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BLUE RIDGE PAPER PRODUCTS, INC.
CANTON, NORTH CAROLINA

CONTRACT DOCUMENTS AND CONSTRUCTION SPECIFICATIONS FOR LANDFILL NO. 6 – AREA A VALLEY FILL CONSTRUCTION

MAY 2006

SME

Sevee & Maher Engineers, Inc.
Waste Management and Hydrogeologic Consultants
Cumberland Center, Maine

NORTH CAROLINA PROFESSIONAL SEAL 20570 ENGINEER JOHN E. SEVEE

BLUE RIDGE PAPER PRODUCTS INC.
CANTON, NORTH CAROLINA

CONTRACT DOCUMENTS AND CONSTRUCTION SPECIFICATIONS FOR LANDFILL NO. 6 – AREA A VALLEY FILL CONSTRUCTION

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CANTON, NORTH CAROLINA

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FOR
LANDFILL NO. 6 – AREA A
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INFORMATION FOR BIDDERS

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INFORMATION FOR BIDDERS

I. Receipt and Opening of Bids

Blue Ridge Paper Products, Inc., (herein called the "Owner"), invites bids on the form attached hereto, all blanks of which must be appropriately filled in. Bids will be received by the Owner at the office of Lynn Sellers until __:00 P.M. prevailing time, _____, 200_ and then at said office privately opened and read. The envelopes containing the bids must be sealed, addressed to:

Blue Ridge Paper Products, Inc.
Attn: Ms. Lynn Sellers
Canton Mill
P.O. Box 4000
Canton NC 28716

Owner may consider informal any bid not prepared and submitted in accordance with the provisions hereof and may waive any informalities or reject any and all bids. Any bid may be withdrawn prior to the above scheduled time for the opening of bids or authorized postponement thereof. Any bid received after the time and date specified shall not be considered. No bidder may withdraw a bid within 90 days after the actual date of the opening thereof.

II. Preparation of Bid

Each bid must be submitted on the prescribed form appended to these documents. All blank spaces for bid prices must be filled in, in ink or typewritten.

Each bid must be submitted in a sealed envelope bearing on the outside the name of the bidder, his address, and the name of the project for which the bid is submitted. If forwarded by mail, the sealed envelope containing the bid must be enclosed in another envelope addressed as specified in the bid form.

III. Subcontractors

The bidder is specifically advised that any person, firm, or other party to whom it is proposed to award a subcontract under this Contract must be acceptable to the Owner. A complete list of proposed subcontractors shall be included in the Contractor's proposal.

IV. Qualification of Bidder

The Owner may make such investigations as he deems necessary to determine the ability of the bidder to perform the work, and the bidder shall furnish to the Owner all such information and data for this purpose as the Owner may request. The Contractor shall submit with the bid the name and resume of the Superintendent who shall be on site during the project. The Owner reserves the right to reject any bid if the evidence submitted by, or investigation of, such bidder fails to satisfy the Owner that such bidder is properly qualified to carry out the obligations of the contract and to complete the work contemplated therein. Conditional bids will not be accepted.

V. Time of Completion and Liquidated Damages

Bidder must agree to complete all work by _____, 200_. Bidder must submit a detailed schedule for all phases of the project showing starting and completion dates of key activities with their bid.

VI. Condition of Work

Each bidder must inform himself fully of the conditions relating to the construction of the project and the employment of labor thereon. Failure to do so will not relieve a successful bidder of his obligations to furnish all material and labor necessary to carry out the provisions of his Contract. Insofar as possible the Contractor, in carrying out his work, must employ such methods or means as will not cause any interruptions of or interference with the work of any other contractor.

VII. Addenda and Interpretations

No interpretation of the meaning of the plans, specifications or other pre-bid documents will be made to any bidder orally. Every request for such interpretation should be in writing addressed to Sevee & Maher Engineers, Inc., 4 Blanchard Rd., P.O. Box 85A, Cumberland Center, Maine 04021 and to be given consideration must be received at least five working days prior to the date fixed for the opening of bids. Any and all such interpretations and any supplemental instructions will be in the form of written addenda to the specifications which, if issued, will be mailed by certified mail with return receipt requested to all prospective bidders (at the respective addresses furnished for such purposes), not later than three days prior to the date fixed for the opening of bids. Failure of any bidder to receive any such addendum or interpretation shall not relieve such bidder

from any obligation under his bid as submitted. All addenda so issued become part of the Contract documents.

VIII. Security for Faithful Performance

If requested by the Owner, simultaneously with his delivery of the executed Contract, the Contractor shall furnish a Surety Bond or Bonds for 100 percent of the Contract amount as security for faithful performance of this Contract and for the payment of all persons performing labor on the project under this Contract and furnishing materials in connection with this Contract. The surety on such bond or bonds shall be a duly authorized surety company satisfactorily to the Owner. The cost of these bonds, if required, will be reimbursed to the Contractor by the Owner.

IX. Power of Attorney

Attorneys-in-fact who sign Contract bonds must file with each bond a certified and effectively dated copy of their power of attorney.

X. Notice of Special Conditions

Attention is particularly called to those parts of the Contract documents and specifications, especially Safety and Conduct Requirements.

XI. Laws and Regulations

The bidder's attention is directed to the fact that all applicable State laws, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the Contract throughout, and they will be deemed to be included in the Contract the same as though herein written out in full.

XII. Method of Award - Lowest Qualified Bidder

If at the time this Contract is to be awarded, the lowest base bid submitted by a reasonable bidder does not exceed the amount of funds then estimated by the Owner as available to finance the Contract, the Contract will be awarded on the base of bid only. If such bid exceeds said amount, the Owner may reject all bids or may award the Contract reducing the amount of unit price work to keep the overall Contract amount within the available funds.

XIII. Obligation of Bidder

At this time of the opening of bids, each bidder will be presumed to have inspected the site and to have read and to be thoroughly familiar with the plans and Contract documents (including all addenda). The failure or omission of any bidder to examine any form, instrument or document shall in no way relieve any bidder from any obligation in respect of his bid.

A pre-bid conference and/or inspection trip for prospective bidders is scheduled for _____, 200_ at _:00 PM, at the Purchasing Office.

BLUE RIDGE PAPER PRODUCTS INC.
CANTON, NORTH CAROLINA

CONTRACT DOCUMENTS AND
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FOR
LANDFILL NO. 6 – AREA A
VALLEY FILL CONSTRUCTION

CONTRACT

BLUE RIDGE PAPER PRODUCTS INC.
CANTON, NORTH CAROLINA

CONTRACT DOCUMENTS AND
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FOR
LANDFILL NO. 6 – AREA A
VALLEY FILL CONSTRUCTION

GENERAL AND SPECIAL CONDITIONS

BLUE RIDGE PAPER PRODUCTS INC.
CANTON, NORTH CAROLINA

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SAFETY AND CONDUCT REQUIREMENTS

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LANDFILL NO. 6 – AREA A
VALLEY FILL CONSTRUCTION

BID SCHEDULE

BLUE RIDGE PAPER PRODUCTS, INC.
CANTON, NORTH CAROLINA

CONTRACT DOCUMENTS AND
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FOR
LANDFILL NO. 6 – AREA A
VALLEY FILL CONSTRUCTION

BID SCHEDULE

Item No.	Approx. Quantity	Item and Unit Price Bid	Unit Prices (numerals)	Extension Amount (numerals)
4.4.1	Lump Sum	Mobilization / Demobilization The lump sum bid of $_____	$_____	$_____
4.4.2	Lump Sum	Area A – East / Area A – West Berm Excavation and Subbase Grading The lump sum bid of $_____	$_____	$_____
4.4.3	Cu Yd. 750	Diversion Berm (Soils to construct furnished from existing cover material to be stripped from Area A-East) The sum of $_____ _____ per cubic yard	$_____	$_____
4.4.4	Cu Yd. 1,400	Compacted Soil Liner The sum of $_____ _____ per cubic yard	$_____	$_____
4.4.5	Sq Ft. 40,000	Geosynthetic Clay Liner (supply and install) The sum of $_____ _____ per square foot	$_____	$_____
4.4.6	Sq Ft. 40,000	60-miL textured HDPE Geomembrane (supply and install) The sum of $_____ _____ per square foot	$_____	$_____
4.4.7	Sq Ft. 40,000	Geotextile; 16 oz/sy Non-Woven (supply and install) The sum of $_____ _____ per square foot	$_____	$_____
4.4.8	Lump Sum	Required Aggregate(s) – To be furnished by Owner on-site (#78M Stone and ABC gravel where needed) The lump sum bid of $_____		

Item No.	Approx. Quantity	Item and Unit Price Bid	Unit Prices (numerals)	Extension Amount (numerals)
4.4.9	Lin Ft. 220	Anchor Trench The sum of $_____ _____ per lineal foot	$_____	$_____
4.4.10	Cu Yd. 10,500	Area A- East Cover Soil Removal The sum of $_____ _____ per cubic yard	$_____	$_____
4.4.11	Cu Yd. 50	Vegetative cover soil (4-inch layer to cover Diversion Berm) The sum of $_____ _____ per cubic yard	$_____	$_____
4.4.12	Units 5	Seeding and Mulching (Diversion Berm) The sum of $_____ _____ per unit	$_____	$_____
4.4.13	Lump Sum	Miscellaneous Work (i.e. Culvert abandonment/removal) The lump sum bid of $_____	$_____	$_____
TOTAL ESTIMATED COST FOR THE AREA A – VALLEY FILL CONSTRUCTION			$_____	

BLUE RIDGE PAPER PRODUCTS INC.
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DRAWING LIST

BLUE RIDGE PAPER PRODUCTS INC.
CANTON, NORTH CAROLINA

CONTRACT DOCUMENTS AND CONSTRUCTION SPECIFICATIONS FOR LANDFILL NO. 6 – AREA A VALLEY FILL CONSTRUCTION

DRAWING LIST

Drawing No.	Title
	Cover Sheet
C-100	Symbols and Abbreviations
C-101	Site Location Plan
C-102	Existing Conditions Plan
C-103	Site Development Plan
C-104	Final Grading Plan - NITC
C-300	Sections and Details – Page 1
C-301	Sections and Details – Page 2
NITC – not in this contract	

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TECHNICAL SPECIFICATIONS

BLUE RIDGE PAPER PRODUCTS INC.
CANTON, NORTH CAROLINA

CONTRACT DOCUMENTS AND CONSTRUCTION SPECIFICATIONS FOR LANDFILL NO. 6 – AREA A VALLEY FILL CONSTRUCTION

TECHNICAL SPECIFICATIONS

DIVISION 1

Section	Title
01010	SUMMARY OF WORK
01300	SUBMITTALS
01400	QUALITY ASSURANCE PLAN

DIVISION 2

Section	Title
02200	EARTHWORK
02270	EROSION CONTROL
02275	GEOSYNTHETIC CLAY LINER
02480	SEEDING
02731	GEOTEXTILES
02771	GEOMEMBRANE (HIGH DENSITY POLYETHYLENE (HDPE))

SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.0 PROJECT DESCRIPTION

The intent of this project is to construct the Valley Fill Cell between existing Area A-West and Area A-East of Landfill No. 6 as described in the Contract drawings and Specifications attached herein. This specific inquiry involves the removal of the access roadway above the dike bisecting Area A-West and Area A-East, stripping of the sideslope cover soils on the west side of Area A-East, engineered backfill, geosynthetics installation, surface water and erosion control measures, etc., delineated in this document.

1.1 PROJECT/WORK IDENTIFICATION:

Project Title:	Landfill No. 6 Area A – Valley Fill Construction
Owner:	Blue Ridge Paper Products, Inc. Canton, North Carolina
Design Engineer:	Sevee & Maher Engineers, Inc. Cumberland Center, Maine

1.2 DEFINITIONS:

1.2.1 Contract: The written agreement between the Owner and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to, the performance of the work, the furnishing of labor and materials and the basis of payment.

The contract includes the proposal, contract form and contract bonds, specifications, supplemental specifications, special provisions, general and detailed plans and notice to proceed, also any change orders and agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

A contract may include any part of a project or one or more projects.

1.2.2 Contract Documents: The contract includes the technical specification documents contained herein, the contract form, the Safety and Conduct Requirements, the General and Special Conditions, bid schedule, the drawings, and the addenda issued in the execution of the described work.

1.2.3 Information Precedence: In the event that any technical information presented herein conflicts with other such information, the information on the drawings will take precedence.

Once such an item is found, it is the contractor's responsibility to report said conflict to the Construction Manager.

1.2.4 Bidder: An individual, firm or corporation submitting a bid for the advertised work.

1.2.5 Contractor: The individual, firm or corporation contracting with the Owner for performance of prescribed work.

1.2.6 Indicated: The term "Indicated" is a cross-reference to graphic representation, notes, or schedules on drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements in the contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for purposes of helping reader locate cross-reference, and no limitation of location is intended except as specifically noted.

1.2.7 Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to project site, ready for unloading, unpacking, assembly, installation, etc., as applicable to each instance.

1.2.8 Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

1.2.9 Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

1.3 PROJECT CONDITIONS:

1.3.1 Permits: All the necessary permits for this project have been filed for from the appropriate agency. If the issuance of any permit affects the scope or specification of work, all parties will be notified as soon as possible to determine the effect of cost, schedule, or previous contractual agreement.

1.3.2 Temporary Utilities: The Contractor shall be responsible for all utilities necessary to execute his contract. There may be some low voltage power and some telephone service available adjacent to the maintenance building. Any labor costs associated with the extension of these utilities will be borne by the Contractor. Any assumptions made by a bidder contrary to the intent of this paragraph must be explicitly detailed in his bid.

1.3.3 Temporary Facilities: Contractor shall provide all temporary facilities including, but not limited to, structures, secured areas for materials storage, potable water, sanitary and medical facilities, etc.

1.4 SUBMITTALS REQUIRED WITH PROPOSAL:

1.4.1 Construction Schedule: Contractor shall submit a preliminary bar-chart type schedule with the Bid Documents. On the schedule, indicate a time bar for each major category or unit of work to be performed at the site, properly sequenced and coordinated with other elements of work. Include estimated man-hours for each activity.

1.4.2 Schedule of Rates: Contractor shall submit with the Bid Documents a Standard Schedule of Rates for Labor, Equipment and Materials. Schedule of Rates will be used as a basis of time and materials payment for extra work.

1.4.3 Proposed Management Personnel: The diligent, proactive management of this project, and this construction contract in particular, is extremely important to the successful execution of the project's stated objectives. Towards this end, each bidder will submit with the proposal, the proposed supervisory structure. At a minimum, it will include one full time superintendent on site, the number and type of foremen required to supervise the various activities and any anticipated clerical assistance. The proposed should be identified by name, with a resume of his associated experience as a superintendent. This portion of the proposal will be reviewed very carefully and will be a major consideration in the contractor selection process.

PART 2 - PROJECT SCHEDULE:

2.1 GENERAL:

The Construction Manager is responsible for the coordination of all activities on site and will work with each contractor to ensure a timely project completion.

2.2 CONTRACTOR'S SUBMITTAL:

Each contractor shall submit to the construction manager a time scaled, pert-type schedule for his/her procurement, construction and quality assurance activities. Once accepted, these schedules become the baseline construction schedules.

2.3 WEEKLY REVIEW, UPDATING AND PROJECTIONS:

This schedule will be updated on a weekly basis to reflect the actual progress and the current completion projection. The updated schedule will be submitted one day prior to the weekly construction meeting. The Construction Manager will review the schedules from both contractors for coordination and project compliance purposes.

PART 3 - CONSTRUCTION SITE MANAGEMENT:

3.1 SAFETY:

Completion of this construction project without incurring an OSHA recordable incident is the first priority of all involved.

3.2 WEEKLY MEETING:

The Construction Manager will conduct a weekly meeting on the job site at a mutually agreed upon time. The meeting will take place at the prescribed time each week. The agenda for this meeting will consist of, at a minimum, progress to date, updated projections for each line item completion, safety performance. At this meeting the Construction Manager will collect from each contractor their updated schedule, weekly safety talk minutes, and any accident investigation reports.

3.3 ACCIDENT REPORTS:

In the event of an accident, the Contractor will inform the Construction Manager of said accident weekly for minor cut and bruises, that day for potential lost time accidents, and just as soon as practical on emergency care accidents.

3.4 JOB SITE COMMUNICATIONS:

Each Contractor on the job site will designate a project superintendent and one substitute. The Owner's representative will be the Construction Manager. All discussions involving variances in schedule, cost, or quality will be directed to the designated representative.

3.5 NOTIFICATION OF POTENTIAL EXTRAS:

Just as soon as a potential contractual extra is revealed, the Contractor shall notify the Construction Manager in writing (i.e. hand written speedy memo) of said potential which will be signed by the Construction Manager and the appropriate superintendent(s).

3.6 RECORD DRAWINGS:

The Contractor shall submit as-built drawings to the Engineer for not more than 30 days following contract completion. The release of the final payment is contingent on the receipt of said drawings.

PART 4 - MEASUREMENT, EXECUTION AND PAYMENT

4.1 DEFINITION OF PAYMENT ITEMS:

Unit price extras under this contract shall be paid as described herein under the appropriate items. Payment of work shall be full compensation for costs incurred by the Contractor in providing the work as described in the Contract Documents.

The Contractor shall provide a detailed breakdown of the lump sum costs, acceptable to the Construction Manager, which will be used for estimating progress payment requests unless otherwise specified herein.

4.2 UNDEFINED AND CONTRACTUAL COSTS:

Costs for work not specifically mentioned, and which are incidental to the overall conduct of the work, shall be included in the Contractor's Bid, distributed into the actual Bid item as deemed appropriate. Examples of these types of costs are, but not necessarily limited to, the following:

Insurance's
Construction Permits and Licenses
Surveying
Temporary Erosion Control

4.3 MEASUREMENTS:

The Construction Manager shall approve all measurements taken for payment on unit price extras. The Contractor shall assist the Construction Manager in conducting measurements for payment.

4.4 EXECUTION AND PAYMENT:

Quantities listed for each item are not guaranteed. The estimated quantities are provided as a Bidder's guide only; the Bidder should verify quantities.

4.4.1 Mobilization/Demobilization:

General: This item shall consist of preparatory work and operations including, but not limited to those necessary to the movement of personnel, equipment, supplies and incidentals to the project site; and for all other work and operations which must be performed or costs incurred prior to beginning work and upon completion of work on the various items on the project site.

Payment: This is a fixed cost lump sum item as stated in the bid. Any changes to the contract price must be based upon a change in the described scope.

4.4.2 Berm Excavation and Subbase Grading (Area A-East/West Divider Berm):

General: This item consists of all labor and equipment required for the removal of geomembrane liner, anchor trench, and berm soils to the grade specified for the Area A-East/West Divider Berm in accordance with the Contract Drawings and Specifications. The excavated berm soils shall be returned to the Owner and stockpiled at the Borrow Source Area on the project site unless directed elsewhere by the Owner. The estimated quantity of berm soils expected for removal on this project is approximately 3,800 cy.

Payment: This is a fixed cost lump sum item as stated in the bid. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

4.4.3 Diversion Berm:

General: This item consists of all labor and equipment required for the placement to grade of the compacted diversion berm on Area A-East in accordance with the Contract Drawings and Specifications. Compacted soils used for the construction of the diversion berm will be reclaimed from the existing cover soil material stripped from the sideslope of Area A-East (see item no. 4.4.9). The estimated quantity of soils required to construct the diversion berm is approximately 750 cy.

Payment: This is a fixed cost lump sum item as stated in the bid. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

4.4.4 Compacted Soil Liner:

General: This item shall consist of all equipment, labor, and materials required to complete the placement to grade of the compacted soil liner in accordance with the Contract Drawings and Specifications. The compacted soil liner shall be a 12-inch compacted layer of 1-inch minus soil

material as specified in Specification 02200, Section 2.1.3, and placed over the prepared subgrade.

The estimated quantity of soil for the compacted soil liner is 1,400 cy.

Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

4.4.5 Geosynthetic Clay Liner:

General: Geosynthetic clay liner (GCL) installation shall consist of installing, deploying, placing, seaming, and repairing of any blemishes for the liner system of the Area A-Valley Fill. Scope of work is for providing all equipment, labor, and materials required to complete the work. Measurement of work will be per square foot of installed GCL. No additional payment will be made for seam overlap or wasted trimmings. The General Contractor will be responsible for providing services, machine and operator, to assist the Geosynthetic Contractor in deploying the GCL. This work shall be installed in accordance with the Contract Drawings and Specifications.

Estimated quantity is 40, 000 sf.

Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

4.4.6 60-mil HDPE Textured Liner:

General: 60-mil HDPE textured liner installation shall consist of installing, deploying, placing, seaming, on-site testing, sampling, and repairing of any testing failures for the liner of the Area A-Valley Fill area, as well as for anchoring liner. The work is also associated with approximately 1,600 ft. of tie-in seam to connect the Valley Fill liner to the existing area A-East liner and Area A-West liner. Scope of work is for providing all equipment, labor, and materials required to complete the work. Measurement of work will be per square foot of installed liner. No additional payment will be made for seam overlap, wasted trimmings, or for liner installed within the anchor trench. The General Contractor will be responsible for providing services, machine and operator, to assist the Geosynthetic Contractor in deploying liner and fabric and will also be responsible for excavating and backfilling the anchor trench. This work shall be installed in accordance with Contract Drawings and Specifications.

Estimated quantity is 40,000 sf.

Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

4.4.7 Geotextile; 16 oz/sy Non-Woven

General: This item shall consist of all equipment, labor, and materials required to complete the geotextile installation consisting of the placement and securing of a 16 oz/sy non-woven geotextile above the geomembrane. Measurement of work will be per square foot of installed geotextile, with no allowance for seam overlap. No payment will be made for wasted trimmings. The General Contractor will be responsible for providing services, machine and operator, to assist the Geosynthetic Contractor in deploying liner and fabric and will also be responsible for excavating and backfilling the anchor trench. This work shall be installed in accordance with the Contract Drawings and Specifications.

Estimated quantity is 40,000 sf.

Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

4.4.8 Required Aggregate(s):

General: This item shall consist of all equipment and labor required to complete the placement of the #78M stone for drainage and ABC Gravel for access road restoration (as needed) required for the Project in accordance with the Contract Drawings and Specifications. The aggregate(s) shall be provided by the Owner, delivered to the project site. The estimated quantity of #78m stone required on this project is 1,400 cy.

Payment: This is a fixed cost lump sum item as stated in the bid. Any changes to the contract price must be based upon a change in the described scope.

4.4.9 Anchor Trench:

General: This item shall consist of all equipment, labor, and materials required to complete the excavation and filling of the anchor trenches associated with liner installation of the Valley Fill between Area A-East and Area A-West. The anchor trenches shall be excavated and filled in accordance with the Contract Drawings and Specifications.

The estimated quantity of anchor trench is 220 lf.

Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

4.4.10 Area A-East Cover Soil Removal:

General: This item consists of all labor and equipment for the removal of the cover system along the west side of the closed sideslope of Area A-East in accordance with the Contract Drawings and Specifications. The excavated cover system soils shall be used to construct the diversion berm (see item no. 4.4.2) with the remainder returned to the Owner, and stockpiled on the project

site where directed by the Owner. The estimated quantity of cover soils expected for removal on this project is 10,500 cy.

Payment: This is a fixed cost lump sum item as stated in the bid. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

4.4.11 Vegetative Cover Soil:

General: This item consists of all labor, equipment, and materials required to complete the placement of a 4" vegetative cover soil layer above the diversion berm on Area A-East in accordance with the Contract Drawings and Specifications.

The estimated quantity of vegetative cover soils is 60 cy.

Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

4.4.12 Seeding and Mulching:

General: This item shall consist of all equipment, labor, and materials required for seeding and mulching of the diversion berm on Area A-East in accordance with the Contract Drawings and Specifications. Seeding includes soil preparation, seed, fertilizer, lime, and mulch.

The estimated quantity of seed and mulch is 6 units.

Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

4.4.13 Miscellaneous Work

General: Miscellaneous work associated with the Valley Fill construction includes the removal of an 18-inch HDPE culvert and riprap at the southwest corner of Area A-East, and the abandonment of the 18-inch HDPE culvert at the northwest corner of Area A-East in accordance with the Contract Drawings and Specifications.

Payment: This is a fixed cost lump sum item as stated in the bid. Any changes to the contract price must be based upon a change in the described scope.

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Submittal procedures.

B. Construction progress schedule.

C. Proposed products list.

D. Shop drawings.

E. Product data.

F. Samples.

G. Manufacturer's instructions.

H. Manufacturer's certificates.

1.2 RELATED SECTIONS AND DOCUMENTS

A. Summary of Work: Section 01010

1.3 SUBMITTAL PROCEDURES:

A. Transmit each submittal with Engineer accepted form.

B. Sequentially number the transmittal forms. Resubmittals to have original number with an alphabetic suffix.

C. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet and detail number(s), and specification Section number, as appropriate.

D. Apply Contractor's stamp, signed or initialed certifying that review, verification of products required, field dimensions, adjacent construction work, and coordination of information, is in accordance with the requirements of the work and Contract Documents.

E. Schedule submittals to expedite the project, and deliver to the Engineer. Coordinate submission of related items. The Contractor may be obligated to provide submittals as dictated in the Contract between the Owner and the Contractor.

F. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of the completed work.

G. Provide space for Contractor and Engineer review stamps.

H. Revise and resubmit submittals as required, identify all changes made since previous submittal.

I. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

1.4 PROPOSED PRODUCTS LIST:

A. Within 15 days after date of Owner-Contractor Agreement submit on forms provided complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give manufacturer trade name, model or catalog designation, and reference standards.

1.5 SHOP DRAWINGS:

A. Submit in the form of one reproducible transparency.

B. After review, distribute in accordance with Article on Procedures above and for Record Documents.

1.6 PRODUCT DATA:

A. Submit the number of copies which the Contractor requires, plus two copies which will be retained by the Engineer.

B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturer's standard data to provide information unique to this project.

C. After review, distribute in accordance with Article on Procedures above and provide copies for Record Documents.

1.7 SAMPLES:

A. Submit samples to illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

B. Submit samples of finishes from the full range of manufacturer's standard colors, textures, and patterns for Engineer's selection.

C. Include identification on each sample, will full project information.

D. Submit the number or samples specified in individual specification sections; one of which will be retained by Engineer.

E. Reviewed samples which may be used in the work are indicated in individual specification sections.

1.8 MANUFACTURER'S INSTRUCTIONS:

A. When specified in individual specification sections, submit manufacturer's printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for Product Data.

B. Identify conflicts between manufacturer's instructions and Contract Documents.

1.9 MANUFACTURER'S CERTIFICATES:

A. When specified in individual specification sections, submit manufacturer's certificate to Engineer for review, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference date, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or product, but must be acceptable to Engineer.

END OF SECTION

SECTION 01400

QUALITY ASSURANCE / QUALITY CONTROL PLAN

See Attached

QUALITY ASSURANCE/ QUALITY CONTROL PLAN FOR BLUE RIDGE PAPER PRODUCTS INC. LANDFILL NO. 6 – AREA A VALLEY FILL CONSTRUCTION

MARCH 2006

SME

Sevee & Maher Engineers, Inc.
Waste Management and Hydrogeologic Consultants
Cumberland Center, Maine

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1.0 SCOPE

This Quality Assurance/Quality Control Plan (Plan) addresses construction quality assurance and quality control for earthwork and geosynthetic installation on the Area A Valley Fill of Blue Ridge Paper Product's, Inc. (BRPP) No. 6 Landfill. The Valley Fill construction between Area A-East and Area A-West encompasses approximately 0.8 acres, and will be constructed over the east/west divider berm with a 12-inch compacted soil liner, GCL, a 60-mil geomembrane, 16 oz. non-woven geotextile, and 12 inches of drainage stone.

This plan addresses the manufacturing and installation quality assurance and quality control procedures associated with selecting and placing the HDPE geomembrane liner, non-woven geotextile, and GCL. This plan also outlines the characterization of the borrow source soil's physical properties to determine its ability to achieve the project's performance criteria; defines procedures for soil placement; defines tests and frequency of testing to assure the construction meets or exceeds design criteria; and provides a method for documenting the soil placement.

1.1 Parties

The parties discussed in this section are associated with the ownership, design, installation, and quality assurance of the liner system. The definitions, qualifications, and responsibilities of these parties are outlined in the following subsections.

Project Manager. The project manager is the official representative of BRPP. In this manual the term Project Manager shall apply equally to Construction Coordinator. The Project Manager is responsible for coordinating construction and quality assurance activities for the project. The Project Manager shall serve as communications coordinator for the project, and is responsible for initiating the pre-bid, pre-construction, and construction meetings. As construction coordinator, the Project Manager shall serve as a liaison between all parties involved in the project to assure that communications are maintained. The Project Manager shall also be responsible for proper resolution of all quality assurance issues that arise during construction. For the development of the Area A Valley Fill, the Project Manager is Guy Cote, P.E. of Sevee & Maher Engineers, Inc.

Qualifications. The selection of the Project Manager is the direct responsibility of the BRPP. Qualifications for this position include familiarity with the following:

1. Applicable QAMs.
2. All applicable regulatory requirements.
3. Policies and procedures for project management.
4. Placement techniques of low hydraulic conductivity material.

Designer (Engineer). The designer (Engineer) is the individual and/or firm responsible for the preparation of the design including, project specific engineering drawings, technical specifications and the Quality Assurance Manual. The Engineer is responsible for approving all design and specification changes, manufacturer's material certifications and contractor submittals, and for making any design clarifications during the contract bidding process and construction of the liner system. The Engineer may attend the pre-bid, pre-construction, and construction meetings upon the request of the Project Manager. The Engineer may also act as the Owner's Representative and Construction Quality Assurance Agent (CQA Agent) during construction of the project. The Design Firm for the cell development of the Landfill is Sevee & Maher Engineers, Inc. (SME) of Cumberland, Maine. The Project Engineer for the development is Guy Cote, P.E. of SME.

Construction Quality Assurance Agent. The CQA Agent is responsible for review of the borrow source and in-place material testing results and for the observation of the Contractor's work to assure that the liner system meets the design specifications. Qualifications for this position include familiarity with the following:

1. Applicable QAMs.
2. All applicable regulatory requirements.
3. Placement techniques of low hydraulic conductivity material.
4. Experience with soil inspection of landfill projects.

The CQA Agent is also responsible for the following:

- Approval/disapproval of borrow source material test results for the liner;

- The in-place testing and approval of the materials placed by the Contractor; and

- Ensure that the placement techniques utilized conform to industry standard and this QAM, and as described in Technical Specification Section 02200 Part 3.2, including the following:

  - measuring barrier soil lift thickness;
  - monitoring and measuring as necessary the maximum clod size of the soil;
  - assuring the proper lift benching techniques are followed; and
  - assuring that proper lift bonding of the soil is achieved.

The CQA Agent will provide continuous monitoring during placement of the soil. It is anticipated that only one CQA Agent will be necessary during construction of the soil liner. However, should the Contractor begin placing the till over separate areas of the landfill simultaneously, additional CQA Agents will be added for oversight. The CQA Agent will be under the direction of a State of North Carolina registered Professional Engineer.

Geosynthetic Construction Quality Assurance Agent. The Geosynthetic Construction Quality Assurance Agent (CQA) is a firm independent from the Manufacturer(s) and Installer that shall be responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic system on behalf of BRPP.

In this QAM the term Geosynthetic Quality Assurance Engineer (QAE) shall be used to designate the engineer (working for the Geosynthetic CQA) in charge of the quality assurance work. In some cases the duties of the QAE described below may be shared by two individuals: a Geosynthetic Quality Assurance Managing Engineer located at the headquarters of the

Geosynthetic CQA; and a Geosynthetic Quality Assurance Site Manager located at the site. The personnel of the Geosynthetic CQA also include Geosynthetic Quality Assurance Monitors who are located at the site for construction observation and documentation. The CQA agent will provide sufficient personnel on-site to enable complete (100%) observation of all deployment, seaming, and testing activities. The required CQA staff level will be a function of the installer's schedule.

The Geosynthetic CQA is responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic system. The Geosynthetic CQA is responsible for implementation of the project QAP prepared by the Project Manager and management of the Geosynthetic Quality Assurance Laboratory. The Geosynthetic CQA is also responsible for issuing a final certification report, sealed by a registered professional engineer.

The specific duties of the Geosynthetic CQA personnel are as follows:

1. The Geosynthetic QAE:

    a. Reviews all design drawings and specifications.

    b. Reviews other site-specific documentation, including proposed layouts, and manufacturer's and installer's literature.

    c. Develops a site-specific addendum for quality assurance of geosynthetics (if necessary) with the assistance of the Project Manager.

    d. Administers the geosynthetic portions of the QAP, e.g. assigns and manages all geosynthetic quality assurance personnel, reviews all field reports, and provides engineering review of all quality assurance related issues.

e. Reviews all changes to design drawings and specifications as issued by the Designer.

f. Acts as the on-site (resident) representative of the Geosynthetic CQA.

g. Familiarizes all Geosynthetic Quality Assurance Monitors with the site and the project QAP.

h. Attends all quality assurance related meetings, e.g. resolution, pre-construction, daily, weekly.

i. Reviews all Manufacturer and Installer certifications and documentation and makes appropriate recommendations.

j. Reviews the Installer's personnel qualifications for conformance with those qualifications pre-approved for work on site.

k. Manages the preparation of the as-built drawing(s).

l. Reviews the calibration certification of the on-site tensiometer, if applicable.

m. Reviews all Geosynthetic Quality Assurance Monitor's daily reports, logs and photographs.

n. Notes any on-site activities that could result in damage to the geosynthetics.

o. Reports to the Project Manager, and logs in the daily report, any relevant observations reported by the Geosynthetic Quality Assurance Monitors.

p. Prepares his own daily report.

q. Prepares a daily summary of the quantities of geosynthetics installed that day.

r. Prepares the weekly summary of geosynthetic quality assurance activities.

s. Oversees the marking, packaging, and shipping of all laboratory test samples.

t. Reviews the results of laboratory testing and makes appropriate recommendations.

u. Designates a Geosynthetic Quality Assurance Monitor to represent the QAE whenever he is absent from the site while operations are ongoing.

v. Reports any unapproved deviations from the QAP to the Project Manager.

w. Prepares the final certification report.

x. Monitors the subgrade condition and overburden soil placement.

y. Perform the following responsibilities during the various weather conditions:

The Geosynthetic Quality Assurance Monitor:

1. Monitors, logs, photographs and/or documents all geosynthetic installation operations. Photographs shall be taken routinely and in critical areas of the installation sequence. These duties shall be assigned by the Geosynthetic QAE.

2. Monitors the following operations for all geosynthetics.

   a. Material delivery.
   b. Unloading and on-site transport and storage.
   c. Sampling for conformance testing.
   d. Deployment operations.
   e. Joining and/or seaming operations.
   f. Condition of panels as placed.
   g. Visual inspection by walkover.
   h. Repair operations.

3. Monitors and documents the geomembrane seaming operations, including:

   a. Trial seams.
   b. Seam preparation.
   c. Seaming.
   d. Nondestructive seam testing.
   e. Sampling for destructive seam testing.
   f. Field tensiometer testing.
   g. Laboratory sample marking.
   h. Repair operations.

4. Documents any on-site activities that could result in damage to the geosynthetics. Any problems noted shall be reported as soon as possible to the Geosynthetic QAE.

The Geosynthetic CQA shall be pre-qualified by BRPP. The Geosynthetic CQA shall be experienced in quality assurance of geosynthetics with emphasis on polyethylene geomembranes. The Geosynthetic CQA shall be experienced in the preparation of quality assurance documentation including: quality assurance forms, reports, certifications, and manuals.

The Geosynthetic Quality Assurance Managing Engineer shall hold a B.S., M.S., or Ph.D. engineering degree and be registered as a professional Engineer in the State of North Carolina. The Geosynthetic Quality Assurance Site Manager shall be specifically experienced in the installation of geosynthetics and shall be trained and certified by the Geosynthetic CQA in the duties of a Geosynthetic QAE.

Geosynthetic Quality Assurance Monitors shall be quality assurance personnel who have been specifically trained in the quality assurance of geosynthetics. The CQA site manager will have a minimum of 5,000,000 ft^2 of field experience in polyethylene geomembrane quality assurance. Other site monitors will have between 500,000 and 1,000,000 ft^2 of experience in polyethylene geomembrane quality assurance.

To be considered for pre-qualification, the Geosynthetic CQA must provide the following information:

1. Corporate background and information.

2. Quality assurance capabilities:

    a. A summary of the firm's experience with geosynthetics.

    b. A summary of the firm's experience in quality assurance, including installation quality assurance of geosynthetics.

    c. A summary of quality assurance documentation and methods used by the firm, including sample quality assurance forms, reports, certifications, and manuals prepared by the firm.

    d. Resumes of key personnel.

Prior to beginning work on a project, the Geosynthetic CQA must provide the Project Manager with the following information:

1. Resumes of personnel to be involved in the project including Geosynthetic QAE, and Geosynthetic Quality Assurance Monitors.

2. Proof of professional engineering registration for the engineer to be designated as the Geosynthetic QAE.

3. Proof of the required quality assurance experience of all of the quality assurance personnel with emphasis on polyethylene geomembranes.

Geosynthetic Quality Assurance Laboratory. The Geosynthetic Quality Assurance Laboratory (QAL) is a firm, independent from the Manufacturer(s) and Installer responsible for conducting tests on samples of geosynthetics taken from the site.

The Geosynthetic QAL shall be responsible for conducting the appropriate laboratory tests as directed by the Geosynthetic QAE. The test procedures shall be done in accordance with the test methods outlined in this QAM and/or the project QAP.

The Geosynthetic QAL shall have experience in testing geosynthetics and be familiar with American Society for Testing and Materials (ASTM), Federal Test Method Standard (FTMS), National Sanitation Foundation (NSF), and other applicable test standards. The Geosynthetic QAL shall be capable of providing verbal results of destructive seam tests within 24 hours of receipt of test samples and shall maintain that standard throughout the installation. The Geosynthetic QAL shall be approved by BRPP.

On-site laboratory facilities may be used by the Geosynthetic QAL, provided they are appropriately equipped and approved by the Geosynthetic CQA and the Project Manager.

The Geosynthetic QAL shall submit all destructive seam test results to the Geosynthetic QAE in written form within 48 hours of receipt of test samples unless otherwise specified by the Project Manager. Geomembrane destructive test results shall typically be provided verbally to the Geosynthetic QAE within 24 hours of receipt of test samples. Written test results shall be in an easily readable format and include references to the standard test methods used.

General Contractor. The general contractor (Contractor) is responsible for construction of the liner system including supplying labor, material, equipment, and supervision for placement of the liner system. The primary responsibility of the general contractor is to ensure the liner system is constructed in accordance with the design and specifications developed by the Engineer and approved by the permitting agency. The Superintendent is the Contractor's designee who is responsible for the Contractor's field crew. The Superintendent shall represent the Contractor at all site meetings and shall be responsible for acting as the Contractor's spokesman for the project. The Contractor shall be responsible for all aspects of liner placement, including but not limited to, placement of all erosion control measures, subgrade preparation, placement of granular drainage material, placement of low hydraulic conductivity soil, topsoil, seeding, fertilizing, and mulching. The Contractor is also responsible for informing the Owner, the Engineer, and the CQA Agent of the scheduling and occurrence of all construction activities and of any discrepancies, errors, or omissions in the Contract Documents.

The Contractor shall be pre-qualified and approved by Blue Ridge Paper Products, Inc. The Superintendent must be qualified based on previously demonstrated construction experience and management ability. Services of the Contractor will be procured through a competitive bid process. Bid packages for the solicitation of construction services will require the Contractor to identify and demonstrate familiarity and experience with the various aspects of landfill construction.

Subcontractors. Subcontractors are responsible for that portion of the work that they are designated to perform by the General Contractor. Subcontractors' work as agents of the General Contractor and as such the General Contractor is responsible for the work and actions of the Subcontractor.

Materials Testing Lab. The materials testing lab is a qualified geotechnical laboratory contracted by the General Contractor, Owner or Owner's Representative to test the borrow source and in-place cover system materials. The material testing laboratory will determine the quality of the borrow source and in-place material in accordance with the ASTM test methods described in the project specifications. The materials testing laboratory will be independent from the General Contractor and the Owner.

Manufacturer. The Manufacturer is the firm responsible for production of any of the various geosynthetic liner system components outlined in this QAM. Each Manufacturer is responsible for the production of its geosynthetic product. In addition, each Manufacturer is responsible for the condition of the geosynthetic until the material is accepted by the Project Manager upon delivery. Each Manufacturer shall produce a consistent product meeting the project specifications. Each Manufacturer shall provide quality control documentation for its product as specified in this QAM.

