#45799

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

CONSTRUCTION QUALITY ASSURANCE PLAN FOR THE DOUBLE LINER SYSTEM FOR CONSTRUCTION OF WASTE DISPOSAL UNIT A2 OF THE CLASS I LANDFILL AT THE RESOURCE RECOVERY FACILITY PASCO COUNTY, FLORIDA

Pasco RRF

Prepared for:

Pasco County, Florida

Prepared by:

Law Engineering, Inc.
Tampa, Florida

November 28, 1994
Law Engineering Project 464-83565.01

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

1.0 INTRODUCTION

This Construction Quality Assurance (CQA) Plan addresses quality procedures to be followed during construction of critical components of Waste Disposal Unit A2 of the Class I Landfill at the Pasco County Resource Recovery Facility. The plan addresses the construction of soil layers comprising the landfill bottom and sides, the placement of synthetic geomembranes, the construction of the leachate collection and removal system, and other miscellaneous site work required to complete Waste Disposal Unit A2 of the landfill.

Other documents related to the CQA Plan are:

- Construction Drawings for Waste Disposal Unit A2 Construction of the Class I Landfill at the Resource Recovery Facility
- Specifications for Waste Disposal Unit A2 Construction of the Class I Landfill at the Resource Recovery Facility (see Appendix A).

The content of this Plan is designed to conform generally to guidance provided in EPA Publication Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/82. The titles for the various quality assurance team members have been modified somewhat from the EPA document referenced above. The reason for the modification is for consistency with definition in Standard General Conditions of the Construction Contract prepared by ENGINEER's Joint Contract Documents Committee which will be used as general conditions for the construction contract.

2.0 PROJECT TEAM AND RESPONSIBILITIES

Construction of the project will be accomplished by a project team involving several parties associated with landfill ownership, project design and construction, geomembrane manufacture and installation, and quality assurance. The roles of team members having responsibilities directly related to quality assurance are discussed below.

2.1 OWNER

The landfill is a public works facility, owned and operated by Pasco County. The OWNER is responsible for the design, construction, and operation of the facility. This responsibility includes complying with the requirements of the permitting agency, the submission of quality assurance documentation, and assuring that the facility was constructed as specified in the Construction Plans and Specifications as approved by the permitting agency. The OWNER has the authority to select and dismiss organizations charged with the design, construction and quality assurance.

2.2 PERMITTING AGENCIES

The construction of this landfill was originally permitted within the preview of the Power Plant Siting Act. The permitting agencies for expansion of the landfill to include Disposal Unit A-2 are Florida Department of Environmental Regulation (FDEP) and Southwest Florida Water Management District (SWFWMD).

2.3 ENGINEER

Law Engineering and Environmental Services, Inc., referred to herein as the ENGINEER, will be responsible for overall monitoring of activities to achieve quality assurance objectives. The ENGINEER is a registered Professional Engineer in Florida. Duties of the ENGINEER will include construction observation, which includes review of materials testing required by the Construction Specifications, monitoring test results, and informing the OWNER and CONTRACTOR of unacceptable work.

The ENGINEER will be responsible for certifying to the FDEP that the project was constructed by the CONTRACTOR in substantial accordance with the Plans and Specifications. The basis for certification will be the results of quality assurance activities and tests conducted in accordance with requirements in each section of the specifications and survey information provided by the CONTRACTOR. Documents submitted for construction approval will be prepared, signed and sealed by a design engineer who will be a registered Professional Engineer in Florida.

The ENGINEER will be responsible for implementing the approved quality assurance plan at the construction site, and as such will act as the quality assurance manager. The ENGINEER will be at the construction site during all major construction operations to oversee the quality assurance personnel.

Duties of the ENGINEER will include:

- Observation and monitoring field activities for conformance with authorized policies, procedures, and sound practices.
- Informing the Project ENGINEER of non-conformance with the approved CQA Plan.
- Record keeping.
- Assigning and directing field technicians.
- Monitoring sampling activities for compliance with approved procedures.
- Preparation of quality assurance memorandums and quality assurance reports.
- Maintenance of this quality assurance plan.

2.4 RESIDENT PROJECT REPRESENTATIVE

The resident project representative, who may be an engineering technician or ENGINEER, will be responsible for field testing and inspection and for preparing daily written reports of field observations and test results. They will be assigned to the project by the ENGINEER will report to the ENGINEER. The ENGINEER may delegate duties and responsibilities described in Section 4.0 of this document as a duty or responsibility of the ENGINEER to the resident project

representative. Resident Project Representative's dealings in matters pertaining to the on-site Work shall in general be only with ENGINEER and CONTRACTOR, and dealings with Subcontractors shall only be through or with the full knowledge of CONTRACTOR. Written communication with OWNER will be only through or as directed by ENGINEER. Copies of their written reports and field notes will be submitted to the ENGINEER for his use in preparing formal documentation of construction. The duties, responsibilities and limitations of authority of the resident project representative are described below:

A. DUTIES AND RESPONSIBILITIES

Resident Project Representative will:

1. Schedules: Review the progress schedule, schedule of Shop Drawing submissions and schedule of values prepared by CONTRACTOR and consult with ENGINEER concerning their acceptability.

