.

B. Where rocks are included in the anchor trench backfill, they shall be mixed with suitable excavated materials to eliminate voids.

C. Material removed during trench excavation may be utilized for anchor trench backfill, provided that all organic material, rubbish, debris, and other objectionable materials are first removed.

2.03 EQUIPMENT

A. The Contractor shall furnish, operate, and maintain grading and compaction equipment as is necessary to produce smooth surfaces for the placement of geosynthetics and acceptable in-place soil density in the anchor trenches.

B. The Contractor shall furnish, operate and maintain tank trucks, pressure distributors, or other equipment designed to apply water uniformly and in controlled quantities for dust control and for moisture conditioning soils to be placed as trench backfill.

C. The Contractor shall be responsible for cleaning up all fuel, oil, or other spills, at the expense of the Contractor, and to the satisfaction of the Engineer.

PART 3 – EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the work in this Section, the Contractor shall become thoroughly familiar with the Site, the Site conditions, and all portions of the work falling within this and other related Sections.

B. The Contractor shall provide for the protection of work installed in accordance with other Sections. In the event of damage to other work, the Contractor shall make repairs and replacements to the satisfaction of the Engineer, at the expense of the Contractor.

3.02 SUBGRADE SOIL

A. The Contractor shall remove vegetation and roots to a minimum depth of 4-inches below ground surface in all areas where geosynthetic materials are to be installed.

B. Contractor shall grade subgrade soil to be uniform in slope, free from ruts, mounds, or depressions.

C. Rock or soil particles larger than 0.5 inches in longest diameter shall be removed from the surface prior to geosynthetics placement.

D. Prior to GCL installation, the subgrade surface shall be proof-rolled with appropriate compaction equipment to confirm subgrade stability.

E. In the case additional soil is imported on the site for subgrade use, it shall be placed in loose lifts of no more than 8 inches and compacted to 90% of the maximum density at a moisture content of between -3% and +3% of optimum moisture content, as determined by ASTM D 1557.

F. Subgrade soils shall be moisture conditioned prior to installation of overlying GCL.

3.03 TRENCH EXCAVATION

A. The Contractor shall excavate the anchor trench to the limits and grades shown on the Drawings.

B. Excavated anchor trench materials shall be returned as backfill for the anchor trench and compacted.

C. Excavated materials not suitable for anchor trench backfill shall be stockpiled in an area as shown on the Drawings in accordance with Subpart 3.05 of this Section, or as designated by the Engineer.

D. Material not suitable for anchor trench backfill shall be relocated as directed by the Engineer.

3.04 TRENCH BACKFILL

A. The anchor trench backfill shall be placed to the lines and grades shown on the Drawings.

B. Soil used for anchor trench backfill shall meet the requirements of Part 2.02 of this Section.

C. Soil used for anchor trench backfill shall be placed in loose lifts of no more than 6 inches and compacted to 90% of maximum dry density per ASTM D 1557. Backfill shall be within -3% to +3% of optimum moisture content. The maximum permissible pre-compaction soil clod size is 6 inches.

D. The Contractor shall compact each lift of anchor trench backfill to the satisfaction of the CQA Consultant.

E. The Contractor shall utilize compaction equipment suitable and sufficient for achieving the soil compaction requirements.

F. During soil wetting or drying, the material shall be regularly disked or otherwise mixed so that uniform moisture conditions are obtained in the appropriate range.

3.05 STOCKPILING

A. Soil and rock materials suitable for earthworks that are required to be stockpiled shall be stockpiled in areas as shown on the Drawings or as designated by the Engineer, and shall be free of incompatible soil, clearing debris, vegetation, trash, large rocks, or other objectionable materials.

B. Stockpiles shall be no steeper than 2H:1V (Horizontal:Vertical) or other slope approved by the Engineer, graded to drain, sealed by tracking parallel to the direction of the slope with a dozer or other means approved by the Engineer, and dressed daily during periods when fill

is taken from the stockpile. The Contractor shall employ temporary erosion and sediment control measures (i.e. silt fence) as directed by the Engineer around all temporary stockpile areas.

C. There are no compaction requirements for stockpiled materials.

3.06 SURVEY CONTROL

A. The Contractor shall perform all surveys necessary for construction layout and control.

B. The Contractor shall perform as built surveys for all completed surfaces for purposes of Record Drawing preparation. At a minimum, survey points shall be obtained at grade breaks, top of slope, toe of slope, and limits of material type.

3.07 PROTECTION OF WORK

A. The Contractor shall protect completed work of this Section.

B. At the end of each day, the Contractor shall verify that the entire work area is left in a state that promotes drainage of surface water away from the area and from finished work.

C. In the event of damage to Work, the Contractor shall make repairs and replacements to the satisfaction of the CQA Engineer, at the expense of the Contractor.

PART 4 – MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Providing for and complying with the requirements for subgrade preparation will be measured on a square foot (SF) basis and payment will be based on the unit price as provided on the Bid Schedule.

B. Providing for and complying with the requirements for anchor trench excavation and backfill shall be measured on a lineal foot (LF) basis and payment will be based on the unit price as provided on the Bid Schedule.

C. The following are considered incidental to the work:

- Submittals.
- Quality Assurance and Quality Control.
- Excavation, loading, and hauling.
- Temporary haul roads.
- Dust control.
- Placement, compaction, and moisture conditioning.
- Stockpiling.
- Record survey.

[END OF SECTION]

SECTION 02225
DRAINAGE AGGREGATE

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, equipment and incidentals necessary for the installation of Drainage Aggregate. The work shall be carried out as specified herein and in accordance with the Drawings and the site Construction Quality Assurance (CQA) Plan.

B. The work shall include, but not be limited to, delivery, offloading, storage, and placement of Drainage Aggregate (aggregate).

1.02 RELATED SECTIONS

Section 02616 – PVC Pipe

Section 02770 – Geomembrane

Section 02771 – Geotextile

Section 02773 – Geonet

1.03 REFERENCES

A. Drawings

B. Site CQA Plan

C. Latest Version of American Society for Testing and Materials (ASTM) Standards:

ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 136	Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 2434	Test Method for Permeability of Granular Soils (Constant Head)
ASTM D 3042	Standard Test Method for Insoluble Residue in Carbonate Aggregates

1.04 SUBMITTALS

A. The Contractor shall submit to the Engineer for approval, at least 7 days prior to the start of construction, Certificates of Compliance for proposed aggregate materials. Certificates of Compliance shall include, at a minimum, typical gradation, insoluable residue content, representative sample, and source of aggregate materials.

B. The Contractor shall submit to the Engineer a list of equipment and technical information for equipment proposed for use in placing the aggregate material in accordance with this Section.

1.05 CONSTRUCTION QUALITY ASSURANCE (CQA) MONITORING

A. The Contractor shall be aware of and accommodate all monitoring and field/laboratory conformance testing required by the CQA Plan. This monitoring and testing, including

random conformance testing of construction materials and completed work, will be performed by the CQA Consultant. If nonconformances or other deficiencies are found in the materials or completed work, the Contractor will be required to repair the deficiency or replace the deficient materials.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Aggregate shall meet the requirements specified in ASTM C 33 and shall not contain limestone. Aggregate shall have a minimum permeability of 1×10^{-1} cm/sec when tested in accordance with ASTM D 2434. The requirements of the Aggregate are presented below:

Maximum Particle Size (in.)	Percent Finer
¾-in.	100
No. 200 Sieve	0 to 2

B. Carbonate loss shall be no greater than 10% by dry weight basis when tested in accordance with ASTM D 3042.

2.02 EQUIPMENT

A. The Contractor shall furnish, operate, and maintain hauling, placing, and grading equipment as necessary for aggregate placement, meeting the ground pressure requirements listed in Subpart 3.02.F.

PART 3 – EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the work in this Section, the Contractor shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this and other related Sections.

B. Inspection:

1. The Contractor shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the installation of the work specified in this Section may properly commence without adverse impact.

2. If the Contractor has any concerns regarding the installed work of other Sections, the Engineer shall be notified in writing prior to commencing work. Failure to notify the Engineer or commencement of the work of this Section will be construed as Contractor's acceptance of the related work of all other Sections.

3.02 PLACEMENT

A. Place after underlying geosynthetic installation is complete, including CQC and CQA work.

B. Place to the lines, grades, and dimensions shown on the Drawings.

C. The subgrade of the aggregate consists of a geotextile overlying a geomembrane. The Contractor shall avoid creating large wrinkles (greater than 6-inches high), tearing,

puncturing, folding, or damaging in any way the geosynthetic materials during placement of the aggregate material.

D. Damage to the geosynthetic liner system caused by the Contractor or his representatives shall be repaired by the Geosynthetic Installer, at the expense of the Contractor.

E. No density or moisture requirements are specified for placement of the aggregate material.

3.03 FIELD TESTING

A. The minimum frequency and details of conformance testing are provided below. This testing will be performed by the CQA Consultant. The Contractor shall take this testing frequency into account in planning the construction schedule.

1. Aggregates conformance testing:

a. particle-size analyses conducted in accordance with ASTM C 136 at a frequency of one test per 5,000 yd^3, minimum 1 per project; and

b. permeability tests conducted in accordance with ASTM D 2434 at a frequency of one test per 10,000 yd^3, minimum 1 per project.

3.04 SURVEY CONTROL

A. The Contractor shall perform all surveys necessary for construction layout, control, and Record Drawings.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all work of this Section.

B. In the event of damage, the Contractor shall make repairs and replacements to the satisfaction of the Engineer at no additional cost to the Owner.

PART 4 – MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Providing for and complying with the requirements set forth in this Section for Drainage Aggregate will be incidental to the PVC pipe, and payment will be based on the unit price for PVC pipe provided on the Bid Schedule.

B. The following are considered incidental to the work:

- Submittals.
- Quality Control.
- Material samples, sampling, and testing.
- Excavation, loading, and hauling.
- Placing and grading.
- Layout survey.
- Rejected material.
- Rejected material removal, re-testing, handling, and repair.
- Mobilization.

[END OF SECTION]

SECTION 02616
POLYVINYL CHLORIDE (PVC) PIPE

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and equipment necessary to install perforated and solid wall polyvinyl chloride (PVC) Schedule 40 pipe and fittings, as shown on the Drawings and in accordance with the Construction Quality Assurance (CQA) Plan.

1.02 RELATED SECTIONS

Section 02225 – Drainage Aggregate

Section 02270 – Geomembrane

Section 02771 – Geotextile

Section 02772 – Geonet

1.03 REFERENCES

A. Drawings.

B. Site CQA Plan.

C. Latest version of the American Society for Testing and Materials (ASTM) standards:

ASTM D 1784	Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
ASTM D 1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
ASTM D 2466	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
ASTM D 2564	Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
ASTM D 2774	Practice for Underground Installation of Thermoplastic Pressure Piping.
ASTM D 2855	Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
ASTM F 656	Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

1.04 SUBMITTALS

A. The Contractor shall submit to the Engineer for approval, at least 7 days prior to installation of this material, Certificates of Compliance for the pipe and fittings to be furnished. Certificates of Compliance shall consist of a properties sheet, including specified properties measured using test methods indicated herein.

B. The Contractor shall submit to the Engineer, Record Drawings of the installed piping at a frequency of not less than once per every 50 feet of installed pipe. Record Drawings shall be submitted within 7 days of completion of the record survey.

1.05 CQA MONITORING

A. The Contractor shall ensure that the materials and methods used for PVC pipe and fittings installation meet the requirements of the Drawings and this Section. Any material or method that does not conform to these documents, or to alternatives approved in writing by the Engineer, will be rejected and shall be repaired or replaced by the Contractor at no additional cost to the Owner.