Each Manufacturer shall be pre-qualified by BRPP. Each Manufacturer shall provide sufficient production capacity and qualified personnel to meet the demands of the project. Each Manufacturer shall have an internal quality control program for its product that meets the requirements presented in this QAM.

A Manufacturer shall meet the following requirements and submit the following information to be considered for pre-qualification:

1. Corporate background and information.

2. Manufacturing capabilities:

    a. Information on plant size, equipment, personnel, number of shifts per day, and capacity per shift.

b. Daily production quantity available for BRPP's facilities.

c. A list of material properties including certified test results, to which are attached geosynthetic samples.

d. A list of at least 15 completed landfill or surface impoundment facilities totaling a minimum of 15,000,000 ft^2 (1,500,000 m^2), for which the Manufacturer has manufactured a geosynthetic. For each facility, the following information shall be provided:

(1) Name and purpose of facility, its location and date of installation.
(2) Name of owner, project manager, designer, fabricator (if any) and installer.
(3) Type of geosynthetic, surface area of geosynthetic manufactured.
(4) Available information on the performance of the lining system and the facility.

3. The Manufacturer's quality control manual, including a description of the quality control laboratory facilities.

4. The origin (supplier's name and production plant) and identification (brand name and number) of resin used to manufacture the product.

5. A fingerprint of the Manufacturer's geosynthetic product (for polyethylene-based geosynthetics) in accordance with fingerprinting protocol listed in the project specifications.

Prior to the installation of any geosynthetic material, a Manufacturer must submit to the Project Manager all quality control documentation required by the appropriate section of this QAM. This documentation shall be reviewed by the Geosynthetic Construction Quality Assurance Agent before installation can begin.

Installer. the Installer is the firm responsible for installation of the geosynthetics. The Installer may be affiliated with the Manufacturer.

The Superintendent is responsible for the Installer's field crew. The Superintendent shall represent the Installer at all site meetings and shall be responsible for acting as the Installer's spokesman on the project.

The Master Seamer shall be the most experienced seamer of the Installer's field crew. The Master Seamer shall provide direct supervision over less experienced seamers.

The Installer shall be responsible for field handling, storing, deploying, seaming, temporary restraining and all other aspects of the geosynthetics installation. The Installer may also be responsible for transportation of these materials to the site and for anchor systems, if required by the project specifications. The Installer shall be responsible for submittal of the documentation from the manufacturer.

The Installer shall be pre-qualified and approved by BRPP. The Installer shall be able to provide qualified personnel to meet the demands of the project. At a minimum, the Installer shall provide a Superintendent and a Master Seamer as described below.

The Superintendent must be qualified based on previously demonstrated experience, management ability, and authority. The Superintendent, unless otherwise approved by the Project Manager, shall have previously managed, at a minimum, two installation projects which entailed the installation of at least a total of 2,000,000 ft^2 (200,000 m^2) of polyethylene geomembrane.

For geomembrane installation all personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. The Master Seamer shall have experience seaming a minimum of 1,000,000 ft^2 (100,000 m^2) of polyethylene geomembrane using the same type of seaming apparatus to be used at the site.

To be considered for pre-qualification, the Installer shall submit the following information:

1. Corporate background and information.

2. Description of installation capabilities:

   a. Information on equipment (numbers and types), and personnel (number of superintendents, number of crews).

   b. Average daily production anticipated.

   c. Samples of field geomembrane seams and a list of minimum values for geomembrane seam properties.

3. A list of at least ten completed facilities, totaling a minimum of 5,000,000 ft^2 (500,000 m^2) for which the Installer has installed geosynthetics. For each installation, the following information shall be provided:

   a. Name and purpose of facility, its location, and date of installation.

   b. Name of owner, project manager, designer, manufacturer, fabricator (if any), and name of contact at the facility who can discuss the project.

   c. Name and qualifications of the Superintendent(s) of the Installer's crew(s).

   d. Type of geosynthetic, and surface area installed.

   e. Type of seaming and type of seaming apparatus used.

f. Duration of installation.

g. Available information on the performance of the lining system and the facility.

4. The Installer's quality control manual.

5. A copy of a letter of recommendation supplied by the geomembrane manufacturer.

Prior to commencement of the installation, the Installer must submit to the Project Manager:

1. Resume of the Superintendent to be assigned to this project, including dates and duration of employment.

2. Resume of the Master Seamer to be assigned to this project, including dates and duration of employment.

3. A panel layout drawing showing the installation layout identifying field seams as well as any variance or additional details which deviate from the engineering drawings. The layout shall be adequate for use as a construction plan and shall include dimensions, details, etc.

4. Installation schedule.

5. A list of personnel performing field seaming operations along with pertinent experience information.

6. All geosynthetic quality control certificates as required by this QAM (unless submitted directly to the Project Manager by the Manufacturer).

7. Certification that extrudate to be used is comprised of the same resin as the geomembrane to be used.

This documentation shall be reviewed by the Geosynthetic Construction Quality Assurance Agent before installation of the geosynthetic can begin.

During the installation, the Installer shall be responsible for the submission of:

1. Quality control documentation recorded during installation.

2. Subgrade surface acceptance certificates for each area to be covered by the lining system, signed by the Installer.

Upon completion of the installation, the Installer shall submit:

1. The warranty obtained from the Manufacturer.

2. The installation warranty.

1.2 Communication

To guarantee a high degree of quality during installation and assure a final product that meets all project specifications, clear, open channels of communication are essential. This section discusses appropriate lines of communication and describes all necessary meetings.

Lines of Communication. The CQAs shall be capable of direct communication with the Project Manager at all times. Access to BRPP's personnel is also available for issue resolution if necessary.

Pre-Construction Meeting. A pre-construction meeting shall be held at the site prior to beginning geosynthetic deployment. Typically, the meeting shall be attended by the Project

Manager, Designer, CQA Agent, Contractor, Supervisor, Installer, Geosynthetic QAE, and a BRPP representative.

Specific topics considered for this meeting include review of the project QAP for any problems or additions. In addition, the responsibilities of each party should be reviewed and understood clearly. The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties.

Progress Meetings. A weekly progress meeting shall be held between the BRPP representative, Superintendent, CQA Agent, Geosynthetic QAE, Installer's Superintendent, Project Manager, and any other concerned parties. This meeting shall discuss current progress, planned activities for the next week, issues requiring resolution, and any new business or revisions to the work. The CQAs shall log any problems, decisions, or questions arising at this meeting in his weekly report. If any matter remains unresolved at the end of this meeting, the Project Manager shall be responsible for the resolution of the matter and the communication of the decision to the appropriate parties.

2.0 GEOMEMBRANES

2.1 Quality Control Documentation

Prior to the installation of any geomembrane material, the Manufacturer or Installer shall provide the Project Manager with the following information:

1. The origin (resin supplier's name and resin production plant), identification (brand name and number), and production date of the resin.

2. Copies of the quality control certificates issued by the resin supplier.

3. Reports on tests conducted by the Manufacturer to verify that the quality of the resin used to manufacture the geomembrane meets the specifications.

4. Reports on quality control tests conducted by the Manufacturer to verify that the geomembrane manufactured for the project meets the project specifications.

5. A statement indicating that the amount of reclaimed polymer added to the resin during manufacturing was done with appropriate cleanliness and does not exceed 2 percent by weight.

6. A list of the materials which comprise the geomembrane, expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.

7. A specification for the geomembrane which includes all properties contained in the specifications measured using the appropriate test methods.

8. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.

9. A characterization of the geomembrane based on the results of fingerprinting tests.

10. Quality control certificates, signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, sampling procedures, and results of quality control tests. At a minimum, results shall be given for:

    a. Density
    b. Carbon black content
    c. Carbon black dispersion
    d. Thickness
    e. Tensile properties
    f. Tear resistance

These quality control tests shall be performed in accordance with the test methods specified in the specifications, for every 40,000 ft^2 (4,000 m^2) of geomembrane produced.

The Manufacturer shall identify all rolls of geomembranes with the following:

1. Manufacturer's name
2. Product identification
3. Thickness
4. Roll number
5. Roll dimensions

2.1.1 Product Review: The Project Manager shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum properties meet the specifications.

2.2 Conformance Testing

Upon delivery of the rolls of geomembrane, the Geosynthetic CQA shall assure that conformance test samples are obtained for the geomembrane. These samples shall then be forwarded to the Geosynthetic QAL for testing to assure conformance to the specifications.

If the Project Manager desires, the Geosynthetic CQA can perform the conformance test sampling at the manufacturing plant. This may be advantageous in expediting the installation process for very large projects.

The following conformance tests shall be conducted:

1. Density
2. Carbon black content
3. Carbon black dispersion
4. Thickness
5. Tensile properties

These conformance tests shall be performance in accordance with the test methods specified in the specifications.

2.2.1 Sampling Procedures: The rolls to be sampled shall be selected by the Geosynthetic CQA. Samples shall be taken across the entire width of the roll and shall not include the first 3 feet (1 m). Unless otherwise specified, samples shall be 3 feet (1 m) long by the roll width. The Geosynthetic CQA shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Geosynthetic CQA based on a review of all roll information including quality control documentation and manufacturing records.

Unless otherwise specified, samples shall be taken at a rate of one per lot, not to exceed one conformance test per 100,000 ft^2 (10,000 m^2) of geomembrane.

2.2.2 Test Results. All conformance test results shall be reviewed and accepted or rejected by the Geosynthetic CQA prior to the deployment of the geomembrane.

The Geosynthetic CQA shall examine all results from laboratory conformance testing and shall report any nonconformance to the Project Manager. The Geosynthetic CQA shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

If the Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested by the Geosynthetic QAL with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different approved independent laboratories at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Project Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out of specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

2.3 Subgrade Preparation

2.3.1 Surface Preparation: The earthwork contractor shall be responsible for preparing the supporting soil for geomembrane placement. The Project Manager shall coordinate the work of the earthwork contractor and the Installer so that the requirements of the specification are met.

Before the geomembrane installation begins, the Geosynthetic CQA shall verify that:

1. A qualified land surveyor has verified all lines and grades.

2. A qualified geotechnical engineer has verified that the supporting soil meets the density specified in the project specifications.

3. The surface to be lined has been rolled, compacted, or handworked so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade.

4. The surface of the supporting soil does not contain stones which may be damaging to the geomembrane.

5. There is no area excessively softened by high water content.

6. There is no area where the surface of the soil contains desiccation cracks with dimensions exceeding those allowed by the project specifications.

The Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. A certificate of acceptance shall be given by the Installer to the Geosynthetic CQA prior to commencement of geomembrane deployment in the area under consideration. The Project Manager shall be given a copy of this certificate by the Geosynthetic CQA.

After the supporting soil has been accepted by the Installer, it is the Installer's responsibility to indicate to the Project Manager any change in the supporting soil condition that may require repair work. The Project Manager may consult with the Geosynthetic CQA regarding the need for repairs. If the Geosynthetic CQA concurs with Installer, the Project Manager shall assure that the supporting soil is repaired.

At any time before or during the geomembrane installation, the Geosynthetic CQA shall indicate to the Project Manager any locations which may not be adequately prepared for the geomembrane.

2.3.2 Anchor Trench: The Geosynthetic CQA shall verify that the anchor trench has been constructed according to the design drawings and specifications.

If the anchor trench is excavated in a clay material susceptible to desiccation, the amount of trench open at any time should be minimized. The Geosynthetic CQA shall inform the Project Manager of any signs of significant desiccation associated with the anchor trench construction.

Slightly rounded corners shall be provided in the trench so as to avoid sharp bends in the geomembrane. Excessive amounts of loose soil shall not be allowed to underlie the geomembrane in the anchor trench.

The anchor trench shall be adequately drained to prevent ponding or softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled and compacted as outlined in the project specifications.

Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The Geosynthetic CQA shall observe the backfilling operation and advise the Project Manager of any problems. Any problems shall be documented by the Geosynthetic CQA in his daily report.

2.4 Geomembrane Deployment

2.4.1 Panel Nomenclature: A field panel is defined as a unit of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of roll cut in the field.

It shall be the responsibility of the Geosynthetic CQA to assure that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code shall be agreed upon by the Project Manager, Installer and Geosynthetic CQA. This field panel identification code shall be as simple and logical as possible. In general, it is not appropriate to identify panels using roll numbers since roll numbers established in the manufacturing plant are usually cumbersome and are not related to location in the field. The Geosynthetic CQA shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code shall be used for all quality assurance records.

The Geosynthetic CQA shall verify that field panels are installed at the locations indicated on the Installer's layout plan, as approved by the Project Manager.

2.4.2 Panel Deployment Procedure: The Geosynthetic CQA shall review the panel deployment progress of the Installer (keeping in mind issues relating to wind, rain, clay liner desiccation, and other site-specific conditions) and advise the Project Manager on its compliance with the approved panel layout drawing and its suitability to the actual field conditions. Once approved, only the Project Manager can authorize changes to the panel deployment procedure. The

Geosynthetic CQA shall verify that the condition of the supporting soil does not change detrimentally during installation.

The Geosynthetic CQA shall record the identification code, location, and date of installation of each field panel.

2.4.3 Deployment Weather Conditions: Geomembrane deployment shall not proceed at an ambient temperature below 32°F (0°C) or above 104°F (40°C) unless otherwise authorized, in writing, by the Project Manager. Geomembrane placement shall not be performed 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. Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment.

The Geosynthetic CQA shall verify that the above conditions are fulfilled. Ambient temperature shall be measured by the Geosynthetic CQA in the area in which the panels are to be deployed. The Geosynthetic CQA shall inform the Project Manager of any weather related problems which may not allow geomembrane placement to proceed.

2.4.4 Method of Deployment: Before the geomembrane is handled on site, the Geosynthetic CQA shall verify that handling equipment to be used on the site is adequate and does not pose risk of damage to the geomembrane. During handling, the Geosynthetic CQA shall observe and verify that the Installer's personnel handle the geomembrane with care.

The Geosynthetic CQA shall verify the following:

1. Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means.

2. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement.

3. Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris.

4. All personnel do not smoke or wear damaging shoes while working on the geomembrane, or engage in other activities which could damage the geomembrane.

5. The method used to unroll the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting soil.

6. The method used to place the panels minimized wrinkles (especially differential wrinkles between adjacent panels).

7. The method used to place the panels prevents bridging of the geomembrane.

8. Adequate temporary loading and/or anchoring (e.g. sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind. In case of high winds, continuous loading, e.g. by sand bags, is recommended along edges of panels to minimize risk of wind flow under the panels.

9. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

The Geosynthetic CQA shall inform the Project Manager if the above conditions are not fulfilled.

2.4.5 Damage and Defects: Upon delivery to the site, the Geosynthetic CQA shall conduct a surface observation of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. The Geosynthetic

CQA shall advise the Project Manager, in writing, of any rolls or portions of rolls which should be rejected and removed from the site because they have severe flaws, and/or minor repairable flaws.

The Geosynthetic CQA shall inspect each panel, after placement and prior to seaming, for damage and/or defects. The Geosynthetic CQA shall advise the Project Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels, or portions of damaged panels, which have been rejected shall be marked and their removal from the work area recorded by the Geosynthetic CQA. Repairs shall be made using procedures described in Section 2.8.

2.4.6 Writing on the Liner: To avoid confusion, the Installer and the Geosynthetic CQA shall each use different colored markers that are readily visible for writing on the geomembrane. The markers used must be semi-permanent and compatible with the geomembrane.

2.5 Field Seaming

2.5.1 Seam Layout: Before installation begins, the Installer must provide the Project Manager and the Geosynthetic CQA with a panel layout drawing, i.e. a drawing of the facility to be lined showing all expected seams. The Geosynthetic CQA shall review the panel layout drawing and verify that it is consistent with accepted state-of-practice. No panels may be seamed without the written approval of the panel layout drawing by the Project Manager. In addition, panels not specifically shown on the panel layout drawing may not be used without the Project Manager's prior approval.

In general, seams should be oriented parallel to the line of maximum slope, i.e. oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 feet (1.5 m) from the toe of the slope, or areas of potential stress concentrations, unless otherwise authorized by the Project Manager.

A seam numbering system compatible with the panel numbering system shall be used by the Geosynthetic CQA.

2.5.2 Accepted Seaming Methods: Approved processes for field seaming are extrusion welding and fusion welding. Proposed alternate processes shall be documented and submitted by the Installer to the Project Manager for approval. Only apparatus which have been specifically approved by make and model shall be used. The Project Manager shall submit all documentation regarding seaming methods to be used to the Geosynthetic CQA for review.

2.5.2.1 Extrusion Process

The Geosynthetic CQA shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any noncompliances to the Project Manager.

The Geosynthetic CQA shall verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus decided upon at the pre-construction meeting.

2. Equipment used for seaming is not likely to damage the geomembrane.

3. Prior to beginning a seam, the extruder is purged until all heat-degraded extrudate has been removed from the barrel.

4. Clean and dry welding rods or extrudate pellets are used.

5. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.

6. Grinding shall be completed no more than 1 hour prior to seaming.

7. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.

8. The geomembrane is protected from damage in heavily trafficked areas.

9. Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instance shall exposed grinding marks extend more than 1/4 inch from the seamed area.

10. In general, the geomembrane panels are aligned to have a nominal overlap of 3 inch (75 mm) for extrusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.

11. No solvent or adhesive is used unless the product is approved in writing by the Project Manager prior to use (samples shall be submitted to the Project Manager for testing and evaluation).

12. The procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any temporary welding apparatus is controlled such that the geomembrane is not damaged or degraded.

2.5.2.2 Fusion Process

The Geosynthetic CQA shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any noncompliances to the Project Manager.

The Geosynthetic CQA shall also verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus decided upon at the pre-construction meeting.

2. Equipment used for seaming is not likely to damage the geomembrane.

3. For cross seams, the edge of the cross seam is ground to an incline prior to welding.

4. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.

5. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.

6. The geomembrane is protected from damage in heavily trafficked areas.

7. A movable protective layer is used as required by the Installer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets and prevent debris from collecting around the pressure rollers.

8. In general, the geomembrane panels are aligned to have a nominal overlap of 5 inches (125 mm) for fusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.

9. No solvent or adhesive is used unless the product is approved in writing by the Project Manager prior to use (samples shall be submitted to the Project Manager for testing and evaluation).

2.5.3 Seam Preparation: The Geosynthetic CQA shall verify that prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris or foreign material of any kind. If seam overlap grinding is required, the Geosynthetic CQA must assure that the process is completed according to the Manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane. The Geosynthetic CQA shall also verify that seams are aligned with the fewest possible number of wrinkles and "fishmouths".

2.5.4 Trial Seams: Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once each five hours, for each production seaming apparatus used that day. Each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams. Additional trial seams will be required after any change of operator, equipment shutdown, significant idle time, or significant weather change. Additional trial seams due to idle time or weather will be at the discretion of the Geosynthetic CQA.

The trial seam sample shall be at least 5 feet (1.0 m) long by 1 foot (0.3 m) wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in Section 2.5.2.

Two specimens shall be cut from the sample with a 1 inch (25 mm) wide die. The specimens shall be cut by the Installer at locations selected randomly along the trial seam sample by the Geosynthetic CQA. The specimens shall be tested in peel using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of 20 inches per minute. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, 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 welds are achieved. The Geosynthetic CQA shall observe all trial seam procedures.

2.5.5 General Seaming Procedures: During general seaming, the Geosynthetic CQA shall be cognizant of the following:

1. For fusion welding, it may be necessary to place a movable protective layer of plastic directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture buildup between the sheets to be welded and prevent debris from collecting around the pressure rollers.

2. If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

3. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches (150 mm) beyond the cut in all directions.

4. If seaming operations are carried out at night, adequate illumination shall be provided.

5. Seaming shall extend to the outside edge of panels placed in the anchor trench.

6. All cross seam tees should be extrusion welded to a minimum distance of 4 inches on each side of the tee.

7. No field seaming shall take place without the Master Seamer being present.

The Geosynthetic CQA shall verify that the above seaming procedures (or any other procedures agreed upon and indicated in the project manual) are followed, and shall inform the Project Manager of any nonconformance.

2.5.6 Seaming Weather Conditions:

2.5.6.1 Normal Weather Conditions

The normal required weather conditions for seaming are as follows:

1. Ambient temperature between 32°F (0°C) and 104°F (40°C).

2. Dry conditions, i.e. no precipitation or other excessive moisture, such as fog or dew.

3. No excessive winds.

The Geosynthetic CQA shall verify that these weather conditions are fulfilled and notify the Project Manager in writing if they are not. Ambient temperature shall be measured by the Geosynthetic CQA in the area in which the panels are to be placed. The Project Manager will then decide if the installation is to be stopped or special procedures used.