2. Conference: Attend preconstruction conferences. Arrange a schedule of progress meetings and other job conference as required in consultation with ENGINEER and notify those expected to attend in advance. Attend meetings, and maintain and circulate copies of minutes thereof.

3. Liaison:
   a. Serve as ENGINEER's liaison with CONTRACTOR, working principally through CONTRACTOR's superintendent and assist him in understanding the intent of the Contract Documents. Assist ENGINEER in serving as OWNER's liaison with CONTRACTOR when CONTRACTOR's operations affect OWNER's on-site operations.

   b. As requested by ENGINEER, assist in obtaining from OWNER additional details or information, when required at the job site for proper execution of the Work.

4. Shop Drawings and Samples:
   a. Receive and record date of receipt of Shop Drawings and samples, receive samples which are furnished at the site by CONTRACTOR, and notify ENGINEER of their availability for examination.

   b. Advise ENGINEER and CONTRACTOR or his superintendent immediately of the commencement of any Work requiring a Shop Drawing or sample submission if the submission has not been approved by the ENGINEER.

5. Review of Work, Rejection of Defective Work, Inspections and Tests:
   a. Conduct on-site observations of the Work in progress to assist ENGINEER in determining if the Work is proceeding in accordance with the Contract Documents and that completed Work will conform to the Contract Documents.

   b. Report to ENGINEER whenever he believes that any Work is unsatisfactory, faulty or defective or does not conform to the Contract Documents, or does not meet the requirements of any inspections, tests or approval required to be made or has been damaged prior to final payment; and advise ENGINEER when he believes Work should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection or approval.

   c. Verify that tests, equipment and systems startups and operating and maintenance instructions are conducted as required by the Contract Documents and in presence of the required personnel, and that CONTRACTOR maintains adequate records thereof; observe, record and report to ENGINEER appropriate details relative to the test procedures and startups.

   d. Accompany visiting inspectors representing public or other agencies having jurisdiction over the Project, record the outcome of these inspections and report to ENGINEER.

6. Interpretation of Contract Documents: transmit to CONTRACTOR, ENGINEER's clarifications and interpretations of the Contract Documents.

7. Modifications: Consider and evaluate CONTRACTOR's suggestions for modifications in Drawings or Specifications and report them with recommendations to ENGINEER.

8. Records:
   a. Maintain at the job site orderly files for correspondence, reports of job conferences, Shop Drawings and samples submissions, reproductions of original Contract Documents including all Addenda, change orders, field orders, additional Drawings issued subsequent to the execution of the Contract, ENGINEER's clarifications and interpretations of the Contract Documents, progress reports, and other Project related documents.

9. Reports:
   a. Furnish ENGINEER periodic reports as required of progress of the Work and CONTRACTOR's compliance with the approved progress schedule and schedule of Shop Drawing submissions.

   b. Consult with ENGINEER in advance of scheduled major tests, inspections or start of important phases of the Work.

   c. Report immediately to ENGINEER upon the occurrence of any accident.

10. Payment Requisitions: Review applications for payment with CONTRACTOR for compliance with the established procedure for their submission and forward them with recommendations to ENGINEER, noting particularly their relation to the schedule of values, Work completed and materials and equipment delivered at the site but not incorporated in the Work.

11. Certificates, Maintenance and Operation Manuals: During the course of the Work, verify that certificates, maintenance and operation manuals and other data required to be assembled and furnished by CONTRACTOR are applicable to the items actually installed; and deliver this material to ENGINEER for his review and forwarding to OWNER prior to final acceptance of the Work.

12. Completion:
    a. Before ENGINEER issues a Certificate of Substantial Completion, submit to CONTRACTOR a list of observed items requiring completion or correction.

    b. Conduct final inspection in the company of ENGINEER, OWNER and CONTRACTOR and prepare a final list of items to be completed or corrected.

    c. Verify that all items on final list have been completed or corrected and make recommendations to ENGINEER concerning acceptance.

B. LIMITATIONS OF AUTHORITY

Except upon written instructions of ENGINEER, Resident Project Representative:

1. Shall not authorize any deviation from the Contract Documents or approve any substitute materials or equipment.

2. Shall not exceed limitations on ENGINEER's authority as set forth in the Contract Documents.

3. Shall not undertake any of the responsibilities of CONTRACTOR, Subcontractors or CONTRACTOR's superintendent, or expedite the Work.