PART 2 – MATERIALS

2.01 PVC PIPE & FITTINGS

A. PVC pipe and fittings shall be manufactured from a PVC compound which meets the requirements of Cell Classification 12454 polyvinyl chloride as outlined in ASTM D 1784.

B. PVC pipe shall meet the requirements of ASTM D 1784 and ASTM D 1785 for Schedule 40 PVC pipe.

C. PVC fittings shall meet the requirements of ASTM D 2466.

D. Clean rework or recycle material generated by the Manufacturer's own production may be used so long as the pipe or fittings produced meet all the requirements of this Section.

E. Pipe and fittings shall be homogenous throughout and free of visible cracks, holes, foreign inclusions, or other injurious defects, being uniform in color, capacity, density, and other physical properties.

F. PVC pipe and fitting primer shall meet the requirements of ASTM F 656 and solvent cements shall meet the requirements of ASTM D 2564.

2.02 PVC PERFORATED PIPE

A. Perforated pipe shall meet the requirements listed above for solid wall pipe, unless otherwise approved by the Engineer. PVC pipe perforations shall be as shown on the Drawings.

2.03 STRIP COMPOSITE

A. Strip composite shall be Contech Strip Composite 80, or Engineer approved equal. Consideration for equality will involve chemical resistance, compressive strength, and flow capacity. Strip composite shall be installed as shown on the Drawings.

PART 3 – PART 3 EXECUTION

3.01 PVC PIPE HANDLING

A. When shipping, delivering, and installing pipe, fittings, and accessories, do so to ensure a sound, undamaged installation. Provide adequate storage for all materials and equipment delivered to the site. PVC pipe and pipe fittings shall be handled carefully in loading and unloading so as not to damage the pipe, fittings, or underlying materials.

3.02 PVC PIPE INSTALLATION

A. PVC pipe installation shall conform to these Specifications, the Manufacturer's recommendations, and as outlined in ASTM D 2774.

B. PVC perforated and solid wall pipe shall be installed as shown on the Drawings.

C. PVC pipe shall be inspected for cuts, scratches, or other damages prior to installation. Any pipe showing damage, which in the opinion of the CQA Consultant will affect performance of the pipe, must be removed from the site. Contractor shall replace any material found to be defective at no additional cost to the Owner.

3.03 JOINING OF PVC PIPES

A. PVC pipe and fittings shall be joined by primer and solvent-cements per ASTM D 2855.

B. All loose dirt and moisture shall be wiped from the interior and exterior of the pipe end and the interior of fittings.

C. All pipe cuts shall be square and perpendicular to the centerline of the pipe. All burrs, chips, etc., from pipe cutting shall be removed from pipe interior and exterior.

D. Pipe and fittings shall be selected so that there will be as small a deviation as possible at the joints, and so inverts present a smooth surface. Pipe and fittings that do not fit together to form a tight fit will be rejected.

3.04 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all work of this Section.

B. In the event of damage, the Contractor shall make all repairs and replacements necessary, to the satisfaction of the Engineer.

PART 4 – MEASUREMENT AND PAYMENT

A. Providing for and complying with the requirements set forth in this Section for 4-inch PVC Pipe will be measured as in-place lineal foot (LF) to the limits shown on the Drawings, and payment will be based on the unit price provided on the Bid Schedule.

B. Providing for and complying with the requirements set forth in this Section for 18-inch PVC Pipe will be measured as in-place lineal foot (LF) to the limits shown on the Drawings, and payment will be based on the unit price provided on the Bid Schedule.

C. Providing for and complying with the requirements set forth in this Section for Strip Drain, including connectors, will be measured as in-place lineal foot (LF) to the limits shown on the Drawings, and payment will be based on the unit price provided on the Bid Schedule.

D. The following are considered incidental to the Work:

- Submittals.
- Quality Control.
- Shipping, handling and storage.
- Fittings.
- Drainage aggregate.
- Joining.
- Mobilization.
- Placement.
- Rejected material.
- Rejected material removal, handling, re-testing, and repair.
- Gravel bags.

[END OF SECTION]

SECTION 02770
GEOMEMBRANE

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, equipment, and incidentals necessary for the installation of smooth high-density polyethylene (HDPE) geomembrane, as shown on the Drawings. The work shall be performed as specified herein and in accordance with the Drawings and the site Construction Quality Assurance (CQA) Plan.

B. The work shall include, but not be limited to, delivery, offloading, storage, placement, anchorage, and seaming of the geomembrane.

1.02 RELATED SECTIONS

Section 02225 – Drainage Aggregate

Section 02771 – Geotextile

Section 02773 – Geonet

1.03 REFERENCES

A. Drawings

B. Site CQA Plan

C. Latest version of the American Society for Testing and Materials (ASTM) standards:

ASTM D 638	Standard Test Method for Tensile Properties of Plastics
ASTM D 792	Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D 1505	Standard Test Methods for Density of Plastics by Density-Gradient Technique
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics
ASTM D 4439	Terminology for Geosynthetics
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 5199	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
ASTM D 5397	Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D 5596	Recommended Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds

ASTM D 5641	Practice for Geomembrane Seam Evaluation by Vacuum Chamber
ASTM D 5820	Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
ASTM D 6365	Standard Test Method for the Non-destructive Testing of Geomembrane Seams using the Spark Test.
ASTM D 6392	Standard Test Method for Determining the Integrity of Non-reinforced Geomembrane Seams Produced using Thermo-Fusion Methods.

1.04 QUALIFICATIONS

A. Geomembrane Manufacturer:

1. The Geomembrane Manufacturer shall be responsible for the production of geomembrane rolls from resin and shall have sufficient production capacity and qualified personnel to provide material meeting the requirements of this Section and the construction schedule for this project.

2. The Geomembrane Manufacturer shall have successfully manufactured a minimum of 20,000,000 ft^2 of polyethylene geomembrane.

B. Geosynthetics Installer:

1. The Geosynthetics Installer shall be responsible and shall provide sufficient resources for field handling, deploying, seaming, temporarily restraining (against wind), and other aspects of the deployment and installation of the geomembrane and other geosynthetic components of the project.

2. The Geosynthetics Installer shall have successfully installed a minimum of 20,000,000 ft^2 of polyethylene geomembrane on previous projects with similar sideslopes, bench widths, and configurations.

3. The installation crew shall have the following experience.

   a. The Superintendent shall have supervised the installation of a minimum of 10,000,000 square feet of polyethylene geomembrane on at least ten (10) different projects.

   b. At least one seamer shall have experience seaming a minimum of 2,000,000 square feet of polyethylene geomembrane using the same type of seaming apparatus to be used at this site. Seamers with such experience will be designated "master seamers" and shall provide direct supervision over less experienced seamers.

   c. All other seaming personnel shall have seamed at least 100,000 square feet of polyethylene geomembrane using the same type of seaming apparatus to be used at this site. Personnel who have seamed less than 100,000 square feet shall be allowed to seam only under the direct supervision of the master seamer or Superintendent.

1.05 WARRANTY

A. The Geosynthetic Manufacturer shall furnish the Owner a 20-year written warranty against defects in materials. Warranty conditions concerning limits of liability will be evaluated by, and must be acceptable to, the Owner.

B. The Geosynthetic Installer shall furnish the Owner with a 1-year written warranty against defects in workmanship. Warranty conditions concerning limits of liability will be evaluated by, and must be acceptable to, the Owner.

1.06 SUBMITTALS

A. The Geosynthetic Installer shall submit the following documentation on the resin used to manufacture the geomembrane to the Engineer for approval 14 days prior to transporting any geomembrane to the site.

1. Copies of quality control certificates issued by the resin supplier including the production dates, brand name, and origin of the resin used to manufacture the geomembrane for the project.

2. Results of tests conducted by the Geomembrane Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the project.

3. Certification that no reclaimed polymer is added to the resin during the manufacturing of the geomembrane to be used for this project, or, if recycled polymer is used, the Manufacturer shall submit a certificate signed by the production manager documenting the quantity of recycled material, including a description of the procedure used to measure the quantity of recycled polymer.

B. The Geosynthetic Installer shall submit the following documentation on geomembrane roll production to the Engineer for approval 14 days prior to transporting any geomembrane to the site.

1. Quality control certificates, which shall include:

a. roll numbers and identification; and

b. results of quality control tests, including descriptions of the test methods used, outlined in Subpart 2.02 of this Section.

2. The manufacturer warranty specified in Subpart 1.05 of this Section.

C. The Geosynthetic Installer shall submit the following information to the Engineer for approval 14 days prior to mobilization.

1. A Panel Layout Drawing showing the installation layout and identifying geomembrane panel configurations, dimensions, details, locations of seams, as well as any variance or additional details that deviate from the Drawings. The Panel Layout Drawing shall be adequate for use as a construction plan and shall include dimensions, details, etc. The Panel Layout Drawing, as modified and/or approved by the Engineer, shall become Subpart of these Technical Specifications.

2. Installation schedule.

3. Copy of Geosynthetic 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. A list of completed facilities for which the Geosynthetic's Installer has installed a minimum of 20,000,000 square feet of polyethylene geomembrane, in accordance with Subpart 1.04 of this Section. The following information shall be submitted to the Engineer for each facility:

   a. the name and purpose of the facility, its location, and dates of installation;

   b. the names of the owner, Engineer, and geomembrane manufacturer;

   c. name of the supervisor of the installation crew; and

   d. thickness and surface area of installed geomembrane.

6. In accordance with Subpart 1.04, a resume of the Superintendent to be assigned to this project, including dates and duration of employment, shall be submitted at least 7 days prior to beginning geomembrane installation.

7. In accordance with Subpart 1.04, resumes of all personnel who will perform seaming operations on this project, including dates and duration of employment, shall be submitted at least 7 days prior to beginning geomembrane installation.

D. A Certificate of Calibration less than 12 months old shall be submitted for each field tensiometer prior to installation of any geomembrane.

E. During installation, the Geosynthetic Installer shall be responsible for the timely submission to the Engineer of:

   1. Quality control documentation; and

   2. Subgrade Acceptance Certificates, signed by the Geosynthetic Installer, for each area to be covered by geosynthetic materials.

F. Upon completion of the installation, the Geosynthetic Installer shall be responsible for the submission to the Engineer of a warranty from the Geosynthetic Installer as specified in Subpart 1.05.B of this Section.

G. Upon completion of the installation, the Geosynthetic Installer shall be responsible for the submission to the Engineer of a Record Drawing showing the location and number of each panel and locations and numbers of destructive tests and repairs.

H. The Geosynthetic Installer shall submit samples and material property cut-sheets on the proposed geomembrane to the Engineer at least 7 days prior to delivery of this material to the site.

I. The Geosynthetic Installer shall submit the following documentation on welding rod to the Engineer for approval 14 days prior to transporting welding rod to the site:

1. Quality control documentation, including lot number, welding rod spool number, and results of quality control tests on the welding rod.

2. Certification that the welding rod is compatible with the geomembrane and this Section.

1.07 CONSTRUCTION QUALITY ASSURANCE (CQA) MONITORING

A. The Geosynthetic Installer shall be aware of and accommodate all monitoring and conformance testing required by the CQA Plan. This monitoring and testing, including random conformance testing of construction materials and completed work, will be performed by the CQA Consultant. If nonconformances or other deficiencies are found in the Geosynthetic Installer's materials or completed work, the Geosynthetic Installer will be required to repair the deficiency or replace the deficient materials.

PART 2 – PRODUCTS

2.01 GEOMEMBRANE PROPERTIES

A. The Geomembrane Manufacturer shall furnish white-or off-white-surfaced (upper side only), smooth geomembrane having properties that comply with the required property values shown in Table 02770-1.