2.5.6.2 Cold Weather Conditions

To assure a quality installation, if seaming is conducted when the ambient temperature is below 32°F (0°C), the following conditions must be met:

1. Geomembrane surface temperatures shall be determined by the Geosynthetic CQA at intervals of at least once per 100 foot of seam length to determine if preheating is required. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32°F (0°C).

2. Preheating may be waived by the Project Manager based on a recommendation from the Geosynthetic CQA, if the Installer demonstrates to the Geosynthetic CQA's satisfaction that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

3. If preheating is required, the Geosynthetic CQA shall inspect all areas of geomembrane that have been preheated by a hot air device prior to seaming, to assure that they have not been overheated.

4. Care shall be taken to confirm that the surface temperatures are not lowered below the minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for the seam area.

5. All preheating devices shall be approved prior to use by the Project Manager.

6. Additional destructive tests (as described in Section 2.4) shall be taken at an interval between 500 feet and 250 feet of seam length, at the discretion of the Geosynthetic CQA.

7. Sheet grinding may be performed before preheating, if applicable.

8. Trial seaming shall be conducted under the same ambient temperature and preheating conditions as the actual seams. Under cold weather conditions, new trial seams shall be conducted if the ambient temperature drops by more than 5°F from the initial trial seam test conditions.

2.5.6.3 Warm Weather Conditions

At ambient temperatures above 104°F, no seaming of the geomembrane shall be permitted unless the Installer can demonstrate to the satisfaction of the Project Manager that geomembrane seam quality is not compromised.

Trial seaming, as described in shall be conducted under the same ambient temperature conditions as the actual seams.

At the option of the Geosynthetic CQA, additional destructive tests (as described in Section 2.4) may be required for any suspect areas.

2.6 Nondestructive Seam Testing

The Installer shall nondestructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), or other approved method. Vacuum testing and air pressure testing are described in Sections 2.6.1 and 2.6.2, respectively. The purpose of nondestructive tests is to check the continuity of seams. It does not provide quantitative information on seam strength. Nondestructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. At a minimum of once every 4 hours of seaming and when operation has been suspended for greater than one hour or if breakdown of seaming equipment occurs, weld samples will be tested in peel and shear in accordance with the destructive test requirements of the contract documents.

For all seams, the Geosynthetic CQA shall:

1. Observe nondestructive testing procedures.

2. Record location, data, test unit number, name of tester, and outcome of all testing.

3. Inform the Installer and Project Manager of any required repairs.

2.6.1 Vacuum Testing. The following procedures are applicable to vacuum testing.

1. The equipment shall consist of the following:

   a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.

   b. A pump assembly equipped with a pressure controller and pipe connections.

   c. A rubber pressure/vacuum hose with fittings and connections.

   d. A soapy solution of distilled water.

   e. A bucket and wide paint brush, or other means of applying the soapy solution.

2. The following procedures shall be followed:

   a. Energize the vacuum pump and reduce the tank pressure to approximately 2.5 to 3.0 psi gauge.

   b. Wet a strip of geomembrane approximately 12 inches by 48 inches (0.3 m x 1.2 m) with the soapy distilled water solution.

   c. Place the box over the wetted area.

   d. Close the bleed valve and open the vacuum valve.

e. Assure that a leak-tight seal is created.

f. For a period of not less than 15 seconds, apply vacuum and examine the geomembrane through the viewing window for the presence of soap bubbles.

g. If no bubble appears after 15 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches (75 mm) overlap, and repeat the process.

h. All areas where soap bubbles appear shall be marked and repaired in accordance with Section 2.8.

2.6.2 Air Pressure Testing. The following procedures are applicable to double fusion welding which produces a double seam with an enclosed space.

1. The equipment shall consist of the following:

   a. An air pump (manual or motor driven), equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi (160 and 200 kPa) and mounted on a cushion to protect the geomembrane.

   b. A rubber hose with fittings and connections.

   c. A sharp hollow needle, or other approved pressure feed device.

2. The following procedures shall be followed:

   a. Seal both ends of the seam to be tested.

b. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.

c. Insert a protective cushion between the air pump and the geomembrane.

d. Energize the air pump to a pressure between 25 and 30 psi (160 and 200 kPa), close valve, allow 2 minutes for pressure to stabilize, and sustain pressure for at least 5 minutes.

e. If loss of pressure exceeds 4 psi (30 kPa) or does not stabilize, locate faulty area and repair in accordance with Section 2.8.

f. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area. Seal the cut end of the air channel.

g. Remove needle or other approved pressure feed device and seal.

2.6.3 Test Failure Procedures. The Installer shall complete any required repairs in accordance with Section 2.8. For repairs, the Geosynthetic CQA shall:

1. Observe the repair and testing of the repair.

2. Mark on the geomembrane that the repair has been made.

3. Document the repair procedures and test results.

2.7 Destructive Seam Testing. Destructive seam tests shall be performed at selected locations. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

2.7.1 Location and Frequency. The Geosynthetic CQA shall select locations where seam samples will be cut out for laboratory testing. Those locations shall be established as follows:

1. A minimum frequency of one test location per 500 feet (150 m) of seam length performed by each welder. This minimum frequency is to be determined as an average taken throughout the entire facility.

2. Test locations shall be determined during seaming at the Geosynthetic CQA's discretion. Selection of such locations may be prompted by suspicion of overheating, contamination, offset welds, or any other potential cause of imperfect welding.

The Installer shall not be informed in advance of the locations where the seam samples will be taken.

2.7.2 Sampling Procedures. Samples shall be cut by the Installer at locations chosen by the Geosynthetic CQA as the seaming progresses so that laboratory test results are available before the geomembrane is covered by another material. The Geosynthetic CQA shall:

1. Observe sample cutting.

2. Assign a number to each sample, and mark it accordingly.

3. Record sample location on layout drawing.

4. Record reason for taking the sample at this location (e.g. statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Section 2.8. The continuity of the new seams in the repaired area shall be tested according to the project specifications.

2.7.3 Sample Dimensions. At a given sampling location, two types of samples shall be taken by the Installer. First, two samples for field testing should be taken. Each of these samples shall be cut with a 1 inch (25 mm) wide die, with the seam centered parallel to the width. The distance between these two samples shall be 42 inches (1.1 m). If both samples pass the field test described in Section 2.6.3, a sample for laboratory testing shall be taken.

The sample for laboratory testing shall be located between the samples for field testing. The sample for laboratory testing shall be 12 inches (0.3 m) wide by 42 inches (1.1 m) long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

1. One portion to the Installer for optional laboratory testing, 12 inches x 12 inches (0.3 m x 0.3 m).

2. One portion for Geosynthetic QAL testing, 12 inches x 18 inches (0.3 m x 0.5 m) and

3. One portion to the Project Manager for archive storage, 12 inches x 12 inches (0.3 m x 0.3 m).

Final determination of the sample sizes shall be made at the pre-construction meeting.

2.7.4 Field Testing. The two 1-inch (25 mm) wide strips mentioned in Section 2.7.3 shall be tested in the field using a tensiometer for peel and shear and shall not fail according to the criteria in the project specifications. The tensiometer shall be capable of maintaining a constant jaw separation rate of 20 inches per minute. If the test passes in accordance with this section, the sample qualifies for testing in the laboratory. If it fails, the seam should be repaired in accordance with Section 2.8. Final judgment regarding seam acceptability, based on the failure criteria, rests with the Geosynthetic CQA. Both tracks are to be tested in peel.

The Geosynthetic CQA shall witness all field tests and mark all samples and portions with their number. The Geosynthetic CQA shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description, and attach a copy to each sample portion.

2.7.5 Laboratory Testing. Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the Geosynthetic QAL in a manner which will not damage the test sample. The Project Manager will be responsible for storing the archive samples. Test samples shall be tested by the Geosynthetic QAL.

Testing shall include properties as defined in the specifications. The minimum acceptable values to be obtained in these tests are indicated in the specifications. At least 5 specimens shall be tested in each shear and peel. Specimens shall be selected alternately by test from the samples (i.e. peel, shear, peel, shear...). Parent material strength will be determined by sampling the actual sheets adjacent to the destructive test location, in the same direction the seam is tested.

The Geosynthetic QAL shall provide verbal test results no more than 24 hours after they receive the samples. The Geosynthetic CQA shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Project Manager.

2.7.6 Destructive Test Failure Procedures. The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetic QAL, or by field tensiometer. The Installer has two options:

1. The Installer can repair the seam between any two passing test locations.

2. The Installer can trace the welding path to an intermediate location (at 10 feet (3 m) minimum from the point of the failed test in each direction) and take a sample with a 1 inch (25 mm) wide die for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is repaired

between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be repaired.

All acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. Passing laboratory destructive tests of trial seam samples taken as indicated in Section 2.5.4 may be used as a boundary for the failing seam. In cases exceeding 150 feet (50 m) of repaired seam, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Section 2.8.

The Geosynthetic CQA shall document all actions taken in conjunction with destructive test failures.

2.8 Defects and Repairs

2.8.1 Identification. All seams and non-seam areas of the geomembrane shall be examined by the Geosynthetic CQA for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be cleaned by the Installer if the amount of dust or mud inhibits examination.

2.8.2 Evaluation. Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in Section 2.6 as appropriate. Each location which fails the nondestructive testing shall be marked by the Geosynthetic CQA and repaired by the Installer. Work shall not proceed with any materials which will cover locations which have been repaired until appropriate nondestructive and laboratory test results with passing values are available.

2.8.3 Repair Procedures. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of

these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Project Manager, Installer, and Geosynthetic CQA.

1. The repair procedures available include:

   a. Patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.

   b. Spot welding or seaming, used to repair small tears, pinholes, or other minor, localized flaws.

   c. Capping, used to repair large lengths of failed seams.

   d. Extrusion welding the flap, used to repair areas of inadequate fusion seams, which have an exposed edge. Repairs of this type shall be approved by the Geosynthetic CQA and shall not exceed 50 feet (15 m) in length.

   e. Removing bad seam and replacing with a strip of new material welded into place.

2. For any repair method, the following provisions shall be satisfied:

   a. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be abraded no more than one hour prior to the repair.

   b. All surfaces shall be clean and dry at the time of the repair.

   c. All seaming equipment used in repairing procedures shall meet the requirements of the QAM.

d. Patches or caps shall extend at least 6 inches (150 mm) beyond the edge of the defect, and all corners of patches shall be rounded with a radius of approximately 3 inches (75 mm).

2.8.4 Repair Verification. Each repair shall be numbered and logged. Each repair shall be nondestructively tested using the methods described in Section 2.6 as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150 feet long may be of sufficient extent to require destructive test sampling, at the discretion of the Geosynthetic CQA. Failed tests indicate that the repair shall be redone and retested until a passing test results. The Geosynthetic CQA shall observe all nondestructive testing of repairs and shall record the number of each repair, date, and test outcome.

2.8.5 Large Wrinkles. When seaming of the geomembrane is completed, and prior to placing overlying materials, the Geosynthetic CQA shall indicate to the Project Manager which wrinkles should be cut and reseamed by the Installer. The number of wrinkles to be repaired should be kept to an absolute minimum. Therefore, wrinkles should be located during the coldest part of the installation process, while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over onto itself. This is generally the case for a wrinkle that extends 12 inches from the subgrade. Seams produced while repairing wrinkles shall be tested as outlined above.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather available. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed by the Geosynthetic CQA to assure that wrinkle formation is minimized.

2.9 Geomembrane Protection

The quality assurance procedures indicated in this section are intended only to assure that the installation of adjacent materials does not damage the geomembrane.

2.9.1 Soils. A copy of the specifications prepared by the Designer for placement of soils shall be given to the Geosynthetic CQA by the Project Manager. The Geosynthetic CQA shall verify that these specifications are consistent with the state-of-practice such as:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32°F (0°C) nor above 104°F (40°C) unless otherwise specified.

2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.

3. A geotextile or other cushion approved by the Designer is generally required between aggregate and the geomembrane.

4. Equipment used for placing soil shall not be driven directly on the geomembrane.

5. A minimum thickness of 1 foot (0.3 m) of soil is specified between a light dozer (ground pressure of 5 psi (35 kPa) or lighter) and the geomembrane.

6. In any areas traversed by any vehicles other than low ground pressure vehicles approved by the Project Manager, the soil layer shall have a minimum thickness of 3 feet (0.9 m). This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns.

The Geosynthetic CQA shall measure soil thickness and verify that the required thicknesses are present. The Geosynthetic CQA must also verify that final thicknesses are consistent with the design and verify that placement of the soil is done in such a manner that geomembrane damage

is unlikely. The Geosynthetic CQA shall inform the Project Manager if the above conditions are not fulfilled.

2.9.2 Sumps and Appurtenances. A copy of the plans and specifications prepared by the Designer for appurtenances shall be given by the Project Manager to the Geosynthetic CQA. The Geosynthetic CQA shall review these plans and verify that:

1. Installation of the geomembrane in appurtenant areas, and connection of geomembrane to appurtenances have been made according to specifications.

2. Extreme care is taken while welding around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas.

3. The geomembrane has not been visibly damaged while making connections to appurtenances.

The Geosynthetic CQA shall inform the Project Manager in writing if the above conditions are not fulfilled.

2.10 Lining System Acceptance

Upon written recommendation by the Geosynthetic CQA, the Project Manager shall consider accepting the geosynthetic lining system. The conditions of acceptance are described below. The Installer and Manufacturer(s) will retain all ownership and responsibility for the geosynthetics in the lining system until acceptance by BRPP. At BRPP's discretion, the geosynthetic lining system may be accepted in sections or at points of substantial completion.

The geosynthetic lining system shall be accepted by BRPP when:

1. The installation of the lining system, or section thereof, is finished.

2. Verification of the adequacy of all seams and repairs, including associated testing, is completed.

3. All documentation of installation is completed.

4. The Geosynthetic CQA is able to recommend acceptance.

The Geosynthetic CQA shall certify that installation has proceeded in accordance with the geosynthetic portions of the project QAP except as noted to the Project Manager.

3.0 GEOTEXTILES

3.1 Quality Control Documentation

Prior to the installation of any geotextile, the Manufacturer or Installer shall provide the Project Manager with the following information:

1. The origin (resin supplier's name and resin production plant) and identification (brand name and number) of the resin used to manufacture the geotextile.

2. Copies of the quality control certificates issued by the resin supplier.

3. Reports on tests conducted by the Manufacturer to verify that the quality of the resin used to manufacture the geotextile meets the Manufacturer's resin specifications.

4. Reports on quality control tests conducted by the Manufacturer to verify that the geotextile manufactured for the project meets the project specifications.

5. A statement indicating that the reclaimed polymer added to the resin during manufacturing was done with appropriate cleanliness.

6. A list of the materials which comprise the geotextile, expressed in the following categories as percent by weight: base polymer, carbon black, other additives.

7. A specification for the geotextile which includes all properties contained in the project specifications measured using the appropriate test methods.

8. Written certification that minimum average roll values given in the specification are guaranteed by the Manufacturer.

9. For non-woven geotextiles, written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and found the geotextile to be needle free.

10. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures and results of quality control tests. At a minimum, results shall be given for those properties stated in Section 02272 Part 1.05(A) of the project specifications.

The Manufacturer shall identify all rolls of geotextiles with the following:

1. Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

3.1.1 Product Review: The Project Manager shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum average roll properties meet the project specifications.

3.2 Geotextile Deployment

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

The Geosynthetic CQA shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Project Manager.

The Installer shall handle all geotextiles in such a manner as to assure they are not damaged in any way, and the following shall be complied with:

1. On slopes, the geotextiles shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.

2. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.

3. Geotextiles shall be cut using a geotextile cutter (hook blade) only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.

4. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

5. During placement of geotextiles, care shall be taken not to entrap, in or beneath the geotextile, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.

6. A visual examination of the geotextile shall be carried out over the entire surface, after installation, to assure that no potentially harmful foreign objects, such as needles, are present.

The Geosynthetic QAL shall note any noncompliance and report it to the Project Manager.

3.3 Seaming Procedures

On slopes steeper than 10 horizontal:1 vertical, all geotextiles shall be continuously sewn (i.e., spot sewing is not allowed). Geotextiles shall be overlapped a minimum of 3 inches prior to seaming. In general, no horizontal seams shall be allowed on sideslopes (i.e., seams shall be along, not across, the slope), except as part of a patch.

On bottoms and slopes shallower than 10 (horizontal):1 (vertical), geotextiles shall be seamed as indicated above (preferred), or thermally bonded with the written approval of the Project Manager.

The Installer shall pay particular attention at seams to assure that no earth cover material could be inadvertently inserted beneath the geotextile.

Any sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Sewing shall be done using machinery and stitch types specified in the project specifications or as approved in writing by the Project Manager.

3.4 Defects and Repairs

Any holes or tears in the geotextile shall be repaired as follows:

On slopes, a patch made from the same geotextile shall be sewn into place in accordance with the project specifications. Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.

Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.

The Geosynthetic CQA shall observe any repair and report any noncompliance with the above requirements in writing to the Project Manager.

3.5 Geotextile Protection

All soil materials located on top of a geotextile shall be deployed in such a manner as to assure:

1. The geotextile and underlying lining materials are not damaged.

2. Minimal slippage of the geotextile on underlying layers occurs.

3. No excess tensile stresses occur in the geotextile.

Unless otherwise specified by the Geosynthetic CQA, all lifts of soil material shall be in conformance with the guidelines given in Section 4.9.1.

4.0 GEOSYNTHETIC CLAY LINERS (GCL)

4.1 Quality Control Documentation

Prior to the installation of any GCL, the Manufacturer or Installer shall provide the Project Manager with the following information:

1. The origin (bentonite and geotextile supplier's name and bentonite and geotextile production plant) and identification (brand name and number) of the bentonite and geotextile used to manufacture the GCL.

2. Copies of the quality control certificates issued by the bentonite and geotextile supplier.

3. Reports on tests conducted by the Manufacturer to verify that the quality of the bentonite and geotextile used to manufacture the GCL meets the Manufacturer's bentonite and geotextile specifications.

4. Reports on quality control tests conducted by the Manufacturer to verify that the GCL manufactured for the project meets the project specifications.

5. A specification for the GCL which includes all properties contained in the project specifications measured using the appropriate test methods.

6. Written certification that minimum average roll values given in the specification are guaranteed by the Manufacturer.

7. For non-woven geotextiles, written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and found the geotextile to be needle free.

8. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures and results of quality control tests. At a minimum, results shall be given for those properties stated in Section 02275 Part 1.04(B) of the project specifications.

   Quality control tests shall be performed in accordance with the test methods specified in the project specifications for at least every ***50,000*** ft^2 of GCL produced.

The Manufacturer shall identify all rolls of GCLs with the following:

1. Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

4.1.1 Product Review: The Project Manager shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum average roll properties meet the project specifications.

4.2 Conformance Testing

Upon delivery of the rolls of GCLs, the Project Manager shall assure that conformance test samples are obtained for the GCL. Samples shall be obtained for conformance testing at a frequency of 1 sample per 100,000 ft^2 delivered, with a minimum of 1 per lift. These samples shall then be forwarded to an independent laboratory for testing to assure conformance to the project specifications.

The conformance tests shall be performed in accordance with the test methods indicated in Section 02275 Part 3.02. Other conformance tests may be required by the Project Manager.

4.2.1 Sampling Procedures: The rolls to be sampled shall be selected by the Project Manager. Samples shall be taken across the entire width of the roll. Samples shall not be taken from any portion of a roll which has been subjected to excess pressure or stretching. Unless otherwise specified, samples shall be 3 ft long by the roll width. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Project Manager based on a review of all roll information including quality control documentation and manufacturing records.

Unless otherwise specified, samples shall be taken at a rate of one per lot, not less than one conformance test per 100,000 ft^2 of GCL.

4.2.2 Test Results. All conformance test results shall be reviewed and accepted or rejected by the Project Manager prior to the deployment of the GCL.

The Project Manager shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

If the Manufacturer has reason to believe that failing tests may be the result of the independent laboratory incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested by the independent laboratory with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different approved independent laboratories at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original independent laboratory test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Project Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out of specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

4.3 GCL Deployment

During shipment and storage, the GCL shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. GCL rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

The Project Manager shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Project Manager.

The Installer shall handle all GCLs in such a manner as to assure they are not damaged in any way, and the following shall be complied with:

1. On slopes, the GCLs shall be securely anchored and then rolled down the slope in such a manner as to continually keep the GCLs fully relaxed (but not wrinkled).