4. Shall not advise on or issue directions relative to any aspect of the means, methods, techniques, sequences or procedures of construction unless such is specifically called for in the Contract Documents.

5. Shall not advise on or issue directions as to safety precautions and programs in connection with the Work.

6. Shall not authorize OWNER to occupy the Project in whole or in part.

7. Shall not participate in specialized field or laboratory tests.

2.5 CONTRACTOR

The CONTRACTOR will be hired by the OWNER to construct the landfill facility. It will be the responsibility of the CONTRACTOR to construct waste containment facility in accordance with the approved contract documents. The CONTRACTOR will purchase materials that meet specifications, enter into contracts with fabricators to supply construction materials and has overall control over the construction operations, including scheduling and quality control. The presence on-site of the ENGINEER and Resident Project Representative will not relieve the CONTRACTOR of these responsibilities.

2.6 EARTHWORK CONTRACTOR

The earthwork CONTRACTOR will be responsible for excavating and filling soil material as needed, preparing the subgrade, and constructing the low-permeability soil layer and earth berms. The earthwork CONTRACTOR is required to see that acceptable fill material is being used, that the moisture content of the material falls within the proper range, and that density objectives for the placed material are met for the duration of the earthwork activities. The earthwork CONTRACTOR is also responsible for informing the OWNER and the ENGINEER of the scheduling and occurrence of all earthwork construction activities.

2.7 GEOMEMBRANE MANUFACTURER

The geomembrane manufacturer will furnish the geosynthetic materials discussed in this document. The geomembrane manufacturer is responsible for providing quality control during production of the membranes and is to be represented on-site during membrane installation. The manufacturer is responsible for certifying that its materials conform to the Specifications in the permit application and any more stringent requirements specified in the contract documents.

2.8 GEOMEMBRANE INSTALLER

The geomembrane installer will be the subcontractor hired by the CONTRACTOR to install the geomembranes discussed in this document. The installer will be prequalified to install geomembranes and must be approved by the geomembrane manufacturer.

The geomembrane installer will be responsible for the handling, storage, placement, and installation of the geomembrane. The geomembrane installer is also responsible for informing the OWNER and the ENGINEER of the scheduling and occurrence of all geosynthetic construction activities.

2.9 TESTING LABORATORY

The testing laboratory will have its own internal quality control plan to ensure that laboratory procedures conform to the appropriate American Society for Testing and Materials (ASTM) standards and other applicable testing standards. The testing laboratory is responsible for ensuring that tests are performed in accordance with applicable methods and standards, for following internal QC procedures, for maintaining sample chain-of-custody records, and for operating data. The testing laboratory shall allow the OWNER, permitting agency, design engineer, installer, or ENGINEER to observe sample preparation and testing procedures, or record keeping procedures, if they so desire. The OWNER, permitting agency, or ENGINEER shall be allowed to observe some or all tests on a particular job at any time, either announced or unannounced. The testing laboratory shall accommodate such observations, but the observer will not interfere with the testing or slow the testing process.

3.0 CONSTRUCTION QUALITY ASSURANCE PERSONNEL QUALIFICATIONS

3.1 RESPONSIBILITY AND AUTHORITY

OWNER: Pasco County Board of County Commissioners, Utility Services Branch - Douglas Bramlett - Assistant County Administrator

ENGINEER: Law Engineering and Environmental Services, Inc.
Richard E. Mayer - Principal Engineer
George W. Ellsworth - Geologist
Curtis Roos - Quality Assurance Committee

A full-time quality assurance staff member will be present all the time that critical work is being performed.

- final grading of subbase
- geomembrane/geonet installation
- leachate collection piping
- placement of drainage sand
- sump; risers and pump installation

3.2 QUALIFICATIONS OF KEY STAFF

Qualifications of the key construction quality assurance staff are described in the appendable specifications. The ENGINEER will review resumes of the CONTRACTORS' staff in accordance with requirements in each specification.

4.0 CONSTRUCTION CONTROL MEASURES

4.1 SITE PREPARATION/TEMPORARY EROSION AND SEDIMENT CONTROL

The CONTRACTOR is to prepare the site for subsequent construction activities in accordance with Section 02110 of the Specifications. From the time the site is cleared and grubbed, erosion and sediment control for disturbed areas is critical. Contract is to observe the requirements in Section 02010, temporary erosion and sediment control. The ENGINEER will make observations for conformance with this specification and inform the CONTRACTOR of corrections, if needed.