B. In addition to the property values listed in Table 02770-1, the geomembrane shall:

1. Contain a maximum of 1 percent by weight of additives, fillers, or extenders (not including carbon black and titanium dioxide).

2. Not have striations, pinholes (holes), bubbles, blisters, nodules, undispersed raw materials, or any sign of contamination by foreign matter on the surface or in the interior.

2.02 MANUFACTURING QUALITY CONTROL (MQC)

A. Rolls:

1. The Geomembrane Manufacturer shall continuously monitor geomembrane during the manufacturing process for defects.

2. No geomembrane shall be accepted that exhibits any defects.

3. The Geomembrane Manufacturer shall measure and report the geomembrane thickness at regular intervals along the roll length.

4. No geomembrane shall be accepted that fails to meet the specified thickness.

5. The Geomembrane Manufacturer shall sample and test the geomembrane at a minimum of once every 50,000 ft^2 to demonstrate that its properties conform to the values specified in Table 02770-1. At a minimum, the following tests shall be performed:

Test	Procedure
Thickness	ASTM D 5199
Specific Gravity	ASTM D 792 Method A or ASTM D 1505
Tensile Properties	ASTM D 638
Puncture Resistance	ASTM D 4833
Carbon Black	ASTM D 1603
Carbon Black Dispersion	ASTM D 5596

6. Tests not listed above but listed in Table 02770-1 need not be run at the 1 per 50,000 ft^2 frequency. However, the Geomembrane Manufacturer shall certify that these tests are in compliance with this Section and have been performed on a sample that is identical to the geomembrane to be used on this project. The Geosynthetic Installer shall provide the test result documentation to the Engineer.

7. Any geomembrane sample that does not comply with the requirements of this Section will result in rejection of the roll from which the sample was obtained and will not be used for this project.

8. If a geomembrane sample fails to meet the quality control requirements of this Section, the Geomembrane Manufacturer shall sample and test, at the expense of the Manufacturer, rolls manufactured in the same resin batch, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established to bound the failed roll(s).

9. Additional testing may be performed at the Geomembrane Manufacturer's discretion and expense, to isolate and more closely identify the non-complying rolls and/or to qualify individual rolls.

B. The Geomembrane Manufacturer shall permit the Engineer to visit the manufacturing plant for project specific visits. If possible, such visits will be prior to or during the manufacturing of the geomembrane rolls for the specific project. The Engineer may elect to collect conformance samples at the manufacturing facility to expedite the acceptance of the materials.

2.03 LABELING

A. Geomembrane rolls shall be labeled with the following information.

1. thickness of the material;

2. length and width of the roll;

3. name of Geomembrane Manufacturer;

4. product identification;

5. lot number; and

6. roll number.

2.04 TRANSPORTATION, HANDLING AND STORAGE

A. The Geosynthetic Manufacturer shall be liable for any damage to the geomembrane incurred prior to and during transportation to the site.

B. Handling and care of the geomembrane at the site prior to and following installation shall be the responsibility of the Geosynthetic Installer. The Geosynthetic Installer shall be liable for all damage to the materials incurred prior to final acceptance of the liner system by the Owner.

C. Geosynthetic Installer shall be responsible for storage of the geomembrane at the site. The geomembrane shall be protected from excessive heat or cold, dirt, puncture, cutting, or other damaging or deleterious conditions. Any additional storage procedures required by the Geomembrane Manufacturer shall be the Geosynthetic Installer's responsibility. Geomembrane rolls shall not be stored or placed in a stack of more than two rolls high.

D. The geomembrane shall be delivered at least 14 days prior to the planned deployment date to allow the CQA Consultant adequate time to perform conformance testing on the geomembrane samples as described in Subpart 3.05 or this Section. If the CQA Consultant performed a visit to the manufacturing plant and performed the required conformance sampling, geomembrane can be delivered to the site within the 14 days prior to the planned deployment date as long as there is sufficient time for the CQA Consultant to complete the conformance testing and confirm that the rolls shipped to the site are in compliance with this Section.

PART 3 – GEOMEMBRANE INSTALLATION

3.01 FAMILIARIZATION

A. Prior to implementing any of the work described in this Section, the Geosynthetic Installer shall become thoroughly familiar with all portions of the work falling within this Section.

B. Inspection:

1. The Geosynthetic Installer shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the work of this Section may properly commence without adverse effect.

2. If the Geosynthetic Installer has any concerns regarding the installed work of other Sections, he shall notify the Engineer in writing prior to the start of the work of this Section. Failure to inform the Engineer in writing or commencing installation of the geomembrane will be construed as the Geosynthetic Installer's acceptance of the related work of all other Sections.

C. A pre-installation meeting shall be held to coordinate the installation of the geomembrane with the installation of other components of the liner system.

3.02 GEOMEMBRANE DEPLOYMENT

A. Layout Drawings:

1. The Geosynthetic Installer shall deploy the geomembrane panels in general accordance with the Panel Layout Drawing specified. The Panel Layout Drawing must be approved by the Engineer prior to installation of any geomembrane.

B. Field Panel Identification:

1. A geomembrane field panel is a roll or a portion of roll cut in the field.

2. Each field panel shall be given a unique identification code (number or letter-number). This identification code shall be agreed upon by the Engineer and Geosynthetic Installer.

C. Field Panel Placement:

1. Field panels shall be installed, as approved or modified, at the location and positions indicated on the Panel Layout Drawing.

2. Field panels shall be placed one at a time, and each field panel shall be seamed immediately after its placement.

3. Geomembrane shall not be placed when the ambient temperature is below 40°F or above 122°F, as measured in Subpart 3.03. C. 3, unless otherwise authorized in writing by the Engineer.

4. Geomembrane shall not be placed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds.

5. The Geosynthetic Installer shall ensure that:

a. No vehicular traffic is allowed on the geomembrane.

b. Equipment used does not damage the geomembrane by handling, trafficking, or leakage of hydrocarbons (i.e., fuels).

c. Personnel working on the geomembrane do not smoke, wear damaging shoes, bring glass onto the geomembrane, or engage in other activities that could damage the geomembrane.

d. The method used to unroll the panels does not scratch or crimp the geomembrane and does not damage the supporting soil or geosynthetics.

e. The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels). The method used to place the panels results in intimate contact between the geomembrane and adjacent components.

f. Temporary ballast and/or anchors (e.g., sand bags) are placed on the geomembrane to prevent wind uplift. Ballast methods must not damage the geomembrane.

g. The geomembrane is especially protected from damage in heavily trafficked areas.

h. Any rub sheets to facilitate seaming are removed prior to installation of subsequent panels.

6. Any field panel or portion thereof that becomes seriously damaged (torn, twisted, or crimped) shall be replaced with new material. Less serious damage to the geomembrane may be repaired, as approved by the Engineer. Damaged panels or portions of damaged panels that have been rejected shall be removed from the work area and not reused.

D. If the Geosynthetic Installer intends to install geomembrane between one hour before sunset and one hour after sunrise, he shall notify the Engineer in writing prior to the start of the work. The Geosynthetic Installer shall indicate additional precautions that shall be taken during these installation hours. The Geosynthetic Installer shall provide proper illumination for work during this time period.

3.03 FIELD SEAMING

A. Seam Layout:

1. In corners and at odd-shaped geometric locations, the number of field seams shall be minimized. No horizontal seam shall be constructed along a slope with an inclination steeper than 10 percent. Horizontal seams shall be considered as any seam having an alignment exceeding 20 degrees from being perpendicular to the slope contour lines, unless otherwise approved by the Engineer. No seams shall be located in an area of potential stress concentration.

2. Seams shall not be allowed within 5 feet of the top or toe of any slope. Horizontal seams can be placed on benches, as long as they are not within 5’ of the top or toe of slope.

B. Personnel:

1. All personnel performing seaming operations shall be qualified as indicated in Subpart 1.04 of this Section. No seaming shall be performed unless a "master seamer" is present on-site.

C. Weather Conditions for Seaming:

1. Unless authorized in writing by the Engineer, seaming shall not be attempted at ambient temperatures below 40°F or above 122°F. If the Geosynthetic Installer wishes to use methods that may allow seaming at ambient temperatures below 40°F or above 122°F, the procedure must be approved by the Engineer.

2. A meeting will be held between the Geosynthetic Installer and Engineer to establish acceptable installation procedures. In all cases, the geomembrane shall be dry and protected from wind damage during installation.

3. Ambient temperatures, measured by the CQA Consultant, shall be measured between 0 and 6 in. above the geomembrane surface.

D. Overlapping:

1. Geomembrane shall be cut and/or trimmed such that all corners are rounded.

2. Geomembrane panels shall be shingled with the upslope panel placed over the downslope panel.

3. Geomembrane panels shall be sufficiently overlapped for welding and to allow peel tests to be performed on the seam. Any seams that cannot be destructively tested because of insufficient overlap shall be treated as failing seams.

E. Seam Preparation:

1. Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.

2. If seam overlap grinding is required, the process shall be completed according to the Geomembrane Manufacturer's instructions within 20 minutes of the seaming operation and in a manner that does not damage the geomembrane. The grind depth shall not exceed ten percent of the geomembrane thickness.

3. Seams shall be aligned with the fewest possible number of wrinkles and "fishmouths."

F. General Seaming Requirements:

1. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle to achieve a flat overlap, ending the cut with circular cut-out. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is insufficient shall be patched with an oval or round patch of geomembrane that extends a minimum of 6 in. beyond the cut in all directions.

2. Any electric generator shall be placed outside the area to be lined or mounted in a manner that protects the geomembrane from damage due to the weight and frame of the generator or due to fuel leakage. The electric generator shall be properly grounded.

G. Seaming Process:

1. Approved processes for field seaming are extrusion welding and double-track hot-wedge fusion welding. Only equipment identified as Subpart of the approved submittal specified in Subpart 1.06 shall be used.

2. Extrusion Equipment and Procedures:

a. The Geosynthetics Installer shall maintain at least one spare operable seaming apparatus on site.

b. Extrusion welding apparatuses shall be equipped with gauges giving the temperatures in the apparatuses.

c. Prior to beginning an extrusion seam, the extruder shall be purged until all heat-degraded extrudate has been removed from the barrel.

d. A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after use.

3. Fusion Equipment and Procedures:

   a. The Geosynthetic Installer shall maintain at least one spare operable seaming apparatus on site.

   b. Fusion-welding apparatus shall be automated vehicular-mounted devices equipped with gauges giving the applicable temperatures and speed.

   c. A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after use.

H. Trial Seams:

1. Trial seams shall be made on fragment pieces of geomembrane to verify that seaming conditions are adequate. Trial seams shall be conducted on the same material to be installed and under similar field conditions as production seams. Such trial seams shall be made at the beginning of each seaming period, typically at the beginning of the day and after lunch, for each seaming apparatus used each day, but no less frequently than once every 5 hours. The trial seam sample shall be a minimum of 5-ft long by 1-ft wide (after seaming) with the seam centered lengthwise for fusion equipment and at least 3-ft long by 1-ft wide for extrusion equipment. Seam overlap shall be as indicated in Subpart 3.03.D of this Section.

2. Four coupon specimens, each 1-in. wide, shall be cut from the trial seam sample by the Geosynthetics Installer using a die cutter to ensure precise 1-in. wide coupons. The coupons shall be tested, by the Geosynthetic Installer, with the CQA Monitor present, in peel (both the outside and inside track) and in shear using an electronic readout field tensiometer in accordance with ASTM D 6392, at a strain rate of 2 in./min. The samples shall not exhibit failure in the seam, i.e., they shall exhibit a Film Tear Bond (FTB), which is a failure (yield) in the parent material. The required peel and shear seam strength values are listed in Table 02770-2. At no time shall specimens be soaked in water.