2. GCLs shall be cut using a utility knife or special (manufacturer) cutter only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the GCLs.

3. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the GCL.

4. A visual examination of the GCL shall be carried out over the entire surface, after installation, to assure that no potentially harmful foreign objects, such as needles, are present.

5. The Installer shall sign and submit subgrade surface acceptance certificates for each area to be covered by the GCL.

6. The Installer shall deploy no more GCL material than can be covered with geomembrane by the end of that working day; this shall be verified by the Project Manager.

7. The Installer shall use a core pipe to lift the GCL during deployment which does not bend excessively creating unacceptable tension in the GCL, this shall be verified by the Project Manager.

8. To prevent damage, the GCL panels should not be dragged along the subgrade surface.

4.4 Seaming Procedures

GCLs shall be overlapped a minimum of 6 inches prior to seaming. In general, no horizontal seams shall be allowed on sideslopes (i.e., seams shall be along, not across, the slope), except as part of a patch. The GCL shall be seamed with a minimum of 115 g/lf of bentonite.

The Project Manager shall pay particular attention at seams to assure that no earth cover material could be inadvertently inserted beneath the GCL.

4.5 Defects and Repairs

Any holes or tears in the GCL shall be repaired as follows:

Place a bead of granular bentonite at the minimum rate of one-half pound per linear foot around the damaged area, cut a batch of new GCL to fit over the damaged area and extending a minimum of two feet beyond it, and carefully backfill.

Care shall be taken to remove any soil or other material which may have penetrated the damaged GCL.

4.6 GCL Protection

All soil materials located on top of a GCL shall be deployed in such a manner as to assure:

1. The GCL is not damaged.

2. Minimal slippage of the GCL on underlying layers occurs.

3. No excess tensile stresses occur in the GCL.

4.7 Installation Documentation

The Project Manager shall prepare and submit the following information as part of the project documentation plan:

1. A panel layout drawing in which the GCL roll numbers are keyed to their location in the field. Location where damage was encountered and repaired shall also be marked.

2. All conformance testing results.

3. All daily reports detailing the GCL deployment.

4. Subgrade surface acceptance certifications signed by the responsible parties.

5. A compilation of all CQA checklists completed during the installation.

6. All manufacturer's certifications and accompanying test data.

7. A description of deviations, if any, made to the original CQA plan during the installation.

8. The Geosynthetic Construction quality Control Agent will accept the GCL prior to placement.

5.0 LINER SOIL QUALITY ASSURANCE

Approximately 1,400 cubic yards of till borrow will be required to cover the base of the Valley Fill cell between Area A-East and Area A-West of Landfill No. 6. An additional 750 cubic yards will be required for the diversion berm. The following quality control procedures will be incorporated into the project specifications to assure that the till borrow source delivered to the site meets the project specifications, and provides the data to define quality control acceptance criteria. Individual moisture density curves from the borrow source testing program will be used to guide soil placement.

Blue Ridge Paper Products, Inc. will retain the services of a technician familiar with various aspects of landfill construction, to serve as the on-site representative during construction. Services of a general contractor will be procured through a competitive bid process. Bid packages for the solicitation of construction services will require the contractor to identify and demonstrate familiarity and experience with the various aspects of landfill construction. To control the quality of the soil materials used in the landfill development, this Quality Assurance/Quality Control (QA/QC) program will be implemented. The program will include borrow source testing to demonstrate compliance with material specifications, and construction testing to demonstrate that materials have been properly installed.

5.1 Borrow Source Testing

The contractor, as part of his proposal, will be required to identify the till borrow source. Once the construction contract has been awarded, the selected contractor will be required to perform an initial borrow source testing program. The contractor shall employ a testing laboratory acceptable to Blue Ridge Paper Products, Inc. to perform the soil testing of a potential borrow source to pre-qualify it. The intent of this program will be to determine the variability of the source properties, and its compliance with the project specifications. BRPP's representative will accompany the contractor during the collection of the soil samples to develop an understanding of the variability of the till borrow source. The contractor will also be required to submit soil logs and a plan of the borrow source showing the locations where the samples were collected.

The laboratory shall perform the analysis as shown on Table 5-1 and Table 5-2.

TABLE 5-1

AREA A – VALLEY FILL
BORROW SOURCE TESTING PROGRAM
COMMON BORROW NO. 1 (WITHIN 2 FEET OF SYNTHETIC LINER)

Test	Method	Test Frequency[1]	Required Properties
Grain Size Analysis	ASTM D 422-63	1/3000 yd^3	Minimum 20% soil particles passing #200 sieve; maximum particle size <1 inch
Moisture/Density	ASTM D 1557	1/3000 yd^3	(2)

Notes:

1. Test frequency per source.
2. Moisture density tests used to define maximum dry density and associated optional moisture content.

TABLE 5-2

AREA A – VALLEY FILL
BORROW SOURCE TESTING PROGRAM
NO. 78 LEACHATE COLLECTION STONE

Test	Method	Test Frequency[1]	Required Properties
Grain Size Analysis	ASTM D 422	1/3000 yd^3	(2)

Notes:

1. Test frequency per source.
2. Grain size distribution listed in specifications packet.

6.0 SOIL QUALITY CONTROL

The following quality control procedures and testing will be utilized by Blue Ridge Paper Products, Inc. to guide and document construction of the soil liner.

6.1 Subgrade Preparation

The areas receiving soil will be prepared by the Contractor prior to placing the till. Preparation of the subgrade will include grading of subgrade.

6.2 Liner Soil Placement

The following QA/QC procedures will be used during placement of the soil liner material.

6.2.1 Moisture Control. Moisture content of the cover shall range from 0 to 6 percent higher than optimum, as determined by ASTM D 1557 (modified proctor) or as determined necessary to meet the project specifications. Where subgrade or a layer of soil material must be moisture conditioned before compaction, water will be uniformly applied to surface of subgrade, or layer of soil material, in proper quantities to prevent free water appearing on surface during or subsequent to compaction operations.

Soil material that is too wet to permit compaction to the specified density will be removed and replaced, or scarified and air dried.

Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. The soils may be disced, harrowed, or pulverized until moisture content is reduced to a satisfactory level.

6.2.2 Placement and Compaction. Placement of fill materials will be in layers not more than 15" in loose depth for material compacted by heavy compaction equipment, and not more than 6" in loose depth for material compacted by hand-operated tampers. Low hydraulic conductivity

cover soil used for the final cover system will have a maximum in-place compacted lift thickness of 12 inches. Lift thickness will be measured by the Contractor and the CQA Agent during placement at the frequency of 5 tests per acre per lift. The Contractor may use driven wooden grade stakes to aid in the placement of each lift provided that all the grade stakes are collected and accounted for at the completion of the work and that all holes left behind by the grade stakes are filled with granular bentonite. Other methods of determining lift thickness such as laser survey or free-standing flexible grade stakes can also be used. The CQA Agent may also determine lift thickness by digging small test pits through the loose soil lift into the underlying layer.

Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content. Compact each layer to required percentage of maximum dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift. To connect soil barrier layer lifts to a completed barrier layer section (as a result of repairs or sequential liner section at construction), offset the lifts by one-half the compaction equipment width to create a horizontal bench without continuous vertical joints through all lifts of the barrier layer.

To provide for clod break-up of the till material, a minimum number of 2 passes will be made with deep footed pad roller. The CQA Agent will perform visual inspections and measurements as necessary to assure the maximum clod size of the cover soil does not exceed 2 to 3 inches. The Contractor shall make the necessary adjustments including increasing the number of passes with the sheepsfoot roller, decreasing the lift thickness or adjusting the moisture content of the clay to control the clod size of the cover soil.

To eliminate desiccation cracks the surface will be moistened (as necessary) and reworked with 2 passes of a smooth drum roller. Desiccation is defined as moisture content below optimum, or cracks deeper than 1 inch.

Sealing the lifts will encourage runoff from storms, thus limiting development of excessively moist or wet lenses of soil within the barrier layer.

To promote good bonding between lifts, the lift surface shall be scarified or otherwise roughened by tracking with a bulldozer prior to placing the next lift of till. The Contractor shall scarify the in-place lift surface to an approximate depth of 1 inch. The CQA Agent shall visually assure that the soil has been properly scarified prior to placement of subsequent lifts. The scarified zone will be considered part of the loose lift thickness of the subsequent lift.

The following types of equipment will be specified for compaction:

Caterpillar 815 Pad Foot Roller or equivalent equipment approved by the CQA Agent. Equivalent equipment shall meet the following specifications:

Minimum Operating Weight	45,900 lbs
Maximum Drum Width	38 inches
Maximum Pad Tip Area	18 square inches
Minimum Pad Height	7.5 inches
Minimum Wheel Diameter	40.5 inches

The passage of compaction equipment in either direction (forward or backward) is considered a "pass".

The following equipment will be used to obtain a smooth roll surface.

Caterpillar CS563 Vibratory Drum Roller or equivalent equipment approved by the CQA Agent. Equivalent equipment shall meet the following specifications:

Minimum Operating Weight	24,500 lbs
Vibration Frequency	1400 to 1800 vpm
Centrifugal Force	
High amplitude	50,000 lbs
Low amplitude	35,000 lbs
Maximum Drum Width	7.0 feet

6.3 Geomembrane Protection

The quality assurance procedures indicated in this section are intended to assure that the installation of adjacent materials does not damage the geomembrane.

6.3.1 Soils. A copy of the specifications prepared by the Designer for placement of soils shall be given to the Geosynthetic CQA by the Project Manager. The Geosynthetic CQA shall verify that these specifications are consistent with the state-of-practice such as:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32°F (0°C) nor above 104°F (40°C) unless otherwise specified.

2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.

3. A geotextile or other cushion approved by the Designer is required between aggregate and the geomembrane.

4. Equipment used for placing soil shall not be driven directly on the geomembrane.

5. A minimum thickness of 1 foot (0.3 m) of soil is specified between a light dozer (ground pressure of 5 psi (35 kPa) or lighter) and the geomembrane.

6. In any areas traversed by any vehicles other than low ground pressure vehicles approved by the Project Manager, the soil layer shall have a minimum thickness of 3 feet (0.9 m). This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns.

The Geosynthetic CQA shall measure soil thickness and verify that the required thicknesses are present. The Geosynthetic CQA must also verify that final thicknesses are consistent with the design and verify that placement of the soil is done in such a manner that geomembrane damage is unlikely. The Geosynthetic CQA shall inform the Project Manager if the above conditions are not fulfilled.

6.3.2 Sumps and Appurtenances. A copy of the plans and specifications prepared by the Designer for appurtenances shall be given by the Project Manager to the Geosynthetic CQA. The Geosynthetic CQA shall review these plans and verify that:

1. Installation of the geomembrane in appurtenant areas, and connection of geomembrane to appurtenances have been made according to specifications.

2. Extreme care is taken while welding around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas.

3. The geomembrane has not been visibly damaged while making connections to appurtenances.

The Geosynthetic CQA shall inform the Project Manager in writing if the above conditions are not fulfilled.

6.4 In-Place Testing

As the liner material is used in the landfill development, in-place testing will be performed by the owner's representative to monitor material placement and conformance with the criteria specified in the construction specifications. In-place material testing will be performed by a qualified materials testing laboratory and will be observed by the CQA Agent. Testing will be performed on each lift prior to placement of the subsequent lift. The contractor will be required to remove or rework material not conforming with material properties specified.

The owner's testing service shall perform the tests specified in Table 6-1 and Table 6-2 to document the liner soil in-place properties.

TABLE 6-1

AREA A – VALLEY FILL
IN-PLACE TESTING PROGRAM
LINER SOIL

Test	Method	Test Frequency[1]	Required Properties
Grain Size Analysis	ASTM D 422-63	1/1000 cy	Minimum 20% soil particles passing #200 sieve; maximum soil particle size <1 inch
Field Moisture Content	ASTM D 3017	10/acre/lift	0 to 6% above optimum
Field Density	ASTM D 2922	10/acre/lift	90% of maximum
Liner Thickness	Hand Auger	5/acre/lift	12 inch per lift

Note

1. Backfill all in-place test holes with bentonite.

TABLE 6-2

AREA A – VALLEY FILL
IN-PLACE TESTING PROGRAM
NO. 78 LEACHATE COLLECTION STONE

Test	Method	Test Frequency	Required Properties
Grain Size Analysis	ASTM D 422-63	1/3000 cy	(1)

Note

1. Grain size distribution listed in specifications packet.

7.0 CONSTRUCTION DOCUMENTATION

During construction, BRPP's representative will document that the compaction procedures are being followed, the soil and geosynthetic materials are provided and installed for the Valley Fill liner as specified. A full-time project representative will be assigned to the construction of the liner.

7.1 Inspection Reports

Inspection reports will be prepared daily and summarized weekly by BRPP's representative during the closure of the Landfill. The reports will include, but is not limited to:

- Contractor submittals,
- Soil and geomembrane material test results,
- A summary of work progress,
- Photographs, and
- Record drawings.

The weekly summaries will be forwarded to the NCDENRDSW on a regular basis.

7.2 Final Construction Certification and Report

A final construction report will be submitted by the BRPP to the NCDENRDSW within 30 days following the completion of construction of the Valley Fill Cell at the Landfill. The report will include, but is not limited to:

- Written certification signed and stamped by Engineer supervising project inspection (Statement of Compliance),
- Submittals,
- Field changes and construction modifications,

- QA/QC testing reports,
- Daily reports, and
- Photographs.

The report will also contain a request that the NCDENRDSW conduct an inspection of the facility for a finding of compliance with the Solid Waste Management Regulations.

SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Erosion Control: Section 02270

B. Geosynthetic Clay Liner: Section 02275

C. Seeding: Section 02480

D. Piping Systems: Section 02730

E. Geotextiles: Section 02731

F. Geomembrane: Section 02771

1.3 DESCRIPTION OF WORK:

Extent of earthwork is indicated on drawings.

Definition: "Excavation" consists of removal of material encountered to subgrade elevations indicated and subsequent disposal or replacement (backfill) of materials removed.

1.4 QUALITY CONTROL:

1.4.1 Codes and Standards: Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

1.4.2 Testing and Inspection Service: The Contractor shall employ a testing laboratory acceptable to Owner's Representative to perform soil testing of materials at point of source. The Contractor shall perform the following analysis on borrow materials used at the site.

- #78M Stone:

  - Grain Size (D422) - 1/3000 cy

- Common Borrow (silty sand, sandy silt or clayey soil):

  - Grain Size (D422) - 1/3000 cy
  - Maximum Dry Density (D1557) – 1/3000 cy

1.5 FIELD QUALITY ASSURANCE

1.5.1 Quality Assurance Testing During Construction: Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed.

Testing shall be as follows:

- #78M Stone:
  - Grain Size (D422) - 1/3000 cy
- Common Borrow (silty sand, sandy silt, etc.):
  - Grain Size (D422) - 1/1000 cy
  - Moisture/Density (D3017/D2922) - 10/acre/lift

If in opinion of Owner's Representative, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction, wetting, drying or removal of material as necessary, and testing at no additional expense.

1.6 JOB CONDITIONS:

1.6.1 Site Information: Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor. Data are made available for convenience of Contractor.

Additional test borings and other exploratory operations may be made by Contractor at no cost to Owner.

1.6.2 Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.

Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Owner's Representative and then only after acceptable temporary utility services have been provided.

Provide minimum of 48-hour notice to Owner's Representative, and receive written notice to proceed before interrupting any utility.

Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

1.6.3 Use of Explosives: (None anticipated)

General: This work shall consist of furnishing, placing and detonating dynamite in places directed for the excavation of related work items in accordance with these specifications and in reasonably close conformity to the lines and grades shown on the plans or as established.

All blasting plans shall be approved prior to placing the explosive charges.

Do not bring explosives onto site or use in work without prior written permission from authorities having jurisdiction.

The Contractor is solely responsible for the handling, storage, and use of explosive materials.

The explosives shall be detonated by the propagation or electric method and shall be detonated the same day it is placed.

No explosives shall be stored on the site overnight.

1.6.4 Materials: Dynamite and caps shall be from fresh stock and shall have a maximum strength as specified in the approved blasting plan.

1.6.5 Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.

Operate warning lights as recommended by authorities having jurisdiction.

Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS:

2.1.1 General: Excavations made at the site for the construction of project facilities will generate unspecified quantities of soil materials. These soils will either be suitable or unsuitable for use as fill in the construction of earth-related portions of the project.

Suitable Materials: Those materials generated from outside excavations that satisfy the specifications for the material for which it is to be used (i.e., compacted silt/sand, common borrow, etc.). Specifications for suitable project materials follow.

Unsuitable Materials: Those materials generated from on-site excavations that do not satisfy the specifications for the project materials identified below. Generally these materials will consist of objectionable quantities of vegetation, organic matter, large stones, debris and frozen material.

2.1.2 #78M Stone: #78M Stone shall be furnished and placed to the lines and dimensions as shown on the Drawings to provide a drainage blanket between the synthetic liner and the waste, as identified in the Drawings.

Sieve Designation	% Passing by Weight
3/4"	100
1/2"	98-100
3/8"	75-100
#4	20-45
#8	0-15
#200	0-0.6

2.1.3 Common Borrow #1 (silty sand, sandy silt): Screened material shall be furnished and placed to the lines and dimensions as shown on the Drawings to construct the cell division berm and any base filling requirements within two (2) feet of the synthetic liner. The soil shall not contain particles of rock which will not pass the 1-inch square mesh sieve. The soil shall have greater than 20 percent passing the U.S. Standard No. 200 Sieve.

2.1.4 Common Borrow #2: Shall be earth suitable for embankment construction for use in any base filling greater than two (2) feet below the synthetic liner. It shall be free of frozen material, perishable rubbish, peat, organic matter, large rock fragments over 12 inches, or other unsuitable material. AASHTO M145 Classifications A-1 through A-5 may be used. Use of other materials as common borrow is at the discretion of the Owner's Representative and only in approved areas.

PART 3 - EXECUTION

3.1 EXCAVATION:

3.1.1 Unclassified Excavation includes excavation of materials and obstructions encountered to subgrade elevations indicated, regardless of character.

3.1.2 Excavation Classifications: The following classifications of excavation will be made when rock excavation is encountered in work:

3.1.3 Earth Excavation includes excavation of pavements and other obstructions visible on ground surface; underground structures, utilities and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.

3.1.4 Rock Excavation: (None anticipated)

Rock excavation in trenches and pits includes removal and disposal of materials and obstructions encountered which cannot be excavated with a 1.0 cubic yard (heaped) capacity, 42" wide bucket on track-mounted power excavator equivalent to Caterpillar Model 215, rated at not less than 90HP flywheel power and 30,000 lb. drawbar pull. Trenches in excess of 10'-0" in width and pits in excess of 30'-0" in either length or width are classified as open excavation.

Rock excavation in open excavations includes removal and disposal of materials and obstructions encountered which cannot be dislodged and excavated with modern track-mounted heavy-duty excavating equipment without drilling, blasting or ripping. Rock excavation equipment is defined as Caterpillar Model No. 973 or No. 977K, or equivalent

track-mounted loader, rated at not less than 170HP flywheel power and developing 40,000 lb. break-out force (measured in accordance with SAE J732C).

Typical of materials classified as rock are boulders 3 cu. yd. or more in volume, solid rock, rock in ledges, and rock hard cementitious aggregate deposits.

Intermittent drilling, blasting or ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.

Do not perform rock excavation work until material to be excavated has been cross-sectioned and classified and worksheets submitted to the Owner's Representative.

Rock payment lines are limited to the following:

In pipe trenches, 6 inches below invert elevation of pipe and 18 inches wider than inside diameter of pipe, but not less than 3 ft.

In open areas, 24 inches below base grade elevation.

3.1.5 Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Owner's Representative. Unauthorized excavation, as well as remedial work directed by Owner's Representative, shall be at Contractor's expense.

Backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Owner's Representative.

3.1.6 Additional Excavation: When excavation has reached required subgrade elevations, notify Owner's Representative who will make an inspection of conditions. Do not backfill excavations without notifying Owner's Representative.

If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated material as directed by Owner's Representative.

Removal of unsuitable material and its replacement as directed will be paid on basis of contract conditions relative to changes in work.

3.1.7 Stability of Excavations: Slope sides of excavations to comply with federal and local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

Maintain sides and slopes of excavations in safe condition until completion of backfilling.

3.1.8 Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.

Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.

Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

Provide permanent steel sheet piling or pressure creosoted timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut off tops as required and leave permanently in place.