4.2 EARTHWORK AND GRADING

Excavation for the landfill cells is to be conducted in accordance with Section 02200 of the Specifications. The ENGINEER will observe stripped and graded surfaces to identify areas that require additional excavation. Excavation of unsuitable material will be accomplished to the depths and limits designated by the ENGINEER.

4.3 SPECIAL FILL

The CONTRACTOR shall submit to the ENGINEER for approval the results of grain size distribution tests for each different source of drainage materials (special fill) proposed for use in the leachate collection system. Care shall be taken by the CONTRACTOR not to damage or disturb the liner system or previously placed portions of the leachate collection and removal system during placement of the drainage aggregate. An ENGINEER will observe and document activities involving placement of the special fill to assess conformance with Section 02220 of the Specifications.

Placement and testing of the drainage/soil protective layer over the geomembrane will be monitored and documented by the ENGINEER.

4.4 LINER SUBBASE

The CONTRACTOR is to provide the low-permeability soil layer for the liner subbase in accordance with Section 02215 of the Specifications. Field observations and quality assurance testing of the low-permeability soil layer will be performed in accordance with the provisions of Section 02215 of the Specifications by an ENGINEER. Placement and testing of the low permeability soil layer will be monitored and documented by the ENGINEER.

4.5 NON-WOVEN NEEDLE PUNCHED GEOTEXTILE

The CONTRACTOR is to provide non-woven needle punched geotextile in accordance with Section 02278 of the Specifications. The ENGINEER will make observations for substantial compliance with this specification and inform the CONTRACTOR of corrections, if needed.

Geotextile is to be placed around coarse drainage aggregate where and as shown on the Drawings and in strict accordance with the manufacturer's instructions. An ENGINEER will observe and document activities involving placement of the geotextile materials.

4.6 GEONET

The CONTRACTOR is to provide geonet in accordance with Section 02279 of the Specifications. The ENGINEER will make observations for substantial compliance with this specification and inform the CONTRACTOR of corrections, if needed.

4.7 GEOMEMBRANE

The CONTRACTOR is to provide geomembrane in accordance with Section 02280 of the Specifications. An ENGINEER will observe the geomembrane installations, observe the field quality control tests of membrane seams specified in Section 02280 of the Specifications, and prepare written records of the results of inspections and field tests. The ENGINEER will monitor and document placement of the membranes and the production and testing of the membrane seams, and inform the CONTRACTOR of corrections, if needed.

4.8 GEOSYNTHETIC/CLAY LINER

CONTRACTOR shall furnish and install geosynthetic/clay liner material in sump areas, as shown in the drawings. The ENGINEER shall observe and document placement of these materials and inform the CONTRACTOR of any non-conforming actions. Refer to Section 02277 for specifications for this application.

4.9 SODDING AND SEEDING

The intent is to cover all areas disturbed by construction with grass established by sodding or seeding, in accordance with Section 02485 of the specifications.

4.10 POLYETHYLENE LEACHATE PIPE

The CONTRACTOR is to provide polyethylene leachate pipe in accordance with Section 02715 of the Specifications.

The ENGINEER will review the manufacturer's technical data for compliance with the specifications. The manufacturer's technical data is to be provided to the ENGINEER for his review and approval prior to beginning installation of the leachate collection and removal system.

The ENGINEER will inspect prefabricated system components before they are installed to check that they are smooth and free of sharp points or edges which could potentially damage the geomembrane. A written record will be made by the ENGINEER of this inspection and provided to the OWNER.

Prior to installing system components, the ENGINEER will check that the geomembrane is protected. The ENGINEER will make observations of the installation for substantial compliance with the specification and inform the CONTRACTOR of corrections, if needed.

4.11 CONCRETE

Concrete is to be placed in strict accordance with Section 03300 of the Specifications. Concrete forms and placement of concrete will be inspected by an engineering technician working under the direction of the ENGINEER. Quality assurance tests will be performed as specified in Section 03300 of the Specifications. The results of inspections and tests will be documented by the ENGINEER.

4.12 LEACHATE PUMPS AND ACCESSORIES

The CONTRACTOR is to provide pumps and other appurtenances that are described in the specifications and the drawings of Section 15420.

Before installing the pumps and associated appurtenances, the ENGINEER will review manufacturers technical data for conformance with the Specifications.

Performance testing of the system will be conducted and satisfactory results obtained prior to acceptance by the ENGINEER/OWNER.