3. If any coupon specimen fails, the trial seam shall be considered failing and the entire operation shall be repeated. If any of the additional coupon specimens fail, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved.

I. Nondestructive Seam Continuity Testing:

1. The Geosynthetic Installer shall nondestructively test for continuity on all field seams over their full length. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. The Geosynthetic Installer shall complete any required repairs in accordance with Subpart 3.03.K of this Section. The following procedures shall apply:

   a. Vacuum testing in accordance with ASTM D 5641.

   b. Air channel pressure testing for double-track fusion seams in accordance with ASTM D 5820 and the following:

      i. Insert needle, or other approved pressure feed device, from pressure gauge and inflation device into the air channel at one end of a double track seam.

ii. Energize the air pump and inflate air channel to a pressure between 25 and 30 pounds per square inch (psi). Close valve and sustain the pressure for not less than 5 minutes.

iii. If loss of pressure exceeds 3 psi over 5 minutes, or if the pressure does not stabilize, locate the faulty area(s) and repair seam in accordance with Subpart 3.03.K of this Section.

iv. After 5 minutes, cut the end of air channel opposite from the end with the pressure gauge and observe release of pressure to ensure air channel is not blocked. If the channel does not depressurize, find and repair the portion of the seam containing the blockage per Subpart 3.03.K of this Section. Repeat the air pressure test on the resulting segments of the original seam created by the repair and the ends of the seam.. Repeat the process until the entire length of seam has successfully passed pressure testing or contains a repair. Repairs shall also be non-destructively tested per Subpart 3.03.K.5 of this Section.

v. Remove needle, or other approved pressure feed device, and seal repair in accordance with Subpart 3.03.K of this Section.

c. Spark test seam integrity verification shall be performed in accordance with ASTM D 6365 if the seam cannot be tested using other nondestructive methods.

J. Destructive Testing:

1. Destructive seam tests shall be performed on samples collected from selected locations to evaluate seam strength and integrity. Destructive tests shall be carried out as the seaming work progresses, not at the completion of all field seaming.

2. Sampling:

a. Destructive test samples shall be collected at a minimum average frequency of one test location per 500 ft of total seam length. Test locations shall be determined during seaming, and may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming. The CQA Consultant will be responsible for choosing the locations. The Geosynthetic Installer shall not be informed in advance of the locations where the seam samples will be taken. The CQA Consultant reserves the right to increase the sampling frequency if observations suggest an increased frequency is warranted.

b. The CQA Consultant shall mark the destructive sample locations. Samples shall be cut by the Geosynthetic Installer at the locations designated by the CQA Consultant as the seaming progresses in order to obtain laboratory test results before the geomembrane is covered by another material. Each sample shall be numbered and the sample number and location identified on the Panel Layout Drawing. All holes in the geomembrane resulting from the destructive seam sampling shall be immediately repaired in accordance with the repair procedures described in Subpart 3.03.K of this Section. The continuity of the new seams associated with the repaired areas shall be tested according to Subpart 3.03.I of this Section.

c. Two coupon strips of dimensions 1-in. wide and 12 in. long with the seam centered parallel to the width shall be taken from any side of the sample location. These samples shall be tested in the field in accordance with Subpart 3.03.J.3 of this Section. If these samples pass the field test, a laboratory sample shall be taken. The laboratory sample shall be at least 1-ft wide by 3.5-ft long with the seam centered along the length. The sample shall be cut into three parts and distributed as follows:

i. One portion 12-inches long to the Geosynthetic Installer.

ii. One portion 18- inches long to the Geosynthetic CQA Laboratory for testing.

iii. One portion 12- inches long to the Owner for archival storage.

3. Field Testing:

a. The two 1-in. wide strips shall be tested in the field tensiometer in the peel mode on both sides of the double track fusion welded sample. The CQA Consultant has the option to request an additional test in the shear mode. If any field test sample fails to meet the requirements in Table 02770-2, then the procedures outlined in Subpart 3.03.J.5 of this Section for a failing destructive sample shall be followed.

4. Laboratory Testing:

a. Testing by the Geosynthetics CQA Laboratory will include "Seam Strength" and "Peel Adhesion" (ASTM D 6392) with 1-in. wide strips tested at a rate of 2 in./min. At least 5 specimens will be tested for each test method (peel and shear). Four of the five specimens per sample must pass both the shear strength test and peel adhesion test when tested in accordance with ASTM D 6392. The minimum acceptable values to be obtained in these tests are indicated in Table 02770-2. Both the inside and outside tracks of the dual track fusion welds shall be tested in peel.

5. Destructive Test Failure:

a. The following procedures shall apply whenever a sample fails a destructive test, whether the test is conducted by the Geosynthetic CQA's laboratory, the Geosynthetic Installer laboratory, or by a field tensiometer. The Geosynthetic Installer shall have two options:

i. The Geosynthetic Installer can reconstruct the seam (e.g., remove the old seam and reseam) between any two laboratory-passed destructive test locations created by that seaming apparatus. Trial welds do not count as a passed destructive test.

ii. The Geosynthetic Installer can trace the welding path in each direction to an intermediate location, a minimum of 10 feet from the location of the failed test, and take a small sample for an additional field test at each location. If these additional samples pass the field tests, then full laboratory samples shall be taken. These full laboratory samples shall be tested in accordance with Subpart 3.03.J.4 of this Section. If these laboratory samples pass the tests, then the seam path between these

locations shall be reconstructed and nondestructively (at a minimum) tested. If a sample fails, then the process shall be repeated, i.e. another destructive sample shall be obtained and tested at a distance of at least 10 more feet in the seaming path from the failed sample. The seam path between the ultimate passing sample locations shall be reconstructed and nondestructively (at a minimum) tested. In cases where repaired seam lengths exceed 150 ft, a destructive sample shall be taken from the repaired seam and the above procedures for destructive seam testing shall be followed.

b. Whenever a sample fails destructive or non-destructive testing, the CQA Consultant may require additional destructive tests be obtained from seams that were created by the same seamer and/or seaming apparatus during the same time shift.

K. Defects and Repairs:

1. 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.

2. At observed suspected flawed location, both in seamed and non-seamed areas, shall be nondestructively tested using the methods described Subpart 3.03.I of this Section, as appropriate. Each location that fails nondestructive testing shall be marked by the CQA Consultant and repaired by the Geosynthetic Installer.

3. When seaming of a geomembrane is completed (or when seaming of a large area of a geomembrane is completed) and prior to placing overlying materials, the CQA Consultant shall identify all excessive geomembrane wrinkles. The Geosynthetic Installer shall cut and reseam all wrinkles so identified. The seams thus produced shall be tested as per all other seams.

4. Repair Procedures:

a. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the Geosynthetic Installer. Several repair procedures are acceptable. The final decision as to the appropriate repair procedure shall be agreed upon between the Engineer and the Geosynthetic Installer. The procedures available include:

i. Patching – extrusion welding a patch to repair holes larger than 1/16 inch, tears, undispersed raw materials, and contamination by foreign matter;

ii. Abrading and reseaming – applying an extrusion seam to repair very small sections of faulty extruded seams;

iii. Spot seaming – applying an extrusion bead to repair minor, localized flaws such as scratches and scuffs;

iv. Capping - extrusion welding a geomembrane cap over long lengths of failed seams; and

v. Strip repairing – cutting out bad seams and replacing with a strip of new material seamed into place on both sides with fusion welding.

b. In addition, the following criteria shall be satisfied:

i. surfaces of the geomembrane that are to be repaired shall be abraded no more than 20 minutes prior to the repair;

ii. all surfaces must be clean and dry at the time of repair;

iii. all seaming equipment used in repair procedures must be approved by trial seaming;

iv. any other potential repair procedures shall be approved in advance, for the specific repair, by the Engineer;

v. patches or caps shall extend at least 6 in. beyond the edge of the defect, and all corners of patches and holes shall be rounded with a radius of at least 3 in.; and

vi. any geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.

5. Repair Verification:

a. Repairs shall be nondestructively tested using the methods described in Subpart 3.03.I of this Section, as appropriate. Repairs that pass nondestructive testing shall be considered acceptable repairs. Repairs that failed nondestructive or destructive testing will require the repair to be reconstructed and retested until passing test results are observed. At the discretion of the CQA Consultant, destructive testing may be required on any caps.

3.04 MATERIALS IN CONTACT WITH THE GEOMEMBRANE

A. The Geosynthetic Installer shall take all necessary precautions to ensure that the geomembrane is not damaged during its installation. During the installation of other components of the liner system by the Contractor, the Contractor shall ensure that the geomembrane is not damaged. Any damage to the geomembrane caused by the Contractor shall be repaired by the Geosynthetic Installer at the expense of the Contractor.

B. Soil and aggregate materials shall not be placed over the geomembranes at ambient temperatures below 40°F or above 104°F, unless otherwise specified.

C. All attempts shall be made to minimize wrinkles in the geomembrane.

D. No vehicles of any kind shall be driven directly on the geomembrane. Construction loads permitted on the geomembrane are limited to foot traffic and ATV vehicles with a contact pressures at or lower than that exhibited by foot traffic.

3.05 CONFORMANCE TESTING

A. Samples of the geomembrane will be removed by the CQA Consultant and sent to a Geosynthetic CQA Laboratory for testing to ensure conformance with the requirements of this Section. The CQA Consultant may collect samples at the manufacturing plant or from the rolls delivered to the site. The Geosynthetic Installer shall assist the CQA Consultant in

obtaining conformance samples from any geomembrane rolls sampled at the site. The Geosynthetic Installer and Contractor shall account for this sampling and testing requirement in the installation schedule, including the turnaround time for laboratory results. Only materials that meet the requirements of Subpart 2.02 this Section shall be installed.

B. Samples will be selected by the CQA Consultant in accordance with this Section and with the procedures outlined in the CQA Plan.

C. Samples will be taken at a minimum frequency of one sample per 100,000 ft^2. If the Geomembrane Manufacturer provides material that requires sampling at a frequency (due to lot size, shipment size, etc.) resulting in one sample per less than 90 percent of 100,000 ft^2 (90,000 ft^2), then the Geosynthetic Installer shall pay the cost for all additional testing.

D. The CQA Consultant may increase the frequency of sampling in the event that test results do not comply with the requirements of Subpart 2.02 of this Section.

E. The following tests will be performed by the CQA Consultant:

Test	Test Method
Specific Gravity	ASTM D 792 or D 1505
Thickness	ASTM D 5199
Tensile Properties	ASTM D 638
Carbon Black Content	ASTM D 1603
Carbon Black Dispersion	ASTM D 5596

F. Any geomembrane that is not certified in accordance with Subpart 1.07.C of this Section, or that conformance testing indicates does not comply with Subpart 2.02 of this Section, shall be rejected. The Geosynthetic Installer shall replace the rejected material with new material.

3.06 GEOMEMBRANE ACCEPTANCE

A. The Geosynthetic Installer shall retain all ownership and responsibility for the geomembrane until accepted by the Owner.

B. The geomembrane will not be accepted by the Owner before:

1. the installation is completed;

2. all documentation is submitted;

3. verification of the adequacy of all field seams and repairs, including associated testing, is complete; and

4. all warranties are submitted.

3.07 PROTECTION OF WORK

A. The Geosynthetic Installer and Contractor shall use all means necessary to protect all work of this Section.

B. In the event of damage, the Geosynthetic Installer shall make all repairs and replacements necessary, to the satisfaction of the Engineer.