3.1.9 Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

Use appropriate erosion control in temporary ditches, as described in Section 02270, Erosion Control.

3.1.10 Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage. Cover or seed stockpiles when long-term storage indicates the potential for wind or water erosion from the stockpile. Place silt fence around downstream edge of stockpile to prevent transportation of soil.

Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.

Dispose of excess soil material and waste materials as herein specified by Owner's Representative.

3.1.11 Excavation for Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10', and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

3.1.12 Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide a minimum 6" to 9" clearance on both sides of pipe or conduit as indicated on Drawings.

Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations.

Where rock or unsuitable material is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel, as approved by Owner's Representative, prior to installation of pipe.

For pipes or conduit 6" or larger in nominal size, tanks and other work indicated to receive subbase, excavate to subbase depth or, if not otherwise indicated, to 6" below bottom of work to be supported.

Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.

Do not backfill trenches until tests and inspections have been made and backfilling authorized by Owner's Representative. Use care in backfilling to avoid damage or displacement of pipe systems. Owner's Representative must be notified of any intention to backfill trench or otherwise permanently cover pipe.

3.1.13 Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35° F. (1°C).

3.1.14 Final Grading: Perform grading in accordance with Contract Drawings, in order to obtain subgrade elevations prior to the placement of the geomembrane. During the regrading, the Contractor shall fill voids encountered below the subgrade elevations with on-site materials or materials provided by the Owner.

3.2 COMPACTION:

3.2.1 General: Control soil compaction during construction providing minimum percentage of density specified for each area classification indicated below.

3.2.2 Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture density relationship (cohesive soils) determined in accordance with ASTM D 1557.

Pipeline: Compact top 6" of subgrade and each 12" layer of backfill or fill material at 90% maximum density.

Dikes: Compact each 12-inch layer of fill material at 90% maximum density.

Liner Subgrade: Compact each 12" lift of subgrade at 90 percent maximum density. Maintain these conditions until geomembrane is installed.

3.2.3 Moisture Control: Moisture content of the liner subgrade soil and/or embankments shall be at, but not greater than 6 percent higher than optimum as determined by ASTM D 1557 (modified proctor). Where subgrade or layer of soil material must be moisture conditioned to meet the allowable range of water content to achieve compaction, uniformly apply water to surface of subgrade, or layer of soil material. Apply water in manner to prevent free water appearing on surface during or subsequent to compaction operations.

Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3.3 BACKFILL AND FILL:

3.3.1 General: Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.

In excavations, use satisfactory excavated or borrow material free of frozen material, large stones, brush, roots, sod, or other unsuitable material.

Under grassed areas, use satisfactory excavated or borrow material.

Under piping and conduit, use subbase material where subbase is indicated under piping or conduit; shape to fit bottom 90° of cylinder.

3.3.2 Backfill excavations as promptly as work permits, but not until completion of the following:

Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.

Inspection by Owner's Representative, testing, approval, and recording locations of underground utilities.

Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.

Removal of trash and debris.

Permanent or temporary horizontal bracing is in place on horizontally supported walls.

3.3.3 Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

3.3.4 Placement and Compaction: Place backfill and fill materials in layers not more than 15" in loose depth for material compacted by heavy compaction equipment, and not more than 6" in loose depth for material compacted by hand-operated tampers. Liner subgrade soil shall have a maximum in-place compacted lift thickness of 12 inches.

Before compaction, moisten or aerate each layer as necessary to provide optimum moisture

content within the optimum range as determined by the soil testing at point of source. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

Place backfill and fill materials evenly adjacent to structures, piping or conduit to required elevations. Take care to prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping or conduit to approximately same elevation in each lift.

To provide for clod break-up of the cover material, a minimum number of 2 passes will be made with deep footed pad roller. To eliminate desiccation cracks the surface will be moistened (as necessary) and reworked with 2 passes of a smooth drum roller. Desiccation is defined as moisture content below optimum, or cracks deeper than 1 inch.

The cover soil shall be compacted and smooth drum rolled at the end of each work day to provide for moisture/density testing and prevent ponding of surface water overnight.

The following equipment will be used for compaction of the cover material:

Caterpillar 815F Pad Foot Roller or equivalent equipment approved by the Engineer. Equivalent equipment shall meet the following specifications:

Minimum Operating Weight	45,900 lbs
Maximum Pad Tip Area	18 square inches
Minimum Pad Height	7.5 inches
Minimum Wheel Diameter	40.5 inches

The passage of compaction equipment in either direction (forward or backward) is considered a "pass".

The following equipment will be used to obtain a smooth roll surface:

Caterpillar CS563 Vibratory Drum Roller or equivalent equipment approved by the Engineer. Equivalent equipment shall meet the following specifications:

Minimum Operating Weight	24,500 lbs
Vibration Frequency	1,400 to 1,800 vpm
Centrifugal Force	
High Amplitude	50,000 lbs
Low Amplitude	35,000 lbs
Maximum Drum Width	7.0 feet

Sealing the lifts will encourage runoff from storms, thus limiting development of excessively moist or wet lenses of soil within the barrier layer. The lift surface shall be scarified or otherwise roughened by tracking with a bulldozer prior to placing the next lift of silt-clay to promote good bonding between lifts.

3.4 MAINTENANCE:

3.4.1 Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

3.4.2 Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, gravel road, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.5 DISPOSAL OF EXCESS AND WASTE MATERIALS:

3.5.1 Removal to Designated Areas on Owner's Property: Transport acceptable excess excavated material to designated soil storage areas on Owner's property. Stockpile soil and seed or spread and seed as directed by Owner's Representative.

Transport waste material, including unacceptable excavated material, trash and debris to designated spoil areas on Owner's property and dispose of as directed.

END OF SECTION

SECTION 02270

EROSION CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

Work covered by this Section includes the control of erosion, siltation, and sedimentation. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division -1 Specification sections, apply to work of this section.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Earthwork: Section 02200

B. Seeding: Section 02480

C. Geotextiles: Section 02731

1.3 PROJECT REQUIREMENTS

1.3.1 Prevention: Take every reasonable precaution and do whatever is necessary to avoid any erosion and to prevent silting of rivers, streams, lakes, reservoirs, impoundment's, and drainage ditches and swales.

1.3.2 Exposure: The exposure of uncompleted cut slopes, embankments, trench excavations, and site graded areas shall be kept as short as possible. Initiate seeding and other erosion control measures on each segment as soon as reasonably possible.

1.3.3 Temporary Protection: Should it become necessary to suspend construction for any length of time, shape all excavated and graded areas in such a manner that runoff will be intercepted and diverted to points where minimal erosion will occur. Provide and maintain temporary erosion and sediment control measures, such as berms, dikes, slope drains, silt stops, and sedimentation basins, until permanent drainage facilities or erosion control features have been completed and are operative.

1.3.4 Handling of Fine Material: Fine material placed or exposed during the work shall be so handled and treated as to minimize the possibility of its reaching any surface waters. Use diversion channels, dikes, sediment traps, or any other effective control measures.

1.3.5 Silt Stops: Provide silt stops wherever erosion control measures may not be totally capable of controlling erosion, such as in drainage channels and where steep slopes may exist.

1.3.6 Special Precautions: Take special precautions in the use of construction equipment to minimize erosion. Do not leave wheel tracks where erosion might begin.

1.3.7 Off-Site Erosion Control: The requirements of this Section also apply to Project-related construction activities away from the Project site, such as at borrow pits, off-site storage areas, and haul and work roads.

1.3.8 Mulching: Mulching shall follow the seeding operation by not more than 24 hours.

1.3.9 Remedial Action: Should any protective measures employed indicate any deficiencies or erosion taking place, immediately provide additional materials or employ different techniques to correct the situation and to prevent subsequent erosion.

1.3.10 Discontinuation: Continue erosion control measures until the permanent measures have been sufficiently established and are capable of controlling erosion on their own.

1.3.11 Federal Permits: Comply with all Federal, state and local laws, ordinances, rules and regulations.

1.4 QUALITY CONTROL:

Provide at least one person who shall be present at all times during erosion control operations and who shall be thoroughly familiar with the types of materials being installed and the best methods for their installation and who shall direct all work performed under this Section.

Material manufacturers and vendors shall be reputable, qualified firms regularly engaged in producing the required types of materials.

Protect and maintain all areas disturbed by the Work, such that erosion is adequately controlled and silt and sediments are not allowed to flow into any watercourse, onto adjacent properties, or into storm drains.

PART 2 - PRODUCTS

2.1 STRAW MULCH:

2.1.1 General: Straw mulches shall be reasonably free from swamp grass, weeds, twigs, debris and other deleterious material, and free from rot, mold, primary noxious weed seeds, and rough or woody materials. Mulches containing mature seed of species which would volunteer and be detrimental to the permanent seeding, or would result in overseeding, or would produce growth which is aesthetically unpleasing, is not permitted.

2.1.2 Straw Mulch: Properly aired native straw, Sudan grass straw, broomsedge straw, legume straw, or similar straw or grass mowings. When air-dried in the loose state, the contents of the representative bale shall lose not more than fifteen (15) percent of the resulting air-dry weight of the bale. Apply at the rate of 2 tons/ac.

2.1.3 Mulch Stabilizers: "Curasol" applied at the rate of 40 gal/ac. or Dow "Mulch Binder" applied at the rate of 45 gal/ac.

2.1.4 Permanent Type Mulch Nets: "Curlex" blanket as manufactured by American Excelsior, or equal.

2.2 SEED AND SOD FOR EROSION CONTROL:

2.2.1 For Temporary Control Use annual or perennial ryegrass.

2.2.2 For Permanent Control See Section "Seeding".

2.3 HAY BALES FOR EROSION CONTROL:

Rectangular shaped bales of straw or straw, weighing at least 40 lbs per bale, free from primary noxious weed seeds and rough or woody materials.

2.4 SILT FENCES:

"Envirofence" by Mirafi, Inc. or an approved equal.

PART 3 - EXECUTION

3.1 STRAW MULCHING:

3.1.1 Install straw mulch immediately after each area has been properly prepared. When permanent seed or seed for temporary erosion control is shown prior to placing the mulch, place mulch on seeded areas within 24 hours after seeding. Engineer may authorize the blowing of chopped mulch provided that 95% of the mulch fibers will be 6" or more in length and that it can be applied in such a manner that there will be a minimum amount of matting that would retard the growth of plants. Straw mulch should cover the ground enough to shade it, but the mulch should not be so thick that a person standing cannot see the ground through the mulch. Remove matted mulch or branches.

3.1.2 Apply a system of pegs and strings, a chemical stabilizer, or temporary type netting to the mulch, where mild winds may blow the mulch, or when ground slopes exceed 15%, or when otherwise required to maintain the mulch firmly in place. Unless otherwise directed, remove the strings and netting prior to the acceptance of the Work.

3.1.3 Apply temporary type netting over the mulch and take whatever measures are necessary to maintain the mulch firmly in place, where high winds exist, or heavy rainstorms are likely, or where ground surfaces are steep, or where other conditions require.

3.1.4 The use of permanent type netting is not permitted without the prior approval of Engineer, unless otherwise specified.

3.2 HAY BALES AND SILT FENCES:

3.2.1 Provide straw bales or silt fences, as required, for the temporary control of erosion and to stop silt and sediment from reaching surface waters, adjacent properties, or entering catch basins, or damaging the Work.

3.2.2 Stake the straw bales as shown in the details to hold them firmly in place. Use a sufficient number of bales to accommodate runoff without causing any flooding and to adequately store any silt, sediment and debris reaching them (minimum of 1 every 50 feet).

3.2.3 Erect silt fences and bury bottom edge in accordance with the manufacturer's recommended installation instructions. Provide a sufficient length of fence to accommodate runoff without causing any flooding and to adequately store any silt, sediment, and debris reaching it.

3.2.4 Leave straw bales and silt fences in place until permanent erosion control measures have stopped all erosion and siltation, then remove and dispose of properly.

3.3 MAINTENANCE

If any temporary erosion and sediment control measures are disturbed, repair them immediately. Check erosion control devices weekly and after any heavy rain storms.

If seed is washed out before germination, repair any damage, refertilize, and reseed.

Maintain mulched and matted areas, silt stops, and other temporary control measures until the permanent control measures are established and no further erosion is likely.

END OF SECTION

SECTION 02275

GEOSYNTHETIC CLAY LINER (GCL)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this Section.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Earthwork: Section 02200

B. Geomembrane: Section 02771

1.3 DESCRIPTION:

Furnish and install a geosynthetic clay liner (GCL) as part of the composite liner in the landfill as shown in the drawings. Sufficient liner material shall be furnished to cover all areas shown on the drawings including overlaps at field seams and anchor trenches.

1.4 SUBMITTALS:

A. A plan showing the proposed liner layout.

B. All required manufacturer's quality control certifications, including, but not limited to, the following:

- verification that clay component of the finished product is 70 to 90 percent sodium montmorillonite clay from the Wyoming/North Dakota "Black Hills" region of bentonite deposits;
- verification that the proper mass per unit area of bentonite clay has been added to the finished product;
- verification that the actual geotextiles used in the finished product meet the manufacturer's specification based on the minimum average roll value (MARV) concept; and
- verification that needle-punched non-woven geotextiles have been inspected continuously for the presence of broken needles using an in-line metal detector.

C. Furnish certified copy of laboratory test results and material sample as evidence that material is similar and equal in the minimum values listed.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. The GCL liner shall be Bentomat ST manufactured by American Colloids Company or equal.

B. The liner shall be manufactured by the mechanical bonding of the needlepunch process to enhance the friction characteristics of the liner and to maintain the integrity of the liner under hydration. No glues or adhesive shall be used in lieu of the needlepunch process so as to retain these characteristics.

Needled GCLs are those which, by the process of a needling board (similar to that used in the manufacture of standard nonwoven geotextiles) have fibers of a nonwoven geotextile pushed through the bentonite clay core and integrated into a woven or nonwoven geotextile without the use of any chemical binders or adhesives.

C. The geocomposite liner shall have a hydraulic conductivity equal to or less than $1x10^{-9}$ cm/sec.

D. The interface friction angle between the textured HDPE geomembrane and the woven geotextile of the GCL shall be >20° and the adhesion shall be >245 lb/ft2 as determined by ASTM D 5321. Values shall be measured at 7 percent strain. Normal stresses shall be 10, 20, and 30 psi, in a drained condition at a strain rate of 0.2 in/min.

E. The geotextiles used in the manufacture of the GCL shall be made up from polypropylene fibers. Any and all substitutions shall be approved by the Owner prior to their use.

PART 3 - EXECUTION

3.1 SHIPPING AND HANDLING:

A. Covering of the Rolls:

1. Manufacturers should clearly stipulate the type of protective covering and the manner of cover placement. The covering should be verified as to its capability for safe storage and proper transportation of the product.

2. The covering should be placed around the GCL in a workmanlike manner so as to effectively protect the product on all of its exposed surfaces and edges.

3. The central core should be accessible for handling by forklift vehicles. For wide GCLs (e.g. wider than approximately 11.5 feet) handling should be by overhead cranes utilizing two dedicated slings provided on each roll at approximately the 1/3rd points.

4. Clearly visible labels should identify the name and address of the manufacturer, trademark, date of manufacture, location of manufacture, style, roll number, lot number, serial number, dimensions, and weight in accordance with ASTM D 4873.

B. Storage at the Manufacturing Facility:

1. GCLs should always be stored indoors until they are ready to be transported to the field site.

2. Handling of the GCL should be such that the protective wrapping is not damaged. If it is, it must be immediately rewrapped by machine or hand; in the case of minor tears it may be taped.

3. Placement and stacking of rolls should be done in a manner so as to prevent thinning of the product at points of contact with the storage frame or with one another.

C. Shipment:

1. The GCLs should be shipped by themselves with no other cargo which could damage them in transit during stops or while off-loading other materials.

2. Method of loading GCLs rolls, transporting them, and off-loading them at the job site should not cause any damage to the GCL, its core or its protective wrapping.

3. Any protective wrapping that is damaged or stripped off the rolls should be repaired immediately or the roll should be moved to an enclosed facility until its repair can be made to the approval of the quality assurance personnel.

4. If any clay has been lost during transportation or from damage of any type, the outer layers of the GCL should be discarded until undamaged product is evidenced. The remaining roll must be wrapped in accordance with the manufacturer's original method to prevent hydration or further damage to the remaining roll.

D. Storage at the Site:

1. Handling of the GCLs should be done in a competent manner such that damage does not occur to the product nor to its protective wrapping.

2. The location of temporary field storage should not be in areas where water can accumulate. The rolls should be stored on high, flat ground or elevated off the ground so as not to form a dam creating the ponding of water. It is recommended to construct a platform or acceptable equivalent method so that GCL rolls are continuously supported along their length.

3. The rolls shall not be stacked more than two high so as not to cause thinning of the product at points of contact. Furthermore, they should be stacked in such a way that access for conformance testing is possible.

4. If outdoor storage of rolls is to be longer than a few weeks, particular care (e.g. using tarpins) should be taken to minimize moisture pick-up or accidental damage. For storage periods longer than two months, a temporary enclosure

should be placed over the rolls or they should be moved within an enclosed facility.

3.2 CONFORMANCE TESTING:

Upon delivery of the GCL to the field site, the CQA officer should see that conformance test samples are obtained. These samples are to be sent to the CQA laboratory for testing to assure that the GCL conforms to the project plan and specifications. Samples should be taken from selected rolls by removing the protective wrapping and cutting a full width 3-foot long sample from the outer wrap of the selected rolls. The rolls should be immediately rewrapped and replaced in the shipping trailers or in the temporary field storage area. Test samples should be identified by type, style, lot, and roll numbers. The machine direction should also be noted on the samples with a waterproof marker. Conformance testing will be performed on a per-lot basis and not less than one conformance test per 100,000 square foot. A lot is defined as a group of consecutively numbered rolls from the same manufacturing line. Material conformance testing will include the following:

A. Mass per unit area per ASTM D 5261;

B. Free swell of clay component per GRI-GCL1; and

C. Hydraulic conductivity per ASTM D 5084.

3.3 INSTALLATION:

A. Installation of the GCL shall include the following considerations:

1. Place in the manner and at the locations shown on the drawings.

2. Rolls shall be handled utilizing a 3 inch schedule 80 steel pipe through the core and slings or straps attached to the ends of the pipe (core pipe). The core pipe shall be suspended from a spreader bar so that the edges of the liner are not damaged by the suspending straps or chains. Panels shall be placed with the nonwoven side against the subgrade and the woven side oriented upwards.

3. Work on the slopes shall be undertaken before the bottom to permit drainage in the event of rainfall. Panels may be pulled up from the bottom of the slope to the anchor trench or anchored first and the roll slowly lowered down the slope. Seams shall be perpendicular to the toe of the slope at all times. Seams at the base of the slope shall be a minimum of 5 feet away from the toe of the slope. Roll end seams or joints will not be allowed on the sideslopes.

4. Seam areas or runs shall be flat and clear of any large rocks, debris or ruts. Contacting surfaces shall be clean and clear of dirt or native soil with all edges pulled tight to maximize contact and to smooth out any wrinkles or creases. Overlaps shall be a minimum of 6 inches and varied by QA/QC personnel. A proper seam shall cover the lap line and leave the match line exposed.

5. Seams shall be augmented with granular bentonite to insure seam integrity. Granular bentonite shall be spread evenly from the panel edge to the lap line at a

minimum rate of 1/4 pound per lineal foot. This rate of application will be assured by using one 50-pound bag of granular bentonite (evenly spaced along the seam) per roll of GCL. Accessory bentonite shall be of the same type as the material within the composite liner itself. Fasteners, anchor pins or adhesives may be used on seams to keep panels in place during backfill operations if necessary. Fasteners and anchor pins used during installation shall be removed prior to installation of the geomembrane.

6. The contractor shall only work on an area that can be completed in one working day. Completion shall be defined as the full installation of the liner and placement of the geomembrane cover (see section 8. below). Prior to deployment of the GCL, the underdrain sand will be smooth to provide a smooth surface free of debris, roots and angular rocks. The GCL subgrade will be inspected and certified by the CQA personnel prior to placement of the GCL. Deployment of the GCL will be visually inspected to assure that no potentially harmful objects are present (e.g. stones, cutting blades, small tools, sandbags, etc.).

7. For any penetrations or structures the liner will contact, a small notch shall be cut along the edge of the area. The liner shall be brought up to the appurtenance and trimmed to fit snugly. The contractor shall then hand apply and compact a pure bead or dry mixture of 1 part bentonite to 4 parts soil (by volume), blended dry, into half of the notch. The liner shall then be inserted into the notch, with the remaining area in the notch refilled with the 1 to 4 mixture and compacted.