5.0 DOCUMENTATION

5.1 DAILY CONSTRUCTION REPORTS

The Resident Project Representative will complete a summary report of each day's construction activities. The daily report will be formatted to provide the following information:

- A report identification number for document control and cross-referencing purposes.
- Date,Project Name, location, and preparer's name.
- The number and names of personnel on-site who are conducting CQA tasks and who report to the ENGINEER.
- Description of weather conditions including humidity, temperature, wind direction, cloud cover and precipitation events.
- Summaries of any meetings held and actions recommended or taken.
- Description of work in progress. This should include major activities, their locations, a brief description of CONTRACTOR's work force and equipment in use,, and a list of personnel involved in major activities.
- Identification of areas or units of work observed. Results of tests performed on-site by personnel under the direction of the ENGINEER or a reference indicating where the test results are recorded.
- Unique identifying geomembrane sheet number for cross referencing and document control
- Description of off-site critical materials delivered to or removed from the job site, including any quality control data provided by the supplier.
- A record of calibrations or standardizations performed on field testing equipment.
- Decisions made regarding approval of units of material or work, and corrective actions to be taken in instances of substandard or suspect quality.

- Description of samples collected and sent to outside laboratories or a reference indicating where such information is recorded.
- A reference indicating where test data submitted by outside laboratories is recorded.
- A record of communications with other CQA personnel, outside companies, regulatory agencies, or consultants regarding the day's construction activities.
- Signature of the ENGINEER.

5.2 OBSERVATION AND TESTING REPORTS

All observations, results of field tests, and results of laboratory tests performed on site or off site will be recorded. As a minimum, the inspection data sheets will include the following information.

- Description or title of the person making the inspection, observation, or test.
- Location of the activity or location from which the sample was obtained.
- Type of procedure used.
- Unique identifying geomembrane sheet number for cross referencing and document control
- Recorded observation or test data.
- Results of the activity (pass/fail) and a comparison with the specification requirements.
- Personnel involved in the inspection besides the individual preparing the data sheet.
- Signature of the quality control technician preparing the data sheet and review signature by the ENGINEER.

5.3 CORRECTIVE ACTION REPORTS (IF REQUIRED)

A Corrective Action Report will be completed by the ENGINEER when any construction material or activity is observed or tested that does not meet the CQA requirements. The reports will

reference data sources or observations which led to the determination of the problem or deficiency. The report will include the following additional information:

- A description of the problem or deficiency, including the location and how and when the problem or deficiency was discovered.
- Unique identifying geomembrane sheet number for cross referencing and document control
- An opinion as to the probable cause of the problem or deficiency.
- A description of recommended corrective action to resolve the problem or deficiency. If the problem or deficiency has already been resolved, then proper documentation supporting the corrective action will be provided. If the problem or deficiency has not be resolved, then the report will clearly indicate that it is an unresolved problem or deficiency.
- Where applicable, suggested methods to prevent occurrence of similar problems.
- Signature of the quality assurance technician and review signature of the ENGINEER.

5.4 DATA SHEETS

It will be the responsibility of the ENGINEER to prepare any forms, checklists or data sheets to record data, or to note communications or observations.

The checklists and forms accompanying this CQA Plan (Appendix B) are proposed for use by the ENGINEER in tracking submittals, test results, etc., related to the geomembrane installation. These lists will supplement the information provided by the Resident Project Representative in the Daily Construction Reports.

5.5 PHOTOGRAPHS

Photographs will be taken throughout the duration of the project by the Resident Project Representative to document construction activities, problem areas and deficiencies. Slide format will be used. The slides will include the date and approximate time of the photograph. The Resident Project Representative will file slides in chronological order in a permanent protective

file. An index will be prepared and maintained showing a unique identifying number for each slide, date and time of slide, location where the slide was taken, and a description of the subject matter.

5.6 RECORD DRAWINGS

Record drawings will be prepared by the ENGINEER using field data provided by the CONTRACTOR. The drawings will show or make note of the following information pertaining to the Phase II work:

- Finished lines and grades of the cell and liner system.
- Location and identifying number of the geomembrane panels, seams and destructive samples.
- As-built location of the leachate collection and removal system.

5.7 FINAL CONSTRUCTION QA DOCUMENTATION REPORT

The Final Construction QA Documentation Report will be prepared by the ENGINEER. It will include summaries of test results for soil and geosynthetic testing, photographic documentation, liner seam layout design, and as-built construction drawings. Significant changes, if any, to the original construction plan will be discussed. The report will be signed by the ENGINEER who will be a registered Professional Engineer in Florida.

6.0 PROJECT MEETINGS

6.1 PRECONSTRUCTION MEETING

A preconstruction meeting will be held prior to beginning work. This quality assurance document will be a key topic of discussion at the meeting. Establishing the organization for the project, discussing communication and procedures will also be included in the agenda.

6.2 DAILY PROGRESS MEETINGS

The resident project representative will meet with the on-site foreman daily to discuss quality assurance issues. The observer will report any deviation from the specifications to the OWNER and the ENGINEER and will inform the CONTRACTOR of any problem areas.