PART 4 – MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Providing for a complying with the requirements set forth in this Section for 60-mil, smooth HDPE geomembrane will be measured as in-place square feet (SF), as measured by the surveyor, including geomembrane in the anchor trench to the limits shown on the Drawings, and payment will be based on the unit price provided on the Bid Schedule.

B. The following are considered incidental to the Work:

- Submittals.
- Quality Control.
- Shipping, handling and storage.
- Deployment.
- Layout survey.
- Mobilization.
- Rejected material.
- Rejected material removal, handling, re-testing, and repair.
- Overlaps and seaming.
- Temporary anchorage.
- Pipe boots.
- Cleaning seam area.

TABLE 02770-1
REQUIRED HDPE GEOMEMBRANE PROPERTIES

PROPERTIES	QUALIFIERS	UNITS	SPECIFIED VALUES	TEST METHOD
Physical Properties				
Thickness	Average Minimum	mils mils	60 54	ASTM D 5199
Density	Minimum	N/A	0.94	ASTM D 792 Method A or ASTM D 1505
Mechanical Properties Tensile Properties (each direction) 1. Tensile (Break) Strength 2. Elongation at Break 3. Tensile (Yield) Strength 4. Elongation at Yield	Minimum	 lb/in % lb/in %	 228 700 126 12	ASTM D 638
Puncture	Minimum	lb	108	ASTM D 4833
Environmental Properties				
Carbon Black Content	Range	%	2-3	ASTM D 1603
Carbon Black Dispersion	N/A	none	Note 1	ASTM D 5596
Environmental Stress Crack	Minimum	hr	400	ASTM D 5397

Notes: (1) Minimum 9 of 10 in Categories 1 or 2; 10 in Categories 1, 2, or 3.

TABLE 02770-2
REQUIRED GEOMEMBRANE SEAM PROPERTIES

PROPERTIES	QUALIFIERS	UNITS	SPECIFIED VALUES(3)	TEST METHOD
Shear Strength(1)				
Fusion	minimum	lb/in	120	ASTM D 6392
Extrusion	minimum	lb/in	120	ASTM D 6392
Peel Adhesion				
FTB(2)				Visual Observation
Fusion	minimum	lb/in	91	ASTM D 6392
Extrusion	minimum	lb/in	78	ASTM D 6392

Notes: (1) Also called "Bonded Seam Strength".
(2) FTB = Film Tear Bond means that failure is in the parent material, not the seam. The maximum seam separation is 25 percent of the seam area.
(3) Four of five specimens per destructive sample must pass both the shear and peel strength tests.

[END OF SECTION]

SECTION 02771
GEOTEXTILE

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, equipment, and incidentals necessary for the installation of the geotextile. The work shall be carried out as specified herein and in accordance with the Drawings and the Construction Quality Assurance (CQA) Plan.

B. The work shall include, but not be limited to, delivery, offloading, storage, placement, and seaming of the various geotextile components of the project.

C. Geotextile shall be used between the Drainage Aggregate and Geomembrane as shown on the Drawings.

1.02 RELATED SECTIONS

Section 02200 – Earthwork

Section 02225 – Drainage Aggregate

Section 02770 – Geomembrane

Section 02773 – Geonet

1.03 REFERENCES

A. Drawings

B. Site CQA Plan

C. Latest version of American Society for Testing and Materials (ASTM) standards:

ASTM D 4355	Standard Test Method for Deterioration of Geotextile from Exposure to Ultraviolet Light and Water
ASTM D 4439	Terminology for Geosynthetics
ASTM D 4491	Standard Test Method for Water Permeability of Geotextile by Permittivity
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextile
ASTM D 4632	Standard Test Method for Breaking Load and Elongation of Geotextile (Grab Method)
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextile, Geomembranes, and Related Products

ASTM D 5261 Standard Test Method for Measuring Mass Per Unit Area of Geotextile

1.04 SUBMITTALS

A. The Contractor shall submit the following information regarding the proposed geotextile to the Engineer for approval at least 7 days prior to geotextile delivery:

1. manufacturer and product name;
2. minimum property values of the proposed geotextile and the corresponding test procedures;
3. projected geotextile delivery dates; and
4. list of geotextile roll numbers for rolls to be delivered to the site.

B. At least 7 days prior to geotextile placement, the Contractor shall submit to the Engineer the Manufacturing Quality Control (MQC) certificates for each roll of geotextile. The certificates shall be signed by responsible parties employed by the geotextile manufacturer (such as the production manager). The MQC certificates shall include:

1. lot, batch, and/or roll numbers and identification;
2. MQC test results, including a description of the test methods used; and
3. Certification that the geotextile meets or exceeds the required properties of the Drawings and this Section.

1.05 CQA MONITORING

A. The Contractor shall be aware of and accommodate all monitoring and conformance testing required by the CQA Plan. This monitoring and testing, including random conformance testing of construction materials and completed work, will be performed by the CQA Consultant. If nonconformances or other deficiencies are found in the Contractor's materials or completed work, the Contractor will be required to repair the deficiency or replace the deficient materials at no additional expense to the Owner.

PART 2 – PRODUCTS

2.01 GEOTEXTILE PROPERTIES

A. The Geotextile Manufacturer shall furnish materials that meet or exceed the criteria specified in Table 02771-1 in accordance with the minimum average roll value (MARV), as defined by ASTM D 4439.

B. The geotextile shall be nonwoven materials, suitable for use in filter/separation and cushion applications.

2.02 MANUFACTURING QUALITY CONTROL (MQC)

A. The geotextile shall be manufactured with MQC procedures that meet or exceed generally accepted industry standards.

B. The Geotextile Manufacturer shall sample and test the geotextile to demonstrate that the material conforms to the requirements of these Specifications.

C. Any geotextile sample that does not comply with this Section shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected rolls.

D. If a geotextile sample fails to meet the MQC requirements of this Section the Geotextile Manufacturer shall additionally sample and test, at the expense of the Manufacturer, rolls manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established to define the bounds of the failed roll(s). All the rolls pertaining to the failed rolls shall be rejected.

E. Additional sample testing may be performed, at the Geotextile Manufacturer's discretion and expense, to identify more closely the extent of non-complying rolls and/or to qualify individual rolls.

F. Sampling shall, in general, be performed on sacrificial portions of the geotextile material such that repair is not required. The Geotextile Manufacturer shall sample and test the geotextile to demonstrate that the geotextile properties conform to the values specified in Table 02771-1.

1. At a minimum, the following MQC tests shall be performed on the geotextile (results of which shall meet the requirements specified in Table 02271):

Test	Procedure	Frequency
Grab strength	ASTM D 4632	130,000 ft^2
Mass per Unit Area	ASTM D 5261	130,000 ft^2
Tear strength	ASTM D 4533	130,000 ft^2
Puncture strength	ASTM D 4833	130,000 ft^2
Permittivity	ASTM D 4491	540,000 ft^2
A.O.S.	ASTM D 4751	540,000 ft^2

G. The Geotextile Manufacturer shall comply with the certification and submittal requirements of this Section.

2.03 PACKING AND LABELING

A. Geotextile shall be supplied in rolls wrapped in relatively impervious and opaque protective covers.

B. Geotextile rolls shall be marked or tagged with the following information:

1. manufacturer's name;

2. product identification;

3. lot or batch number;

4. roll number; and

5. roll dimensions.

2.04 TRANSPORTATION, HANDLING, AND STORAGE

A. The Geosynthetic Manufacturer shall be liable for any damage to the geotextile incurred prior to and during transportation to the site.

B. The geotextile shall be delivered to the site at least 14 days prior to the planned deployment date to allow the CQA Consultant adequate time to perform conformance testing on the geotextile samples as described in Subpart 3.06 of this Section.

C. Handling, unloading, storage, and care of the geotextile at the site, prior to and following installation, are the responsibility of the Contractor. The Contractor shall be liable for any damage to the materials incurred prior to final acceptance by the Owner.

D. The Contractor shall be responsible for offloading and storage of the geotextile at the site.

E. The geotextile shall be protected from sunlight, puncture, or other damaging or deleterious conditions. The geotextile shall be protected from mud, dirt, and dust. Any additional storage procedures required by the geotextile Manufacturer shall be the responsibility of the Contractor.

PART 3 – EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the work described in this Section, the Contractor shall become thoroughly familiar with the site, the site conditions, and all portions of the work falling within this Section.

B. If the Contractor has any concerns regarding the installed work of other Sections or the site, the Engineer shall be notified, in writing, prior to commencing the work. Failure to notify the Engineer or commencing installation of the geotextile will be construed as Contractor's acceptance of the related work of all other Sections.

3.02 PLACEMENT

A. Geotextile installation shall not commence over other materials until CQA conformance evaluations, by the CQA Consultant, of underlying materials are complete, including evaluations of the Contractor's survey results to confirm that the previous work was constructed to the required grades, elevations, and thicknesses. Should the Contractor begin the work of this Section prior to the completion of CQA evaluations for underlying materials or this material, this shall be at the risk of removal of these materials, at the Contractor’s expense, to remedy the non-conformances. The Contractor shall account for the CQA conformance evaluations in the construction schedule.

B. The Contractor shall handle all geotextile in such a manner as to ensure it is not damaged in any way.

C. The Contractor shall take any necessary precautions to prevent damage to underlying materials during placement of the geotextile.

D. After unwrapping the geotextile from its opaque cover, the geotextile shall not be left exposed for a period in excess of 15 days unless a longer exposure period is approved in writing by the Geotextile Manufacturer.

E. The Contractor shall take care not to entrap stones, excessive dust, or moisture in the geotextile during placement.

F. The Contractor shall anchor or weight all geotextile with sandbags, or the equivalent, to prevent wind uplift.

G. The Contractor shall examine the entire geotextile surface after installation to ensure that no foreign objects are present that may damage the geotextile or adjacent layers. The Contractor shall remove any such foreign objects and shall replace any damaged geotextile.

3.03 SEAMS AND OVERLAPS

A. On slopes steeper than 10 horizontal to 1 vertical, geotextiles shall be continuous down the slope; that is, no horizontal seams are allowed. Horizontal seams shall be considered as any seam having an alignment exceeding 20 degrees from being perpendicular to the slope contour lines, unless otherwise approved by the Engineer. No horizontal seams shall be allowed within 5 feet of the top or toe of the slopes.

B. Geotextile shall be overlapped a minimum of 12-inches.

3.04 REPAIR

A. Any holes or tears in the geotextile shall be repaired using a patch made from the same geotextile. If a tear exceeds 50% of the width of a roll, that roll shall be removed and replaced.

3.05 PLACEMENT OF SOIL MATERIALS

A. The Contractor shall place soil materials on top of the geotextile in such a manner as to ensure that:

1. the geotextile and the underlying materials are not damaged;

2. minimum slippage occurs between the geotextile and the underlying layers during placement; and

3. excess stresses are not produced in the geotextile.

B. Equipment shall not be driven directly on the geotextile.

3.06 CONFORMANCE TESTING

A. Conformance samples of the geotextile materials will be removed by the CQA Consultant after the material has been received at the site and sent to a Geosynthetic CQA Laboratory for testing to ensure conformance with the requirements of this Section and the CQA Plan. This testing will be carried out, in accordance with the CQA Plan, prior to the start of the work of this Section.

B. Samples of each geotextile will be taken, by the CQA Consultant, at a minimum frequency of one sample per 260,000 ft^2 (minimum of one).

C. The CQA Consultant may increase the frequency of sampling in the event that test results do not comply with requirements of Subpart 2.01 of this Section until passing conformance test results are obtained for all material that is received at the site. This additional testing shall be performed at the expense of the Contractor.