8. Large rips, or tears shall be repaired by placing a patch over the defect, with a minimum overlap of 12 inches on all edges. Accessory bentonite shall be placed between the patch and the repaired material at a rate of 1/4 pound per lineal foot of edge.

9. Overlap joints and seams shall be measured as a single layer of geotextile.

10. Securely anchor GCL as shown on the drawings.

11. The GCL will be rejected if allowed to hydrate, i.e., the moisture content of the bentonite increases above its natural moisture content, before placement of the HDPE geomembrane. Replacement of hydrated GCL shall be the Contractor's responsibility.

B. Protection of Geosynthetic Clay Liner:

1. Exercise necessary care while transporting and installing the geocomposite to prevent damaging it.

2. Stored rolls shall be on a flat dry surface and tarped to avoid any unnecessary stress on the packaging.

END OF SECTION

SECTION 02480

SEEDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Earthwork: Section 02200

B. Erosion Control: Section 02270

1.3 DESCRIPTION OF WORK:

Work specified in this section shall consist of furnishing all labor, materials, and equipment to perform seeding work in conformity with the contract drawings and as specified herein.

1.4 QUALITY ASSURANCE:

Subcontract the seeding work to a single firm specializing in landscape work.

A. Source Quality Control:

1. General: Ship landscape materials with certificates of inspection as required by governmental authorities. Comply with governing regulations applicable to landscape materials.

2. Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agricultural Chemists, wherever applicable or as further specified.

3. Grass Seed: All seed shall be certified as to mixture, germination, and purity, as being in conformity with the following requirements:

   a. Each variety of seed shall have a percentage of germination of not less than 80, a percentage of purity of not less than 85, and shall have not more than one percent of weed content.

   b. All seed shall be from the same or previous year's crop unless recent tests by an approved testing agency demonstrates that older seed meets the above requirements.

4. Inspection: The Owner's Representative reserves the right to inspect any plant materials either at the place of growth or at the site before planting, for compliance with requirements for name, variety, size and quality.

1.5 SUBMITTALS

A. Certification: For information only, submit 2 copies of certificates of inspection as required by governmental authorities, and manufacturer's or vendors analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.

Submit seed vendor's certified statement for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed for each grass seed species.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery, and while stored at the site.

1.7 JOB CONDITIONS:

Contractor must examine the subgrade, verify the elevations, observe the conditions under which work is to be performed and notify the Owner's Representative of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

It shall be the Contractor's responsibility to restore to the line, grade, and surface of all eroded areas with approved material and to keep topsoiled areas in acceptable condition until turf is established and accepted by the Owner's Representative.

Proceed with and complete the seeding work as rapidly as portions of the site become available, working within the required seasonal limitations.

A. Seeding Seasons: Unless variance is requested in writing and approved by the Owner's Representative, seeding shall be done within the following dates:

Permanent Seeding:	May 1 – August 15
Temporary Seeding:	August 15 – December 30

PART 2 - PRODUCTS

A. Vegetative Soil (Topsoil): Vegetative soil shall be loam, sandy loam, silt loam, sandy clay loam, silty clay loam, clay loam or loamy sand. Vegetative layer shall be fertile, friable soil free of roots stumps, stones larger than 3 inches in diameter, live plants, noxious weeds, and foreign matter. It shall contain more than of 1.5% organic matter by weight and should have a pH of above 3.6 before liming, and should have less than 500 parts per million of soluble salts.

An agronomic study should be performed on all vegetative soil sources planned use on the site. Agronomic testing should be performed by the North Carolina Department of Agriculture soil testing laboratory or by commercial laboratories qualified to perform agronomic testing.

B. Soil Amendments:

1. Lime: Natural limestone containing not less than 90% of total carbonates, ground so that not less than 100% passes a 10-mesh sieve, not less than 90% passes a 20 mesh sieve, and not less than 50% passes a 100 mesh sieve.

2. Fertilizer: Fertilizer shall be a commercial type with 50 percent of the elements derived from organic sources and shall conform to the recommendations of the agronomic testing.

2.1 GRASS MATERIAL:

A. Grass Seed: Provide fresh, clean, new-crop seed complying with the tolerance for purity and germination established by the Official Seed Analysts of North America. Provide seed of the grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed, as specified.

The seed mixtures shall consist of seeds proportioned by weight as follows:

Permanent Seeding		Temporary Seeding	
Tall Fescue	80 lbs/acre	Rye	40 lbs/acre
Sericea lespedeza	20 lbs/acre		
Korean lespedeza	10 lbs/acre		
	100 lbs/acre		

2.2 MISCELLANEOUS LANDSCAPE MATERIALS:

A. Mulch for Seeded Areas:

1. Hay or straw mulch shall consist of long fibered hay or straw, reasonably free from noxious weeds and other undesirable material. No material shall be used which is too wet, decayed, or compacted as to inhibit even and uniform spreading. No chopped hay, grass clippings or other short fibered material shall be used unless directed.

2. Cellulose fiber mulch shall consist of natural wood, recycled paper or humus cellulose fiber containing no materials which will inhibit seed germination or plant growth. Sufficient non-toxic water soluble green dye shall be added to provide a definite color contrast to the ground surface to aid in even distribution. Cellulose fiber mulch shall be supplied in moisture resistant, sealed bags marked with the manufacturer's name, the air dry weight, and composition of the contents.

B. Mulch Binder: Material for mulch tackifier shall be a non-asphaltic base product, such as Hydro Glass Corporation Hydrotack or an Owner's Representative approved equivalent.

PART 3 - EXECUTION

3.1 SEEDING:

A. Locations: All areas disturbed as a result of construction shall require seeding and mulching.

B. Do not use wet seed or seed which is moldy or otherwise damaged in transit or storage.

C. Rates of Application: Rates of application for limestone, fertilizer, and grass seed shall be in accordance with the Construction Drawings.

D. The hydraulic spray method shall be used for seeding all areas unless alternative methods are approved by the Owner's Representative.

E. Application Procedure:

1. Hydraulic Spray Method: The hydraulic spray method of sowing seed shall be done with an approved machine operated by a competent crew. Seed and fertilizing materials shall be mixed with water in the tank of the machine and kept thoroughly agitated so the materials are uniformly mixed and suspended in the water at all times during operation. The spraying equipment must be designed and operated to distribute seed and fertilizing materials evenly and uniformly on the designated areas at the required rates. If the Owner's Representative finds the application uneven or otherwise unsatisfactory, he may require the hydraulic spray method to be abandoned and the balance of the work done as specified under another method.

F. Mulching:

1. Cellulose fiber mulch shall be applied as a waterborne slurry. The cellulose fiber and water shall be thoroughly mixed and sprayed on the area to be covered so as to form a uniform mat of mulch at a rate that completely covers the ground.

   Cellulose fiber mulch may be mixed with the proper quantities of seed, fertilizer, and agricultural limestone as required, or may be applied separately the next day after seeding.

2. Hay or straw mulch shall be spread evenly and uniformly over any designated areas or as directed by the Owner's Representative in the field so to avoid damage to seeded areas. Unless otherwise directed, mulch shall be applied at the rate of 2 tons (approximately 90-100 bales) per acre. Too heavy application of mulch shall be avoided. Lumps and thick mulch material shall be thinned.

   Unless otherwise authorized, the mulch shall be anchored in place by uniformly applying an acceptable mulch binder. Application of a concentrated stream of mulch binder will not be allowed. Other methods of anchoring mulch such as mulch netting shall be used as approved by the Owner's Representative.

3. Areas which cannot be seeded within the growing season shall be temporary seeded and mulched to provide protection to the soil surface. An organic mulch other than wood fiber alone shall be used along with a mulch netting. The areas will be reseeded with permanent seed as soon as seeding dates and weather conditions permit.

G. Erosion Control Blanket:

1. Erosion Control Blanket shall be placed at locations indicated on Contract Drawings. The anchoring of the blanket shall be as indicated on the Contract Drawings and as recommended by the manufacturer. All blankets shall be placed after seeding.

3.2 MAINTENANCE AND ACCEPTANCE:

A. Seeded Areas:

1. Maintain seeded areas by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, regrading and replanting as required to establish a smooth, acceptable grass growth, free of eroded or bare areas.

2. Seeding, March 1 to September 15, Inclusive: The Contractor shall maintain each seeded area until acceptance of the individual area. Maintenance shall consist of providing protection by erecting necessary signs and barriers and by repairing damaged areas as directed. Damaged areas and areas which do not produce a satisfactory stand of grass shall be repaired to re-establish the condition and grade of the area prior to the original seeding and then refertilized, reseeded and remulched as specified to produce satisfactory results.

   Areas fertilized and seeded by the hydraulic method will be accepted only upon attainment of a reasonable thick uniform stand of not less than 90 percent coverage of permanent grasses, free from sizable thin or bare spots.

3. Seeding, September 16 to February 28, Inclusive: The Contractor shall maintain each seeded area until acceptance of the individual area. Maintenance shall consist of providing protection by erecting necessary signs or barriers and by repairing damaged areas as directed. Damaged areas shall be repaired by re-establishing the grade of the area prior to damage and by reapplying mulch. Refertilizing and reseeding will not be required during this period. Necessary maintenance or repairs will not be paid for but shall be considered incidental to the Contract. Areas fertilized, seeded and mulched between September 16 and February 31 will be accepted only upon attainment of a reasonably thick uniform stand of not less than 90 percent coverage of permanent grasses, free from sizable thin or bare spots.

4. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorously growing condition for two cuttings.

5. Immediately reseed areas which show bare spots.

3.3 RESTORATION

A. Restore improvements damaged by or removed by this work to original condition, as acceptable to Owners or other parties or authorities having jurisdiction including but not limited to fences, curbs, signs, trees, shrubs, vegetation, poles, posts.

END OF SECTION

SECTION 02731

GEOTEXTILES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of section.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Earthwork: Section 02200

B. Erosion Control: Section 02270

C. Geomembrane: Section 02771

1.3 DESCRIPTION OF WORK

Extent of geotextile work is indicated on drawings and schedules, and by requirements of this section.

1.4 QUALIFICATIONS AND WARRANTIES

1.4.1 Manufacturer's Qualifications: Firms regularly engaged in manufacture of products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.4.2 Installer's Qualifications: Firms regularly engaged in installation of products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.5 QUALITY CONTROL DOCUMENTATION

1.5.1 Product Data: Prior to the installation of any geotextile, the Manufacturer or Installer shall provide the Project Manager with the following information:

1. Written certification that minimum average roll values given in the specification are guaranteed by the Manufacturer.

2. For non-woven geotextiles, written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and found the geotextile to be needle free.

3. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures and results of quality control testes. At a minimum, results shall be given for:

a. Mass per unit area
b. Grab strength
c. Trapezoidal tear strength
d. Burst strength
e. Puncture strength
f. Apparent Opening Size

Quality control tests shall be performed in accordance with the test methods specified in the project specifications for at least every 100,000 ft^2 of geotextile produced.

The Manufacturer shall identify all rolls of geotextiles with the following:

1. Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

1.4.2 Product Review: The Owner's Representative shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum average roll properties meet the project specifications.

PART 2 - PRODUCTS

2.1 GEOTEXTILE:

2.1.1 General: Provide geotextiles as indicated on Drawings.

2.1.2 Non-Woven Geotextile: 16 oz/sy - The geotextile between the 60-mil textured HDPE geomembrane and the #78M stone shall be Nicolon S1600, or meet the minimum requirements listed below:

PROPERTY	TEST PROCEDURE	MINIMUM VALUE(1)
Weight	ASTM D 3776	16 oz/sy
Grab Strength	ASTM D 4632	500 lbs
Tear Strength	ASTM D 4533	150 lbs
Mullen Burst	ASTM D 3786	800 psi
Puncture Resistance	ASTM D 4833	240 lbs
AOS	ASTM D 4751	60 - 100 U.S Sieve

(1) Values in weaker principle direction. All minimum values represent minimum average roll values (i.e. test results from any sampled roll in a lot, tested in accordance with ASTM D 4759-88 shall meet or exceed the minimum values listed.)

PART 3 - QUALITY ASSURANCE

3.1 GEOTEXTILE DEPLOYMENT

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

The Owner's Representative shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Project Manager.

The Installer shall handle all geotextiles in such a manner as to assure they are not damaged in any way, and the following shall be complied with:

1. On slopes, the geotextiles shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.

2. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.

3. Geotextiles shall be cut using a geotextile cutter (hook blade) only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.

4. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

5. During placement of geotextiles, care shall be taken not to entrap, in or beneath the geotextile, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.

6. A visual examination of the geotextile shall be carried out over the entire surface, after installation, to assure that no potentially harmful foreign objects, such as needles, are present.

3.2 SEAMING PROCEDURES

On slopes steeper than 10(horizontal):1(vertical), all geotextiles shall be continuously sewn (i.e. spot sewing is not allowed). Geotextiles shall be overlapped a minimum of 3 inches (75 mm) prior to seaming. In general, no horizontal seams shall be allowed on sideslopes (i.e. seams shall be along, not across, the slope), except as part of a patch.

On bottoms and slopes shallower than 10 (horizontal):1 (vertical), geotextiles shall be seamed as indicated above (preferred), or thermally bonded with the written approval of the Owner's Representative.

The Installer shall pay particular attention at seams to assure that no earth cover material could be inadvertently inserted beneath the geotextile.

Any sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile.

3.3 DEFECTS AND REPAIRS

Any holes or tears in the geotextile shall be repaired as follows:

On slopes, a patch made from the same geotextile shall be sewn into place in accordance with the project specifications. Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.

Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.

The Owner's Representative shall observe any repair and report any noncompliance with the above requirements in writing to the Project Manager.

3.4 GEOTEXTILE PROTECTION

All soil materials located on top of a geotextile shall be deployed in such a manner as to assure:

1. The geotextile and underlying lining materials are not damaged.
2. Minimal slippage of the geotextile on underlying layers occurs.
3. No excess tensile stresses occur in the geotextile.

Unless otherwise specified by the Owner's Representative, all lifts of soil material shall be in conformance with the guidelines given in Section 02200 and 02771-4.7.1.

END OF SECTION

SECTION 02771

GEOMEMBRANE (HIGH DENSITY POLYETHYLENE (HDPE))

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of section.

The requirements set forth by the Quality Assurance/Quality Control Plan provided in Specification 01400 shall apply to the work specified in this Section.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Earthwork: Section 02200

B. Geosynthetic clay liner: Section 02275

1.3 DESCRIPTION OF WORK

Furnish and install a 60-mil high-density polyethylene (HDPE) geomembrane as part of the composite liner in the landfill as shown in the drawings. Sufficient liner material shall be furnished to cover all areas shown on the drawings including overlaps at field seams, anchor trenches, and waste.

1.4 QUALITY ASSURANCE, QUALIFICATIONS, AND WARRANTIES

1.4.1 Manufacturer's Experience: The manufacturer supplying the membrane shall satisfactorily demonstrate previous experience by letter of certification. Certification shall indicate that the manufacturer has produced, and has in service in similar applications for a period of not less than two (2) years, at least fifteen (15) million sq ft of HDPE material meeting these Specifications.

1.4.2 Installer's Experience: The Installer proposing to install the lining shall satisfactorily demonstrate previous experience by letter of certification. Certification shall indicate the Installer's successful past installation of at least 5,000,000 sq ft of HDPE membrane lining.

Installation shall be performed under the direction of a single installation supervisor who shall remain on site and be in responsible charge throughout the liner installation, including subgrade acceptance, liner layout, seaming, testing and repairs, and all other activities contracted for with the Installer. The installation supervisor shall have supervised the installation of at least 2,000,000 sf of polyethylene geomembrane. Actual seaming shall be performed under the direction of a master seamer who may be the same person as the installation supervisor, and who has a minimum of 1,000,000 sf polyethylene geomembrane seaming experience using the same type of seaming apparatus as that specified in this project. The installation supervisor or master seamer must be on site whenever seaming is being performed. No seaming may be done by any individual with less than 500,000 sf of polyethylene geomembrane seaming experience.

1.4.3 Manufacturer's Guarantee: The manufacturer of the membrane liner shall enter into agreement with the Owner guaranteeing the membrane as follows:

The manufacturer warrants the HDPE liner which is manufactured, sold as first quality, and installed with technical assistance and/or by an approved installation contractor to be (1) furnished free of manufacturing defects in workmanship or material for a period of one year from the time of delivery with the basis for judgment of defects being the applicable product specifications in effect at the time the order was placed unless modified by mutual written agreement; (2) shall not develop cracks/holes which go completely through the membrane due to the effects of normal service for a period of twenty (20) years from the date of delivery. "Normal service" does not include physical damage caused by acts of God, casualty, or catastrophe such as (but not limited to) earthquakes, fire, explosion, floods, lightning, piercing hail, tornadoes, corrosive air pollution, mechanical abuse by machinery, equipment, people or animals, or excessive flexures, pressures or stress from any source other than faulty installation, and (3) immune to chemical attack and degradation by chemicals, specified in the manufacturer's literature, as compatible with, and as not having an adverse effect on the membrane; and (4) immune to chemicals tested by the manufacturer for the Owner.

Should defects or weathering degradation within the scope of the above warranty occur, the manufacturer shall refund to the purchaser-user the pro-rata part for the unexpired term of the warranty of the purchaser-user's original cost of such product, or will supply repair or replacement materials at the then-current price. In the event the manufacturer supplies repair or replacement materials, against the then- current price, the manufacturer will credit the lesser of (1) the pro-rata part of the original sales price of the material so repaired or replaced for the unelapsed period of the warranty, or (2) the pro-rata part of the then-current price of the material so repaired or replaced to the unelapsed period of the warranty. The warranty shall continue in effect on the repaired or replaced material for the unelapsed term of the original warranty. To enable the manufacturer's technical staff to properly determine the cause of any alleged defect and to take appropriate steps to effect timely corrective measures if such defect is within the warranty, any claim for alleged breach of warranty will be made and presented in writing to manufacturer and the installing Contractor within thirty (30) days after the alleged defect was first noticed.

1.5 QUALITY CONTROL DOCUMENTATION

1.5.1 Product Data: Prior to the installation of any geomembrane, the manufacturer or Installer shall provide the Owner's Representative with the following information:

1. Copies of the quality control certificates issued by the resin supplier which include resin supplier's name and production plant, brand name and number, and production date of the resin.

2. Reports on tests conducted by the Manufacturer to verify that the quality of the resin used to manufacture the geomembrane meets the specifications.

3. Reports on quality control tests conducted by the Manufacturer to verify that the geomembrane manufactured for the project meets the project specifications.

4. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.

5. Quality control certificates, signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, sampling procedures, and results of quality control tests. At a minimum, results shall be given for:

   a. Density
   b. Carbon black content
   c. Carbon black dispersion
   d. Thickness
   e. Tensile properties
   f. Tear resistance

   These quality control tests shall be performed in accordance with the test methods specified in the specifications, for every 40,000 ft^2 (4,000 m^2) of geomembrane produced.

The Manufacturer shall identify all rolls of geomembranes with the following:

1. Manufacturer's name
2. Product identification
3. Thickness
4. Roll number
5. Roll dimensions

1.5.2 Product Review: The Owner's Representative shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum properties meet the specifications.

PART 2 - PRODUCTS

2.1 HIGH DENSITY POLYETHYLENE (HDPE) MEMBRANE

2.1.1 General: The materials supplied under these Specifications shall be first quality products designed and manufactured specifically for the purposes of this work, and which have been satisfactorily demonstrated by prior use to be suitable and durable for such purposes.

2.1.2 Description of HDPE Material: **The membrane shall be a high density polyethylene (HDPE) of 60-mils thickness textured, containing no reground additives, fillers or extenders.**. Carbon black 2 to 3 percent shall be added to the resin for ultraviolet resistance.

The lining material shall be manufactured a minimum of 20 feet seamless widths.