6.3 PROBLEM OR WORK DEFICIENCY MEETINGS

Meetings will be held on an as needed basis to resolve problems and work deficiencies. The objective will be to define the problem, develop solutions and produce a schedule for resolution.

6.4 MONTHLY PROGRESS MEETINGS

The OWNER, Project ENGINEER and the CONTRACTOR will meet once a month to discuss progress, quality of work and other issues.

APPENDIX A

SPECIFICATIONS

SECTION 02010

TEMPORARY EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.01 SCOPE

A. The work specified in this Section consists of designing, providing, maintaining, and removing temporary erosion and sedimentation controls as necessary.

B. Temporary erosion controls include, but are not limited to: grassing, mulching, netting, watering, reseeding on-site surfaces, reseeding spoil and borrow area surfaces, and providing interceptor ditches at ends of berms and at those locations which will ensure that erosion during construction will be either eliminated or maintained within acceptable limits as established by the County or other regulatory agencies having jurisdiction.

C. Temporary sedimentation controls include, but are not limited to: silt dams, traps and appurtenances at the foot of sloped surfaces which will ensure that sedimentation pollution will be either eliminated or maintained within acceptable limits as established by the County or other regulatory agencies having jurisdiction.

D. CONTRACTOR is responsible for providing effective temporary erosion and sediment control measures during construction or until final controls become effective.

E. The work specified in this Section shall be in compliance with Section 104 of the FDOT "Standard Specifications for Road and Bridge Construction". Section 104 will govern if any conflict arises between the contents of this specification and the FDOT procedures.

1.02 REFERENCE DOCUMENTS

A. Florida Department of Transportation (FDOT), "Roadway and Traffic Design Standards"

B. FDOT, "Standard Specifications for Road and Bridge Construction".

PART 2 - PRODUCT

2.01 MATERIAL

A. Sod is specified in Section 02485.

B. Seed is specified in Section 02485.

C. Mulch is specified in Section 02485.

D. Fertilizer is specified in Section 02485.

E. Watering is specified in Section 02485.

F. Netting is specified in Section 02485.

G. Sedimentation barriers, silt fences, and turbidity barriers as defined in FDOT drawings 102 & 103 of the "Roadway and Traffic Design Standards" manual and Section 104 of the FDOT "Specifications for Road and Bridge Construction".

PART 3 - EXECUTION

3.01 EROSION CONTROL

A. CONTRACTOR is to begin restoration to any area directly affected by the construction within 48 hours of testing and approval. Should substantial erosion occur, within 48 hours, the CONTRACTOR will be responsible for restoring those areas to their natural state before proceeding with construction.

B. Minimum procedures for grassing slopes less than 3:1 shall be in accordance with section 570 of FDOT "Standard Specifications for Road and Bridge Construction" and as listed below:

1. Scarify slopes to a depth of not less than six inches and remove large clods, rocks, stumps, debris, and roots larger than 1/2-inch in diameter.

2. Sow seed within twenty-four (24) hours after the ground is scarified with a mechanical hand seeder.

3. Apply mulch loosely and to a thickness of between 3/4-inch and 1-1/2-inches.

4. Apply netting over mulched areas on sloped surfaces and stake.

5. Roll and water seeded areas in a manner which will enhance sprouting of seeds and growing of grass. Reseed areas which exhibit unsatisfactory growth. Backfill and seed eroded areas.

C. Minimum procedures for sodding slopes 3:1 or steeper are:

1. Slopes steeper than 3:1 shall be sodded in accordance with the provisions of Section 575 of the FDOT "Standard Specifications for Road and Bridge Construction".

3.02 SEDIMENTATION CONTROL

A. Silt Fencing:

1. Install and maintain a "Type III" FDOT standard silt fence when shown on Contract Drawings.

2. The silt fence shall be installed between the construction area and the stream, or to the down side of the slope.

3. At stream crossings or where applicable, the fence shall terminate at the end of the wing wall or headwall to the bridge or culvert.

B. Turbidity Barrier:

1. Install a FDOT standard "Staked Turbidity Barrier" to the downstream side of all subaqueous stream crossings.

2. Where the direction of flow is uncertain, a turbidity barrier will be required on each side.

C. Locate all silt fencing within the designated right of way, easement, or utility corridor as applicable.

D. Maintain silt fence in good condition until restoration of area is complete and approved by the ENGINEER.

E. It is the CONTRACTOR's responsibility to provide bypassing routes or detours of stormwater or streams as necessary to prevent flooding damage or obstruction to adjacent lands due to construction or sedimentation control.

F. Install and maintain silt dams, traps and appurtenances as shown on the Contract drawings and as approved by the ENGINEER.