D. The following conformance tests will be performed (results of which shall meet the requirements specified in Table 02271):

Test	Procedure
Grab strength	ASTM D 4632
Mass per Unit Area	ASTM D 5261
Puncture strength	ASTM D 4833
Permittivity	ASTM D 4491
A.O.S.	ASTM D 4751

E. Any geotextile that is not certified in accordance with Subpart 1.04 of this Section, or that conformance testing results do not comply with Subpart 2.01 of this Section, will be rejected. The Contractor shall replace the rejected material with new material. All other rolls that are represented by failing test results will also be rejected, unless additional testing is performed to further determine the bounds of the failed material.

3.07 PROTECTION OF WORK

A. The Contractor shall protect all work of this Section.

B. In the event of damage, the Contractor shall make repairs and replacements to the satisfaction of the Engineer at the expense of the Contractor.

PART 4 – MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Providing for and complying with the requirements set forth in this Section for Geotextile will be incidental to PVC Pipe, and payment will be based on the unit price provided for PVC Pipe on the Bid Schedule.

B. The following are considered incidental to the work:

- Submittals.
- Quality Control.
- Shipping, handling and storage.
- Layout survey.
- Mobilization.
- Rejected material.
- Overlaps and seaming.
- Rejected material removal, handling, re-testing, and repair.
- Temporary anchorage.

TABLE 02771-1
REQUIRED PROPERTY VALUES FOR GEOTEXTILE

PROPERTIES	QUALIFIERS	UNITS	SPECIFIED VALUES	TEST METHOD
Mass per unit area	Minimum	oz/yd^2	16	ASTM D 5261
Apparent opening size (O_{95})	Maximum	mm	0.21	ASTM D 4751
Permittivity	Minimum	s^{-1}	0.5	ASTM D 4491
Grab strength	Minimum	lb	390	ASTM D 4632
Tear strength	Minimum	lb	150	ASTM D 4533
Puncture strength	Minimum	lb	240	ASTM D 4833
Ultraviolet Resistance @ 500 hours	Minimum	%	70	ASTM D 4355

[END OF SECTION]

SECTION 02772
GEOSYNTHETIC CLAY LINER

PART 1 – GENERAL

1.01 SCOPE

A. The Geosynthetic Installer shall furnish all labor, materials, tools, supervision, transportation, equipment, and incidentals necessary for installation of the geosynthetic clay liner (GCL). The work shall be carried out as specified herein and in accordance with the Drawings and Construction Quality Assurance (CQA) Plan.

B. The work shall include, but not be limited to, delivery, offloading, storage, placement, anchorage, and seaming of the GCL.

1.02 RELATED SECTIONS

Section 02220 – Subgrade Preparation

Section 02770 – Geomembrane

1.03 REFERENCES

A. Drawings

B. Site CQA Plan

C. Latest Version American Society of Testing and Materials (ASTM) Standards:

ASTM D 5887	Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens using a Flexible Wall Permeameter
ASTM D 5888	Guide for Storage and Handling of Geosynthetic Clay Liners
ASTM D 5890	Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
ASTM D 5891	Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
ASTM D 5993	Test Method for Measuring Mass per Unit Area of Geosynthetic Clay Liners

1.04 QUALIFICATIONS

A. GCL Manufacturer:

1. The Manufacturer shall be a well-established firm with more than five (5) years of experience in the manufacturing of GCL.

2. The GCL Manufacturer shall be responsible for the production of GCL rolls and shall have sufficient production capacity and qualified personnel to provide material meeting the requirements of this Section and the construction schedule for this project.

B. GCL Installer:

1. The Geosynthetic Installer shall install the GCL and shall meet the requirements of Section 02770 Subpart 1.04. B and this Section.

2. The Geosynthetics Installer shall be responsible and shall provide sufficient resources for field handling, deploying, temporarily restraining (against wind), and other aspects of the deployment and installation of the GCL and other geosynthetic components of the project.

1.05 SUBMITTALS

A. At least 7 days before transporting any GCL to the site, the Manufacturer shall provide the following documentation to the Engineer for approval.

1. list of material properties, including test methods utilized to analyze / confirm properties.

2. GCL samples.

3. projected delivery dates for this project.

4. Manufacturing quality control certificates for each shift's production for which GCL for the project was produced, signed by responsible parties employed by the Manufacturer (such as the production manager).

5. Manufacturer Quality Control (MQC) certificates, including:

a. roll numbers and identification; and

b. MQC results, including description of test methods used, outlined in Subpart 2.01 of this Section.

6. Certification that the GCL meets all the properties outlined in Subpart 2.01 of this Section.

1.06 CONSTRUCTION QUALITY ASSURANCE (CQA) MONITORING

A. The Geosynthetic Installer shall be aware of all monitoring and conformance testing required by the CQA Plan. This monitoring and testing, including random conformance testing of construction materials and completed work, will be performed by the CQA Consultant. If nonconformances or other deficiencies are found in the materials or completed work, the Geosynthetic Installer will be required to repair the deficiency or replace the deficient materials at no additional cost to the Owner.

PART 2 – PRODUCTS

2.01 MATERIAL PROPERTIES

A. The flux of the bentonite portion of the GCL shall be no greater than 1×10^{-8} m^3/m^2-sec, when measured in a flexible wall permeameter in accordance with ASTM D 5887 under an effective confining stress of 5 pounds per square inch.

B. The GCL shall have the following minimum dimensions:

1. the minimum roll width shall be 15 feet; and

2. the linear length shall be long enough to conform with the requirements specified in this Section.

C. The bentonite used to fabricate the GCL shall be comprised of at least 90 percent sodium montmorillonite.

D. The bentonite component of the GCL shall be applied at a minimum concentration of 0.75 pound per square foot (psf), when measured at a water content of 0 percent.

E. The GCL shall meet or exceed all required property values listed in Table 02772-1.

F. The bentonite will be adhered to the backing material(s) in a manner that prevents it from being dislodged when transported, handled, and installed in a manner prescribed by the Manufacturer. The method used to hold the bentonite in place shall not be detrimental to other components of the lining system.

G. The geotextile components of he GCL shall be woven and nonwoven and have a combined mass per unit area of 9 oz./SY.

H. The GCL shall be needle punched.

2.02 MANUFACTURING QUALITY CONTROL (MQC)

A. The GCL shall be manufactured with quality control procedures that meet or exceed generally accepted industry standards.

B. The Manufacturer shall sample and test the GCL to demonstrate that the material complies with the requirements of this Section.

C. Any GCL sample that does not comply with this Section will result in rejection of the roll from which the sample was obtained. The Manufacturer shall replace any rejected rolls.

D. If a GCL sample fails to meet the quality control requirements of this Section, the Engineer will require that the Manufacturer sample and test, at the expense of the Manufacturer, rolls manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established to determine the bounds of the failed roll(s). All rolls pertaining to failed tests shall be rejected.

E. Additional sample testing may be performed, at the Manufacturer's discretion and expense, to more closely identify the extent of any non-complying rolls and/or to qualify individual rolls.

F. Sampling shall, in general, be performed on sacrificial portions of the GCL material such that repair is not required. The Manufacturer shall sample and test the GCL to demonstrate that its properties conform to the requirements stated herein. At a minimum, the following (MQC) tests shall be performed by the Manufacturer: dry mass per unit area (ASTM D5993) and index flux at frequencies of at least 1 per 50,000 ft^2 and 1 per 200,000 ft^2, respectively.

G. The Manufacturer shall comply with the certification and submittal requirements of this Section.

2.03 PACKING AND LABELING

A. GCL shall be supplied in rolls wrapped in impervious and opaque protective covers.

B. GCL shall be marked or tagged with the following information:

1. Manufacturer's name;
2. product identification;
3. lot number;
4. roll number; and
5. roll dimensions.

2.04 TRANSPORTATION, HANDLING AND STORAGE

A. The Geosynthetic Manufacturer shall be liable for any damage to the GCL incurred prior to and during transportation to the site.

B. Handling, storage, and care of the GCL at the site prior to and following installation, are the responsibility of the Geosynthetic Installer, until final acceptance by the Owner.

C. The GCL shall be stored and handled in accordance with ASTM D 5888.

D. The Geosynthetic Installer shall be liable for all damage to the materials incurred prior to and during transportation to the site including hydration of the GCL prior to placement.

E. The GCL shall be on-site at least 14 days prior to the scheduled installation date to allow for completion of conformance testing described in Subpart 3.08 of this Section.

PART 3 – EXECUTION

3.01 FAMILIARIZATION

A. Prior to implementing any of the work described in this Section, the Geosynthetic Installer shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the installation of this Section may properly commence without adverse impact.

B. If the Geosynthetic Installer has any concerns regarding the installed work of other Sections, he should notify the Engineer in writing prior to commencing the work. Failure to notify the Engineer or commencing installation of the GCL will be construed as Geosynthetic Installer's acceptance of the related work of all other Sections.

C. A pre-installation meeting shall be held to coordinate the installation of the GCL with the installation of other components of the lining system.

3.02 SURFACE PREPARATION

A. The Geosynthetics Installer shall provide certification in writing that the surface on which the GCL will be installed is acceptable. This certification of acceptance shall be given to the Engineer's representative prior to commencement of geosynthetics installation in the area under consideration.

B. Special care shall be taken to maintain the prepared soil surface. The subgrade shall be moisture conditioned prior to installation of the GCL.

C. No GCL shall be placed onto an area that has been softened by precipitation or that has cracked due to desiccation. The soil surface shall be observed daily to evaluate the effects of desiccation cracking and/or softening on the integrity of the prepared subgrade.

3.03 HANDLING AND PLACEMENT

A. The Geosynthetic Installer shall handle all GCL in such a manner that it is not damaged in any way.

B. In the presence of wind, all GCL shall be sufficiently weighted with sandbags to prevent their movement.

C. Any GCL damaged by stones or other foreign objects, or by installation activities, shall be repaired in accordance with Subpart 3.07 by the Geosynthetic Installer, at the expense of the Geosynthetic Installer.

D. The GCL shall not be installed on standing water.

E. The GCL shall be installed with the woven geotextile facing up (against the overlying geomembrane).

3.04 OVERLAPS

A. On slopes steeper than 10 horizontal to 1 vertical, all GCL shall be continuous down the slope, i.e., no horizontal seams shall be allowed on the slope. Horizontal seams shall be considered as any seam having an alignment exceeding 20 degrees from being perpendicular to the slope contour lines, unless otherwise approved by the Engineer.

B. All GCL shall be overlapped in accordance with the Manufacturer's recommended procedures. At a minimum, along the length (i.e., the sides) of the GCL placed on slopes steeper than 10:1 (horizontal:vertical), the overlap shall be 12 inches, and along the width (i.e., the ends) the overlap shall be 24 inches.

C. At a minimum, along the length (i.e., the sides) of the GCL placed on non-sloped areas (i.e. slopes no steeper than 10:1), the overlap shall be 6-inches, and along the width (i.e., the ends) the overlap shall be 12-inches.

3.05 MATERIALS IN CONTACT WITH THE GCL

A. Installation of other components of the liner system shall be carefully performed to avoid damage to the GCL.

B. Engineer approved low ground pressure equipment may be driven directly on the GCL.

C. Installation of the GCL in appurtenant areas, and connection of the GCL to appurtenances shall be made according to the Drawings. The Geosynthetic Installer shall ensure that the GCL is not damaged while working around the appurtenances.