2.1.3 Physical Characteristics: The HDPE materials shall have the following physical characteristics:

Test	Test Designation	60-mil Requirement
Sheet thickness, textured (with smooth edges)	ASTM D 5994-96 para. 8.1.3	60-mils plus or minus 10 percent
Asperity height	GM 12	7-mil
Specific gravity	ASTM D 792-91 Method A	min. 0.940
Melt index	ASTM D 1238-95 Condition E	0.1 to 0.3g per 10 minutes
Tensile strength yield	ASTM D 638-96	min. 126 lb per in. width
Tensile strength at break	ASTM D 638-96	min. 90 lb per in. width
Elongation at yield	ASTM D 638-96	min. 12 percent
Elongation at break	ASTM D 638-96	min. 100 percent
Modulus of elasticity	ASTM D 638-96	min. 80,000 lb per sq in
Tear resistance	ASTM D 1004-94A	min. 42 lb per min.
Puncture resistance	ASTM D 4833	min. 90 lb
Resistance to soil burial	ASTM D 3083-76	10 percent max. change
Dimensional stability (each direction)	ASTM D 1204-94 212°F, 15 min.	3 percent max. change
Environmental stress crack	ASTM D 5397	200 hrs
Low temperature brittleness	ASTM D 746-95 Procedure B	minus 76°F
Carbon black content	ASTM D 1603-95	2 to 3 percent
Carbon black dispersion	ASTM D 5596	Categories 1, 2, or 3
Shear Strength Shear Peel	ASTM D 4437[1]	 .90*PM .65*PM Fusion .55*PM Extrusion

Note

PM is Parent Material yield strength as found from the average of the Roll Certificate values minus two (2) standard deviations.

The geomembrane shall be produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter, and shall not have striations, pinholes or bubbles on the surface.

2.1.4 Factory Bonded Seam: Calendered HDPE sheeting may not be fabricated into large sections at the factory.

2.1.5 Extrusion Joining Resin: Resin for extrusion joining sheets shall be HDPE produced from the same material as the sheet resin. Physical properties shall be the same as those of the resin used in the manufacture of the HDPE liner. The resin shall be supplied in black and/or natural color. Natural resin shall be colored black through addition of 2.0 to 3.0 percent master batch colorant before use.

2.1.6 Documentation: Prior to delivery of the geomembrane to the job site, the Installer shall provide the Owner with a written certification that the product delivered was extruded from the

specified resin. The manufacturer shall provide quality control certificates for each batch of resin and each shift's production of geomembrane, and shall follow the quality control testing program as described in Section 4.1. These quality control certificates shall be signed by responsible parties employed by the Manufacturer, and shall be supplied to the Owner. No geomembrane will be permitted to be delivered until the Owner has in his possession such certification.

2.1.7 Roll Identification: Each roll shall have permanently affixed both inside and outside the roll the following information: name of manufacturer; date of manufacture; resin batch code; thickness of the material; roll number; roll length; and roll width.

2.2 MISCELLANEOUS MATERIALS

2.2.1 Pipe Boots, Vents, and Patches: All such devices shall be of the same material as the lining or a compatible approved equal.

2.2.2 Mechanical Fastenings: Mechanical fastenings shall be of the material, size, and type as detailed on the plans or approved shop drawings.

PART 3 - QUALITY ASSURANCE

3.1 CONFORMANCE TESTING

Upon delivery of the rolls of geomembrane, the Owner's Representative shall assure that conformance test samples are obtained for the geomembrane. These samples shall then be forwarded to the independent laboratory for testing to assure conformance to the specifications.

At a minimum the following conformance tests shall be conducted:

1. Density
2. Carbon black content
3. Carbon black dispersion
4. Thickness
5. Tensile characteristics

These conformance tests shall be performed in accordance with the test methods specified in section 2.1.3.

3.1.1 Sampling Procedures: The rolls to be sampled shall be selected by the Owner's Representative. Samples shall be taken across the entire width of the roll and shall not include the first 3 feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The Owner's Representative shall mark the machine direction on the samples with an arrow.

Unless otherwise specified, samples shall be taken at a rate of one per 100,000 ft^2 of geomembrane.

3.1.2 Test Results. All conformance test results shall be reviewed and accepted or rejected by the Owner's Representative prior to the deployment of the geomembrane.

The Owner's Representative shall examine all results from laboratory conformance testing and shall report any nonconformance to the Project Manager. The Owner's Representative shall be responsible for checking that all test results meet or exceed the property values listed in Section 2.1.3.

PART 4 - EXECUTION

4.1 SUBGRADE PREPARATION

4.1.1 Surface Preparation: The earthwork contractor shall be responsible for preparing the supporting soil for geomembrane placement. The Project Manager shall coordinate the work of the earthwork contractor and the Installer so that the requirements of the specification are met.

Before the geomembrane installation begins, the Owner's Representative shall verify that:

1. A qualified land survey has verified all lines and grades.
2. A qualified geotechnical engineer has verified that the supporting soil meets the density specified in the project specifications.
3. The surface to be lined has been rolled, compacted, or handworked so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade.
4. The surface of the supporting soil does not contain stones which may be damaging to the geomembrane.
5. There is no area excessively softened by high water content.
6. There is no area where the surface of the soil contains desiccation cracks with dimensions exceeding those allowed by the project specifications.

The Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. A certificate of acceptance shall be given by the Installer to the Owner's Representative prior to commencement of geomembrane deployment in the area under consideration. The Project Manager shall be given a copy of this certificate by the Owner's Representative.

After the supporting soil has been accepted by the Installer, it is the Installer's responsibility to indicate to the Owner's Representative any change in the supporting soil condition that may require repair work.

4.1.2 Anchor: The Owner's Representative shall verify that the geomembrane anchor has been constructed according to the design drawings and specifications.

4.2 GEOMEMBRANE DEPLOYMENT

4.2.1 Panel Nomenclature: A field panel is defined as a unit of geomembrane which is to be seamed in the field, i.e. a field panel is a roll or a portion of roll cut in the field.

It shall be the responsibility of the Owner's Representative to assure that each field panel is given an identification code (number or letter-number) consistent with the layout plan.

4.2.2 Panel Deployment Procedure: The Owner's Representative shall review the panel deployment progress of the Installer (keeping in mind issues relating to wind, rain, clay liner desiccation, and other site-specific conditions).

The Owner's Representative shall record the identification code, location, and date of installation of each field panel.

4.2.3 Deployment Weather Conditions: Geomembrane deployment shall not proceed at an ambient temperature below 32°F or above 104°F unless otherwise authorized, in writing, by the Owner's Representative. Geomembrane placement shall not be performed 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. Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment.

4.2.4 Method of Deployment: Before the geomembrane is handled on site, the Owner's Representative shall verify that handling equipment to be used on the site is adequate and does not pose risk of damage to the geomembrane. During handling, the Owner's Representative shall observe and verify that the Installer's personnel handle the geomembrane with care.

The Owner's Representative shall verify the following:

1. Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means.

2. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement.

3. Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris.

4. All personnel do not smoke or wear damaging shoes while working on the geomembrane, or engage in other activities which could damage the geomembrane.

5. The method used to unroll the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting soil.

6. The method used to place the panels minimized wrinkles (especially differential wrinkles between adjacent panels).

7. Adequate temporary loading and/or anchoring (e.g. sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind. In case of high winds, continuous loading, e.g. by sand bags, is recommended along edges of panels to minimize risk of wind flow under the panels.

8. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

4.2.5 Damage and Defects: Upon delivery to the site, the Owner's Representative shall conduct a surface observation of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected.

4.3 FIELD SEAMING

4.3.1 Seam Layout: Before installation begins, the Installer must provide the Owner's Representative with a panel layout drawing, i.e. a drawing of the facility to be lined showing all expected seams. The Owner's Representative shall review the panel layout drawing and verify that it is consistent with accepted state-of-practice.

In general, seams should be oriented parallel to the line of maximum slope, i.e. oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 feet (1.5 m) from the toe of the slope, or areas of potential stress concentrations, unless otherwise authorized by the Owner's Representative.

4.3.2 Accepted Seaming Methods: Approved processes for field seaming are extrusion welding and fusion welding. Proposed alternate processes shall be documented and submitted by the Installer to the Owner's Representative for approval. Only apparatus which have been specifically approved by make and model shall be used.

4.3.2.1 Extrusion Process:

The Owner's Representative shall verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus decided upon at the pre-construction meeting.

2. Equipment used for seaming is not likely to damage the geomembrane.

3. Prior to beginning a seam, the extruder is purged until all heat-degraded extrudate has been removed from the barrel.

4. Clean and dry welding rods or extrudate pellets are used.

5. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.

6. Grinding shall be completed no more than 1 hour prior to seaming.

7. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.

8. The geomembrane is protected from damage in heavily trafficked areas.

9. Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instance shall exposed grinding marks extend more than 1/4 inch from the seamed area.

10. In general, the geomembrane panels are aligned to have a nominal overlap of 3 inch for extrusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.

11. No solvent or adhesive is used unless the product is approved in writing by the Owner's Representative prior to use.

12. The procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any temporary welding apparatus is controlled such that the geomembrane is not damaged or degraded.

4.3.2.2 Fusion Process:

The Owner's Representative shall also verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus decided upon at the pre-construction meeting.

2. Equipment used for seaming is not likely to damage the geomembrane.

3. For cross seams, the edge of the cross seam is ground to an incline prior to welding.

4. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.

5. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.

6. The geomembrane is protected from damage in heavily trafficked areas.

7. A movable protective layer is used as required by the Installer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets and prevent debris from collecting around the pressure rollers.

8. In general, the geomembrane panels are aligned to have a nominal overlap of 5 inches for fusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.

9. No solvent or adhesive is used unless the product is approved in writing by the Owner's Representative.

4.3.3 Seam Preparation: The Owner's Representative shall verify that prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris or foreign material of any kind. If seam overlap grinding is required, the Owner's Representative must assure that the process is completed according to the Manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane. The Owner's Representative shall also verify that seams are aligned with the fewest possible number of wrinkles and "fishmouths".

4.3.4 Trial Seams: Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once each five hours, for each production seaming apparatus used that day. Each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be at least 5 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in Section 4.3.2.

Five specimens shall be cut from the sample with a 1 inch wide die. The specimens shall be cut by the Installer at locations selected randomly along the trial seam sample by the Owner's Representative. The specimens shall be tested in peel using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of two (2) inches per minute and be calibrated to provide accurate results. They should not fail in the seam. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, 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 welds are achieved. The Owner's Representative shall observe all trial seam procedures.

4.3.6 Seaming Weather Conditions:

4.3.6.1 Normal Weather Conditions: The normal required weather conditions for seaming are as follows:

1. Ambient temperature between 32°F and 104°F.

2. Dry conditions, i.e. no precipitation or other excessive moisture, such as fog or dew.

3. No excessive winds.

4.3.6.2 Cold Weather Conditions: To assure a quality installation, if seaming is conducted when the ambient temperature is below 32°F, the following conditions must be met:

1. Geomembrane surface temperatures shall be determined by the Owner's Representative. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32°F.

2. Preheating may be waived by the Owner's Representative based on if the Installer demonstrates that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

3. If preheating is required, the Owner's Representative shall inspect all areas of geomembrane that have been preheated by a hot air device prior to seaming, to assure that they have not been overheated.

4. Care shall be taken to confirm that the surface temperatures are not lowered below the minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for the seam area.

5. All preheating devices shall be approved prior to use by the Owner's Representative.

6. Additional destructive tests (as described in Section 4.5) shall be taken at the discretion of the Owner's Representative.

7. Sheet grinding may be performed before preheating, if applicable.

8. Trial seaming, as described in Section 4.3.4, shall be conducted under the same ambient temperature and preheating conditions as the actual seams. Under cold weather conditions, new trial seams shall be conducted if the ambient temperature drops by more than 10°F from the initial trial seam test conditions.

4.3.6.3 Warm Weather Conditions: At ambient temperatures above 104°F, no seaming of the geomembrane shall be permitted unless the Installer can demonstrate to the satisfaction of the Owner's Representative that geomembrane seam quality is not compromised.

Trial seaming, as described in Section 4.3.4, shall be conducted under the same ambient temperature conditions as the actual seams.

At the option of the Owner's Representative, additional destructive tests (as described in Section 4.5) may be required for any suspect areas.

4.4 NONDESTRUCTIVE SEAM TESTING

4.4.1 Concept: The Installer shall nondestructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), or other approved method. Vacuum testing and air pressure testing are described in Sections 4.4.2 and 4.4.3, respectively. Liner penetrations shall be tested with a vacuum box or electric spark test as described in Section 4.4.4. The purpose of nondestructive tests is to check the continuity of seams. It does not provide quantitative information on seam strength. Nondestructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

For all seams, the Owner's Representative shall:

1. Observe nondestructive testing procedures.

2. Record location, data, test unit number, name of tester, and outcome of all testing.

3. Inform the Installer of any required repairs.

4.4.2 Vacuum Testing. The following procedures are applicable to vacuum testing.

1. The equipment shall consist of the following:
   a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.
   b. A pump assembly equipped with a pressure controller and pipe connections.
   c. A rubber pressure/vacuum hose with fittings and connections.
   d. A soapy solution.
   e. A bucket and wide paint brush, or other means of applying the soapy solution.

2. The following procedures shall be followed:

   a. Energize the vacuum pump and reduce the tank pressure to approximately 5 psi gauge.
   b. Wet a strip of geomembrane approximately 12 inches by 48 inches with the soapy solution.
   c. Place the box over the wetted area.
   d. Close the bleed valve and open the vacuum valve.
   e. Assure that a leak-tight seal is created.
   f. For a period of not less than 10 seconds, apply vacuum and examine the geomembrane through the viewing window for the presence of soap bubbles.
   g. If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches overlap, and repeat the process.
   h. All areas where soap bubbles appear shall be marked and repaired in accordance with Section 4.6.

4.4.3 Air Pressure Testing: The following procedures are applicable to double fusion welding which produces a double seam with an enclosed space.

1. The equipment shall consist of the following:

   a. An air pump (manual or motor driven), equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane.
   b. A rubber hose with fittings and connections.
   c. A sharp hollow needle, or other approved pressure feed device.

2. The following procedures shall be followed:

   a. Seal both ends of the seam to be tested.
   b. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.
   c. Insert a protective cushion between the air pump and the geomembrane.
   d. Energize the air pump to a pressure between 25 and 30 psi, close valve, allow 2 minutes for pressure to stabilize, and sustain pressure for at least 5 minutes.
   e. If loss of pressure exceeds 4 psi or does not stabilize, locate faulty area and repair in accordance with Section 4.6.
   f. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area. Seal the cut end of the air channel.
   g. Remove needle or other approved pressure feed device and seal.

4.4.4 Membrane Penetrations: Accessible pipe boot seems for all membrane penetrations shall be vacuum tested as described above. Areas not accessible to vacuum testing shall be non destructively tested using an electric spark test. The electric spark test shall employ a continuous length of 24 gauge copper wire, placed under the geomembrane seam within 1/4-inch of the edge. A portable pulse-type detector, equipped with a brush-type electrode, charged with a low amperage current of 20,000 to 30,000 volts, will be advanced along the seam at approximately 20 to 30 feet per minute. Seam defects are detected when a spark arks from the sire to the electrode,

closing the circuit and sounding an audible alarm. All seam defects shall be repaired and retested as described herein. Alternative testing methods shall be submitted to the Geosynthetic CQA and the MDEP for approval prior to commencement of testing.

4.4.5 Test Failure Procedures: The Installer shall complete any required repairs in accordance with Section 4.6. For repairs, the Owner's Representative shall:

1. Observe the repair and testing of the repair.

2. Mark on the geomembrane that the repair has been made.

3. Document the repair procedures and test results.

4.5 DESTRUCTIVE SEAM TESTING

4.5.1 Concept: Destructive seam tests shall be performed to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

4.5.2 Sampling Procedures: Samples shall be located by the Owner's Representative on average every 500 linear feet of seaming. The samples shall be cut by the Installer in a timely fashion, field tested and shipped to the independent laboratory so that test results are available as the work is performed.

All holes in the geomembrane resulting from destructive seam sampling shall be repaired in accordance with repair procedures described in Section 4.6. The continuity of the new seams in the repaired area shall be tested according to Section 4.4.

4.5.3 Sample Dimensions: At each sampling location the installer will cut a portion of the seam, 12" wide by 48" long, centered on the seam. The sample will cut into four sections, one for the independent laboratory, one for the Owner archive, one for the installer, and one for the field testing. The field testing portion of the sample will be cut into 5 coupons and tested in peel, according to Section 2.1.3.

4.5.4 Field Testing: The tensiometer shall be capable of maintaining a constant jaw separation rate of two (2) inches per minute. If the test fails the specification, the failed seam should be bound by two passing tests and the area between the two test repaired in accordance with Section 4.6. Final judgment regarding seam acceptability, based on the failure criteria, rests with the Owner's Representative.

The Owner's Representative shall witness all field tests and mark all samples and portions with their number. The Owner's Representative shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description, and attach a copy to each sample portion.

4.5.5 Laboratory Testing: Samples will be tested according to section 2.1.3. Specimens shall be selected alternately by test from the samples (i.e. peel, shear, peel, shear...). The independent laboratory shall provide verbal test results no more than 24 hours after they receive the samples. The Owner's Representative shall review laboratory test results as soon as they become available.

4.5.6 Destructive Test Failure Procedures: The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the independent laboratory, or by field tensiometer. The Installer has two options:

1. The Installer can repair the seam between two passing test locations.

2. The Installer can trace the welding path to an intermediate location (at 10 feet minimum from the point of the failed test in each direction) and take a sample with a 1 inch wide die for an additional field test at each location (independent laboratory testing only). In the event of a field test failure, the installer shall perform an additional trial weld to verify the settings of the welding machine.

The Owner's Representative shall document all actions taken in conjunction with destructive test failures.

4.6 DEFECTS AND REPAIRS

4.6.1 Identification: All seams and non-seam areas of the geomembrane shall be examined by the Owner's Representative for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be cleaned by the Installer if the amount of dust or mud inhibits examination.

4.6.2 Evaluation. Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in Section 4.5 as appropriate. Each location which fails the nondestructive testing shall be marked by the Owner's Representative and repaired by the Installer. Work shall not proceed with any materials which will cover locations which have been repaired until appropriate nondestructive and laboratory test results with passing values are available.

4.6.3 Repair Procedures: Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas.

1. The repair procedures available include:

   a. Patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
   b. Spot welding or seaming, used to repair small tears, pinholes, or other minor, localized flaws.
   c. Capping, used to repair large lengths of failed seams.
   d. Extrusion welding the flap, used to repair areas of inadequate fusion seams, which have an exposed edge. Repairs of this type shall be approved by the Owner's Representative and shall not exceed 50 feet in length.
   e. Removing bad seam and replacing with a strip of new material welded into place.

2. For any repair method, the following provisions shall be satisfied:

a. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be abraded no more than one hour prior to the repair.
b. All surfaces shall be clean and dry at the time of the repair.
c. All seaming equipment used in repairing procedures shall meet the requirements of the project manual.
d. Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of approximately 3 inches.

4.6.4 Repair Verification: Each repair shall be numbered and logged. Each repair shall be nondestructively tested using the methods described in Section 4.5 as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150 feet long may be of sufficient extent to require destructive test sampling, at the discretion of the Owner's Representative. Failed tests indicate that the repair shall be redone and retested until a passing test results. The Owner's Representative shall observe all nondestructive testing of repairs and shall record the number of each repair, date, and test outcome.

4.6.5 Large Wrinkles: When seaming of the geomembrane is completed, and prior to placing overlying materials, the Owner's Representative shall indicate to the Project Manager which wrinkles should be cut and reseamed by the Installer. The number of wrinkles to be repaired should be kept to an absolute minimum. Therefore, wrinkles should be located during the coldest part of the installation process, while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over onto itself. This is generally the case for a wrinkle that extends 12 inches from the subgrade. Seams produced while repairing wrinkles shall be tested as outlined above.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather available. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed by the Owner's Representative to assure that wrinkle formation is minimized.

4.7 GEOMEMBRANE PROTECTION

The quality assurance procedures indicated in this Section are intended only to assure that the installation of adjacent materials does not damage the geomembrane.

4.7.1 Soils:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32°F (0°C) nor above 104°F (40°C) unless otherwise specified.

2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.

3. Equipment used for placing soil shall not be driven directly on the geomembrane.

4. A minimum thickness of 1 foot of soil is specified between a light dozer (ground pressure of 5 psi or lighter) and the geomembrane.

5. In any areas traversed by any vehicles other than low ground pressure vehicles shall have a minimum thickness of 3 feet. This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns.

4.8 COMPLETION OF WORK

A. Requirements: The installation of the geomembrane shall be considered totally complete when: all required deployment, seaming, repairs, testing, and site clean-up have been completed by the Installer; the Installer has submitted all the required quality control certificates to the Owner; and the Owner and/or his Representative is satisfied that the geomembrane has been installed in accordance with the above Specifications.

END OF SECTION