3.03 PERFORMANCE

A. The CONTRACTOR must undertake all efforts to prevent any erosion or turbid water from being discharged off site, into wetlands, and/or into waters of the state.

B. Should any of the temporary erosion and sediment control measures employed by the CONTRACTOR fail to produce results which comply with the requirements of the State of Florida and local government agency, the CONTRACTOR shall immediately take whatever steps are necessary to correct the deficiency at his own expense.

SECTION 02110

SITE PREPARATION

PART 1 - GENERAL

1.01 SCOPE

A. This section covers clearing, and grubbing the site.

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION

3.01 CLEARING

A. The surface of the ground, for the area to be cleared and grubbed shall be completely cleared of all timber, brush, stumps, roots, grass, weeds, rubbish, and all other objectionable obstructions resting on or protruding through the surface of the ground. Clearing operations shall be conducted so as to prevent damage to existing structures and installations (monitoring wells), and to those under construction, so as to provide for the safety of employees and others.

3.02 GRUBBING

A. Grubbing shall consist of the complete removal of all stumps, roots larger than 1 inch in diameter, matted roots, brush, timber, logs, and any other organic or metallic debris not suitable for foundation purposes, resting on, under or protruding through the surface of the ground to a depth of 18 inches below the subgrade. All depressions excavated below the original ground surface for or by the removal of such objects, shall be refilled as described in these specifications.

3.03 DISPOSAL OF CLEARED AND GRUBBED MATERIAL

A. The CONTRACTOR shall dispose of all material and debris from the clearing and grubbing operation by hauling such material and debris off-site to the Class III areas and dump as directed by the OWNER of the site. The cost of disposal (including hauling) of cleared and grubbed material and debris shall be considered a subsidiary obligation of the CONTRACTOR; the cost of which shall be included in the prices bid for the various classes of work.

SECTION 02200

EARTHWORK & GRADING

PART 1 - GENERAL

1.01 SCOPE

A. Included in this section is all excavation, filling, and finishing necessary for the construction, preparation and completion of all embankments and structure backfill, intermediate cover for Disposal Unit A-1, drainage layer, liner subbase, and gravel envelopes or base. The work shall be done in accordance with the required contours, spot elevations and cross sections shown on the drawings or as directed by the ENGINEER.

PART 2 - PRODUCTS

2.01 EMBANKMENTS, STRUCTURE BACKFILL AND INTERMEDIATE COVER

A. The CONTRACTOR may excavate and borrow material from the borrow area designated in the drawings. Borrow material shall conform to Unified Soil Classification SP, SM or SC. Off-site borrow material shall be certified by a professional geotechnical engineer as meeting the specifications. The borrow material shall be clean and free of rocks or cemented nodules greater than one inch in diameter, lumber, roots, trash or other debris.

2.02 DRAINAGE LAYER

A. The soil used for the drainage layer shall be either masonry sand or concrete sand as described in the Florida Department of Transportation Standard Specification for Road and Bridge Construction, Sections 902-1.1, 902-1.2 and 902-2.2, with drainage characteristics (permeability) of at least 5.0×10^{-3} cm/second at a compacted density greater than or equal to the value called for in these specifications and a $D_{85} = 2.36$ mm.

2.03 GRAVEL

A. The CONTRACTOR shall use river rock or crushed granitic rock as described in the Florida Department of Transportation Standard Specification for Road and Bridge Construction for the gravel envelope or base.

1. All river rock or crushed granitic rock shall be material that is sound, hard, durable, resistant to weathering and shall be free of overburden, spoil, shale, limestone and organic material. The rock shall be free of deleterious materials such as flat, elongated, friable, decomposed, or micaceous pieces. Broken pieces of concrete, asphalt, or brick are not acceptable.

2. River rock or crushed granitic rock for the leachate collection system shall meet requirements of Section 901-1.4 of FDOT standard specification.

3. Inspection and Acceptance - Materials offered as river rock or crushed granitic rock shall be subject to inspection at the source(s) and upon delivery at the site. The OWNER and its ENGINEER reserve the right of acceptance or rejection upon delivery at the site or during progress of the work.

PART 3 - EXECUTION

3.01 EXCAVATION

A. The CONTRACTOR shall perform all excavation necessary to accomplish the construction indicated on the plans. All clean and usable excavated material not required for fill or embankment shall be deposited on the project site as directed by the OWNER or his ENGINEER. The CONTRACTOR shall do all shoring necessary to perform and protect the excavation and as necessary for the safety of the workers and any existing facilities. Wherever excavations are made below the grades indicated on the plans, clean soils shall be used to restore the area to the proper grade and shall be compacted in accordance with these specifications.

3.02 DEWATERING

A. Dewater all excavations as necessary to maintain stability of the excavations and to allow for proper compaction of backfill.