3.06 REPAIR

A. Any holes or tears in the GCL shall be repaired by placing a GCL patch over the defect. On slopes steeper than 10 percent, the patch shall overlap the edges of the hole or tear by a minimum of 2 feet in all directions. On slopes 10 percent or flatter, the patch shall overlap the edges of the hole or tear by a minimum of 1 foot in all directions. The patch shall be secured with a Manufacturer recommended water-based adhesive.

B. Care shall be taken to remove any soil, rock, or other materials, which may have penetrated the torn GCL.

C. The patch shall not be nailed or stapled.

3.07 CONFORMANCE TESTING

A. Samples of the GCL will be removed by the CQA Consultant and sent to a Geosynthetic CQA Laboratory for testing to ensure conformance with the requirements of this Section and the CQA Plan. The Geosynthetic Installer shall assist the CQA Consultant in obtaining conformance samples. The Geosynthetic Installer shall account for this testing in the installation schedule.

B. At a minimum, the following conformance tests will be performed at a minimum frequency rate of one sample per 100,000 ft^2: mass per unit area (ASTM D 5993) and bentonite moisture content (ASTM D 5993). At a minimum, the following conformance tests will be performed at a frequency of one sample per 400,000 ft^2: index flux (ASTM D 5887). If the GCL Manufacturer provides material that requires sampling at a frequency (due to lot size, shipment size, etc.) resulting in one sample per less than 90 percent of 100,000 ft^2 (90,000 ft^2), then the Geosynthetic Installer shall pay the cost for all additional testing.

C. The CQA Consultant may increase the frequency of sampling in the event that test results do not comply with the requirements of Subpart 2.01 of this Section until passing conformance test results are obtained for all material that is received at the site. This additional testing shall be performed at the expense of the Geosynthetic Installer.

D. Any GCL that is not certified by the Manufacturer in accordance with Subpart 1.05 of this Section or that does not meet the requirements specified in Subpart 2.01 shall be rejected and replaced by the Geosynthetic Installer, at the expense of the Geosynthetic Installer.

3.08 PROTECTION OF WORK

A. The Geosynthetic Installer shall protect all work of this Section.

B. In the event of damage, the Geosynthetic Installer shall immediately make all repairs and replacements necessary to the approval of the Engineer, at the expense of the Geosynthetic Installer.

PART 4 – MEASUREMENT AND PAYMENT

A. Providing for and complying with the requirements set forth in this Section for GCL will be measured as in-place square feet (SF), as measured by the surveyor, to the limits shown on the Drawings, and payment will be based on the unit price provided on the Bid Schedule.

B. The following are considered incidental to the Work:

- Submittals.
- Quality Control.
- Shipping, handling and storage.
- Overlaps and seaming.
- Layout survey.
- Mobilization.
- Rejected material.
- Rejected material removal, handling, re-testing, and repair.
- Overlaps and seaming.
- Temporary anchorage.
- Visqueen.

TABLE 02772-1
REQUIRED GCL PROPERTY VALUES

PROPERTIES	QUALIFIERS	UNITS	SPECIFIED(1) VALUES	TEST METHOD
Bentonite Content(3)	minimum	lb/ft^2	0.75	ASTM D 5993
Bentonite Swell Index	minimum	mL/2g	24	ASTM D 5890
Bentonite Fluid Loss	maximum	mL	18	ASTM D 5891
Hydraulic Flux	maximum	m^3/m^2-s	1×10^{-8}	ASTM D 5887(2)

Notes: (1) All values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table).
(2) Hydraulic flux testing shall be performed under an effective confining stress of 5 pounds per square inch.
(3) Measured at a moisture content of 0 percent.

[END OF SECTION]

SECTION 02773
GEONET

PART 1 – GENERAL

1.01 SCOPE

A. The Geosynthetic Installer shall furnish all labor, materials, tools, supervision, transportation, equipment, and incidentals necessary for installation of the geonet. The work shall be carried out as specified herein and in accordance with the Drawings and Construction Quality Assurance (CQA) Plan.

B. The work shall include, but not be limited to, delivery, offloading, storage, placement, anchorage, and seaming of the geonet.

1.02 RELATED SECTIONS

Section 02225 – Drainage Aggregate

Section 02220 – Subgrade Preparation

Section 02616 – PVC Pipe

Section 02270 – Geomembrane

Section 02771 – Geotextile

1.03 REFERENCES

A. Drawings

B. Site CQA Plan

C. Latest Version American Society of Testing and Materials (ASTM) Standards:

ASTM D792	Standard Test Methods for Specific Gravity and Density of Plastics by Displacement
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603	Standard Test Method for Carbon Black in Olefin Plastics
ASTM D4218	Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by Muffle-Furnace Technique
ASTM D4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Place Flow) of Geotextiles and Geotextile Related Products
ASTM D5199	Standard Test Method for Measuring Nominal Thickness of Geosynthetics

1.04 QUALIFICATIONS

A. Geonet Manufacturer:

1. The Manufacturer shall be a well-established firm with more than five (5) years of experience in the manufacturing of geonet.

2. The Manufacturer shall be responsible for the production of geonet rolls and shall have sufficient production capacity and qualified personnel to provide material meeting the requirements of this Section and the construction schedule for this project.

B. Geonet Installer:

1. The Geosynthetic Installer shall meet the requirements of Subpart 1.04. B of Section 02770, and this Section.

2. The Geosynthetics Installer shall be responsible and shall provide sufficient resources for field handling, deploying, temporarily restraining (against wind and re-curling), and other aspects of the deployment and installation of the geonet and other geosynthetic components of the project.

1.05 SUBMITTALS

A. At least 7 days before transporting any geonet to the site, the Manufacturer shall provide the following documentation to the Engineer for approval.

1. list of material properties, including test methods utilized to analyze / confirm properties.

2. geonet samples.

3. projected delivery dates for this project.

4. Manufacturing Quality Control (MQC) certificates for each shift's production for which geonet for the project was produced, signed by responsible parties employed by the Manufacturer (such as the production manager). MQC certificates shall include:

a. roll numbers and identification; and

b. MQC results, including description of test methods used, outlined in Subpart 2.01 of this Section.

c. Certification that the geonet meets all the properties outlined in Subpart 2.01 of this Section.

1.06 CONSTRUCTION QUALITY ASSURANCE (CQA)

A. The Geosynthetic Installer shall ensure that the materials and methods used for producing and handling the geonet meet the requirements of the Drawings and this Section. Any material or method that does not conform to these documents, or to alternatives approved in writing by the Engineer, will be rejected and shall be repaired or replaced, at the Geosynthetic Installer’s expense.

B. The Geosynthetic Installer shall be aware of all monitoring and conformance testing required by the CQA Plan. This monitoring and testing, including random conformance testing of

construction materials and completed work, will be performed by the CQA Consultant. If nonconformances or other deficiencies are found in the materials or completed work, the Geosynthetic Installer will be required to repair the deficiency or replace the deficient materials at now additional cost to the Owner.

PART 2 – PRODUCTS

2.01 GEONET PROPERTIES

A. The Manufacturer shall furnish geonet having properties that comply with the required property values shown on Table 02773-1.

B. In addition to documentation of the property values listed in Table 02073-1, the geonet shall contain a maximum of one percent by weight of additives, fillers, or extenders (not including carbon black) and shall not contain foaming agents or voids within the ribs of the geonet.

2.02 MANUFACTURING QUALITY CONTROL (MQC)

A. The geonet shall be manufactured with MQC procedures that meet or exceed generally accepted industry standards.

B. Any geonet sample that does not comply with the Specifications will result in rejection of the roll from which the sample was obtained. The Geonet Manufacturer shall replace any rejected rolls at no additional cost to Owner.

C. If a geonet sample fails to meet the MQC requirements of this Section, then the Geonet Manufacturer shall sample and test each roll manufactured, in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.

D. Additional sample testing may be performed, at the Geonet Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

E. Sampling shall, in general, be performed on sacrificial portions of the geonet material such that repair is not required. The Manufacturer shall sample and test the geonet, at a minimum, once every 100,000 ft^2 to demonstrate that its properties conform to the values specified in Table 02773-1.

F. At a minimum, the following MQC tests shall be performed:

Test	Procedure
Density	ASTM D 792 or D 1505
Thickness	ASTM D 5199
Carbon Black Content	ASTM D 1603

G. The hydraulic transmissivity test (ASTM D 4716) in Table 02073-1 need not be performed at a frequency of one per 100,000 ft^2. However, the Geonet Manufacturer will certify that this test has been performed on a sample of geonet identical to the product that will be delivered to the Site. The Geonet Manufacturer shall provide test results as part of MQC documentation.

H. The Geonet Manufacturer shall comply with the certification and submittal requirements of this Section.

2.03 LABELING

A. Geonet shall be supplied in rolls labeled with the following information:

1. manufacturer's name;
2. product identification;
3. lot number;
4. roll number; and
5. roll dimensions.

2.04 TRANSPORTATION

A. Transportation of the geonet shall be the responsibility of the Geonet Manufacturer. The Geonet Manufacturer shall be liable for all damages to the materials incurred prior to and during transportation to the site.

B. Geonet shall be delivered to the site at least 7 days before the scheduled date of deployment to allow the CQA Consultant adequate time to inventory the geonet rolls and obtain additional conformance samples, if needed. The Geosynthetic Installer shall notify the CQA Consultant a minimum of 48 hours prior to any delivery.

2.05 HANDLING AND STORAGE

A. The Geosynthetic Manufacturer shall be responsible for handling, off-loading, storage, and care of the geonet prior to and following installation at the Site. The Geosynthetic Installer shall be liable for all damages to the materials incurred prior to final acceptance of the geonet drainage layer by the Owner.

B. The geonet shall be stored off the ground and out of direct sunlight, and shall be protected from mud and dirt. The Geosynthetic Installer shall be responsible for implementing any additional storage procedures required by the Geonet Manufacturer.

2.06 CONFORMANCE TESTING

A. Conformance testing, if required, shall be performed in accordance with the CQA Plan. The Geosynthetics installer shall assist the CQA Consultant in obtaining conformance samples, if requested. The CQA Consultant has the option of collecting samples at the manufacturing facility.

B. Passing conformance testing results, if applicable, are required before any geonet is deployed.

C. Samples shall be taken at a minimum frequency of one sample per 200,000 ft^2 with a minimum of one sample per lot. If the Geonet Manufacturer provides material that requires sampling at a frequency (due to lot size, shipment size, etc.) resulting in one sample per less than 90 percent of 200,000 ft^2 (180,000 ft^2), then the Geosynthetic Installer shall pay the cost for all additional testing.

D. The CQA Consultant may increase the frequency of sampling in the event that test results do not comply with the requirements of Subpart 2.01 of this Section until passing conformance test results are obtained for all material that is received at the Site. This additional testing shall be performed at the expense of the Geosynthetic Installer.

E. Any geonet that are not certified in accordance with Subpart 1.05 of this Section, or that conformance testing indicates do not comply with Subpart 2.01 of this Section, will be rejected by the CQA Consultant. The Geonet Manufacturer shall replace the rejected material with new material at no additional cost to the Owner.

PART 3 – EXECUTION

3.01 HANDLING AND PLACEMENT

A. On slopes steeper than 10 horizontal to 1 vertical, all geonet shall be continuous down the slope, i.e., no horizontal seams shall be allowed on the slope. Horizontal seams shall be considered as any seam having an alignment exceeding 20 degrees from being perpendicular to the slope contour lines, unless otherwise approved by the Engineer.

B. Geonet shall be placed with the machine direction perpendicular to the contour intervals (direction of flow).

C. The geonet shall be handled in such a manner as to ensure it is not damaged in any way.

D. Precautions shall be taken to prevent damage to underlying layers during placement of the geonet.

E. The geonet shall be installed in a manner that minimizes wrinkles.

F. Care shall be taken during placement of geonet to prevent dirt or excessive dust in the geonet that could cause clogging and/or damage to the adjacent materials.

3.02 JOINING AND TYING

A. Adjacent panels of geonet shall be overlapped by at least 4 in. These overlaps shall be secured by tying with nylon ties.

B. Tying shall be achieved by plastic fasteners or polymer braid. Tying devices shall be white or yellow for easy inspection. Metallic devices shall not be used.

C. Tying shall be performed at a minimum interval of every 5 ft. along the geonet roll edges and 2 ft. along the geonet roll ends.

3.03 REPAIR

A. Any holes or tears in the geonet shall be repaired by placing a patch extending 1 ft. beyond the edges of the hole or tear. The patch shall be placed under the panel and secured to the original geonet by tying every 6 in. with approved tying devices. If the hole or tear width across the roll is more than 50 percent of the width of the roll, then the damaged area shall be cut out and the two portions of the geonet shall be joined in accordance with the requirements of Subpart 3.02 of this Section.

3.04 PRODUCT PROTECTION

A. The Geosynthetics Installer shall use all means necessary to protect all prior work, and all materials and completed work of other Sections.

B. In the event of damage to the geonet, the Geosynthetic Installer shall immediately make all repairs per the requirements of this Section.

PART 4 – MEASUREMENT AND PAYMENT

A. Providing for and complying with the requirements set forth in this Section for geonet will be measured as in-place square feet (SF), as measured by the surveyor, to the limits shown on the Drawings, and payment will be based on the unit price provided on the Bid Schedule.

B. The following are considered incidental to the Work:

- Submittals.
- Quality Control.
- Shipping, handling and storage.
- Overlaps and seaming.
- Layout survey.
- Offloading.
- Mobilization.
- Rejected material.
- Rejected material removal, handling, re-testing, and repair.
- Temporary anchorage.

TABLE 02773-1
REQUIRED GEONET PROPERTY VALUES

PROPERTIES	QUALIFIERS	UNITS	SPECIFIED(1) VALUES	TEST METHOD
Resin Density	Minimum	g/cc	0.94	ASTM D792 or D1505
Carbon Black Content	Range	%	2.0 – 3.0	ASTM D1603 or D4218
Thickness	Minimum	mils	300	ASTM D5199
Transmissivity(2)	Minimum	m^2 / sec	8×10^{-3}	ASTM D4716

Notes: (1) All values (except transmissivity) represent average roll values.
(2) Transmissivity shall be measured using water at 68°F with a gradient of 0.1 under a confining pressure of 7,000 lb/ft^2. The geonet shall be placed in the testing device between 60-mil HDPE smooth geomembrane. Measurements are taken one hour after application of confining pressure.

[END OF SECTION]

SECTION 03400
CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, transportation and equipment necessary to construct a cast-in-place spillway crossing as shown on the Drawings and as specified herein.

B. The Work shall include, but not be limited to, procurement, delivery, subgrade preparation, formwork, concrete placement, control joints, surface treatment, and curing.

1.02 RELATED SECTIONS

None.

1.03 REFERENCES

A. Drawings

B. Construction Quality Assurance (CQA) Plan

C. Latest version of American Concrete Institute (ACI) standards:

ACI 117	Tolerances for Concrete Construction and Materials
ACI 211.1	Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301	Structural Concrete for Buildings
ACI 304R	Measuring, Mixing, Transporting, and Placing Concrete
ACI 308	Standard Practice for Curing Concrete
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 347R	Formwork for Concrete

D. Latest version of the American Society for Testing and Materials (ASTM) standards:

ASTM A 615	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 33	Concrete Aggregates
ASTM C 39	Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	Ready- Mixed Concrete
ASTM C 127	Specific Gravity and Adsorption of Coarse Aggregate
ASTM C 128	Specific Gravity and Adsorption of Fine Aggregate
ASTM C 143	Slump of Hydraulic Cement Concrete

ASTM C 150	Portland Cement
ASTM C 171	Sheet Materials for Curing Concrete
ASTM C 192	Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 309	Liquid Membrane - Forming Compounds for Curing Concrete
ASTM C 403	Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C 494	Chemical Admixtures for Concrete
ASTM C 618	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

1.04 SUBMITTALS

A. At least 7 days prior to construction of the concrete, Contractor shall submit a mix design for the type of concrete. Submit a complete list of materials including types, brands, sources, amount of cement, fly ash, pozzolans, retardants, and admixtures, and applicable reference specifications for the following:

1. Slump design based on total gallons of water per cubic yard.
2. Type and quantity of cement.
3. Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture.
4. Compressive strength based on 28-day compression tests.

B. Delivery Tickets:

1. Provide duplicate delivery tickets with each load of concrete delivered, one for Contractor's records and one for Engineer, with the following information:
   a. Date and serial number of ticket.
   b. Name of ready-mixed concrete plant, operator, and job location.
   c. Type of cement, admixtures, if any, and brand name.
   d. Cement content, in bags per cubic yard (CY) of concrete, and mix design.
   e. Truck number, time loaded, and name of dispatcher.
   f. Amount of concrete (CY) in load delivered.
   g. Gallons of water added at job, if any, and slump of concrete after water was added.

C. Delivery

1. The Concrete Manufacturer shall be liable for all damage to the materials incurred prior to and during transportation to the Site.

1.05 MANUFACTURER QUALITY CONTROL (MQC)

A. Aggregates shall be sampled and tested in accordance with ASTM C 33.

B. Concrete test specimens shall be made, cured, and stored in conformity with ASTM C 192 and tested in conformity with ASTM C 39.

C. Slump shall be determined in accordance with ASTM C 143.

1.06 LIMITING REQUIREMENTS

A. Unless otherwise specified, each concrete mix shall be designed and concrete shall be controlled within the following limits:

1. Concrete slump shall be kept as low as possible, consistent with proper handling and thorough compaction. Unless otherwise authorized by the Engineer, slump shall not exceed 5 in.

2. The admixture content, batching method, and time of introduction to the mix shall be in accordance with the manufacturer's recommendations for minimum shrinkage and for compliance with this Section. A water-reducing admixture may be included in concrete.

PART 2 – PRODUCTS

2.01 PROPORTIONING AND DESIGN MIXES

A. Concrete shall have the following properties.

1. 3,000 psi, 28-day compressive strength.

2. Slump range of 1 to 5 inches.

3. Coarse Aggregate Gradation, ASTM C 33, Number 57 or 67.

B. Retarding admixture in proportions recommended by the manufacturer to attain additional working and setting time from 1 to 5 hours.

2.02 CONCRETE MATERIALS

A. Cement shall conform to ASTM C 150 Type II.

B. Water shall be fresh, clean, and potable, free from oils, acids, alkalis, salts, organic materials, and other substances deleterious to concrete.

C. Aggregates shall conform to ASTM C 33. Aggregates shall not contain any substance which may be deleteriously reactive with the alkalis in the cement, and shall not possess properties or constituents that are known to have specific unfavorable effects in concrete.

D. The Contractor may use a water reducing chemical admixture. The water reducing admixture shall conform to ASTM C 494, Type A. The chemical admixture shall be approved by the Engineer.

2.03 REINFORCING STEEL

A. The reinforcing steel shall be Grade 60 in accordance with ASTM A 615.

B. Unless otherwise noted on the Drawings, all reinforcement bars shall be No.3 (3/8-inch diameter) in accordance with ASTM A 615 and welded wire fabric shall be sized as 6 x 6, W1.4 x W1.4..

PART 3 – EXECUTION

3.01 BATCHING, MIXING, AND TRANSPORTING CONCRETE

A. Batching shall be performed according to ASTM C 94, ACI 301, and ACI 304R, except as modified herein. Batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Concrete Manufacturer shall furnish mandatory batch ticket information for each load of ready mix concrete.

B. Machine mixing shall be performed according to ASTM C 94 and ACI 301. Mixing shall begin within 30 minutes after the cement has been added to the aggregates. Concrete shall be placed within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

C. Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.02 SUBGRADE PREPARATION

A. Subgrade shall be graded to the lines and elevations as shown on the Drawings.

B. Standing water, mud, debris, and foreign matter shall be removed before concrete is placed.

3.03 PLACING CONCRETE

A. Place concrete in accordance with ACI 301, ACI 318, and ACI 304R. Place concrete as soon as practicable after the forms and the reinforcement have been approved by the CQA Consultant. Do not place concrete when weather conditions prevent proper placement and consolidation, in uncovered areas during periods of precipitation, or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Place concrete in one continuous operation from one end of the structure towards the other

B. Ensure reinforcement is not disturbed during concrete placement.

C. Do not allow concrete temperature to decrease below 50 degrees F while curing. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 5 degrees F in any 1 hour and 50 degrees F per 24 hours after heat application.

D. Do not spread concrete with vibrators. Concrete shall be placed in final position without being moved laterally more than five feet.

E. When placing of concrete is temporarily halted or delayed, provide construction joints.

F. Concrete shall not be dropped a distance greater than five feet.

G. Place concrete with aid of internal mechanical vibrator equipment capable of 9,000 cycles/min. Transmit vibration directly to concrete.

H. Hot Weather:

1. Comply with ACI 304R.
2. Concrete temperature shall not exceed 90°F.
3. At air temperatures of 80°F or above, keep concrete as cool as possible during placement and curing. Cool forms by water wash.
4. Evaporation reducer shall be used in accordance with manufacturer recommendations (Subpart 2.03).

3.04 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury in accordance with ACI 308.

B. Immediately after placement, protect concrete from plastic shrinkage by applying evaporation reducer in accordance with manufacturer recommendations (Subpart 2.03).

C. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete (Subpart 2.03).

D. Protect from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.

E. Membrane curing compound shall be spray applied at a coverage of not more than 300 square ft per gallon. Unformed surfaces shall be covered with curing compound within 30 minutes after final finishing. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surfaces before they dry out.

F. Curing compound shall be suitably protected against abrasion during the curing period.

G. Film curing will not be allowed.

3.05 FORMS

A. Formwork shall prevent leakage of mortar and shall conform to the requirements of ACI 347R.

B. Do not disturb forms until concrete is adequately cured.

C. Form system design shall be the Contractor's responsibility.

3.06 CONTROL JOINTS

A. Control joints shall consist of plastic strips set flush with finished surface or ¼ inch wide joints formed with a trowel immediately after pouring or cut with a diamond saw within 12 hours after pouring.

B. Control joints shall be installed in a 15 ft x 15 ft grid spacing along the slab unless otherwise approved by the Engineer. Control joints shall be no greater than 1 ½ inch below the surface.

3.07 SLAB FINISHES

A. Unformed surfaces of concrete shall be screeded and given an initial float finish followed by additional floating, and troweling where required.

B. Concrete shall be broom finished.

3.08 SURVEY

A. The Surveyor shall locate the features of the concrete structure. The dimensions, locations and elevations of the features shall be presented on the Surveyor's Record Drawings.

PART 4 – MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Providing for and complying with the requirements set forth in this Section for Cast-In-Place Concrete will be measured as lump sum (LS), and payment will be based on the unit price provided on the Bid Schedule.

B. The following are considered incidental to the work:

- Mobilization.
- Submittals.
- Quality Control.
- Excavation.
- Subgrade preparation.
- Concrete batching, mixing, and delivery.
- Layout and as-built Record Survey.
- Subgrade preparation.
- Reinforcing steel.
- Formwork.
- Concrete placement and finishing.
- Sawcutting and control joints.
- Rejected material removal, handling, re-testing, repair, and replacement.

[END OF SECTION]