3.03 UNSUITABLE MATERIAL

A. Where muck, rock, clay or other material within the limits of construction is, in the opinion of the ENGINEER, unsuitable in its original position, the CONTRACTOR shall excavate such material and backfill the excavated area with suitable material, which shall be compacted and shaped to conform to the required section.

3.04 FILL

A. Fill shall be placed in successive uniform lifts of 12 inches, measured loose or as approved by the ENGINEER. Each lift shall be compacted in accordance with the requirements specified in this section prior to placing the next successive lift. The fill placed over the liner shall be placed to avoid damage to the liner, and the CONTRACTOR shall submit a plan for undertaking this operation to the ENGINEER for review prior to beginning of this operation. Prior to placing any fill for berms, the surface to receive the fill shall be plowed or scarified to a depth of 12 inches.

3.05 STRUCTURE BACKFILL

A. All backfill material shall be thoroughly compacted in lifts not to exceed twelve inches (prior to compaction) and brought to an elevation above the finished grade sufficient to allow for settlement. Prior to placing backfill, the areas around structures upon which the backfill is to be placed shall be cleaned of all trash and debris of any nature. Any sheeting and bracing allowed to be left in place shall be cut off at the elevation directed by the ENGINEER. The CONTRACTOR shall be responsible for performing the compaction so as to prevent damage to structures.

3.06 PIPE BACKFILL

A. Under Pipe: Trenches shall be backfilled from the bottom of the trench to the centerline of the pipe with soil free from rocks or stones, placed in twelve-inch layers and compacted, as specified below, using the appropriate equipment, under and on each side of the pipe and between the pipe and wall of trench. Backfilling material shall be deposited in the trench for its full width simultaneously on each side of the pipe.

B. Over Pipe: From the centerline of the pipe, fittings and appurtenances, to an elevation one foot above the top of the pipe. The backfill material shall be as specified in A, above, and shall be compacted by use of tampers.

3.07 COMPACTION

A. Areas to be compacted shall be moistened to within + or - 3 percent of optimum moisture and compacted by either rolling, tamping or any other method approved by the ENGINEER in order to obtain the desired density. All fill material, including backfill and embankment, shall be compacted to densities as follows:

1. Leveling course beneath structures and pipes - not less than 95% of modified Proctor maximum dry density (ASTM D1557)

2. Drainage Layer and gravel envelope - not less than 92% modified Proctor maximum dry density (ASTM D1557)

3. Embankment for berms and swales - not less than 95% modified Proctor maximum dry density (ASTM D1557).

4. Intermediate cover - not less than 90% modified Proctor maximum dry density (ASTM D1557).

3.08 DRAINAGE LAYER

A. Once the liner system is in place, the CONTRACTOR shall place and compact the 2 foot thick (after completion) drainage layer uniformly over the bottom and side slopes of the cell.

B. Placement of drainage layer over liner system - refer to Section 02280 Geomembrane.

3.09 GRAVEL

A. The gravel envelope shall be placed around the primary and secondary leachate pipes, as shown in the drawings.

B. The CONTRACTOR shall submit a proposed method for placing the gravel to the ENGINEER for review prior to beginning the placement. The proposed methodology shall demonstrate that the liners will not be damaged in any way during placement.

PART 4 - QUALITY ASSURANCE PROGRAM

4.01 TESTING LABORATORY

A. The OWNER will retain an independent soil testing laboratory who has specific equipment to provide test results specified below in a timely manner. The ENGINEER shall select the location for sampling. The CONTRACTOR shall coordinate and schedule all tests as required by the plans and specifications. the CONTRACTOR shall instruct the testing laboratory to forward copies of all test reports to the ENGINEER.

4.02 WORKMANSHIP

A. The CONTRACTOR is responsible for correction of portions of the work which do not conform to the specified project requirements at no cost to the OWNER. If, in the ENGINEER's opinion, additional density tests (beyond those predetermined in this quality assurance program) are required, such test shall be made as directed by the ENGINEER and paid for by the CONTRACTOR.

4.03 TESTING DURING CONSTRUCTION

A. Grain size analyses or percent fines determinations shall be conducted on samples from each 22,000 square feet of each lift installed. Tests shall be conducted in accordance with ASTM D-1140 to determine the percentage by dry weight.

B. Field density and moisture content shall be determined on each 22,000 square feet lift or every 50 feet and leachate main (both sides) and once per lift in structure backfill. Nuclear and Speedy determinations shall not be used unless a product-specific correlation has been established at the job-site with more accurate methods, i.e., drive cylinder (ASTM D-2937), sand-cone (ASTM D1558) and oven-drying (ASTM D-2216) methods.

C. Depth measurements to determine the thickness of the drainage layer shall be conducted every 11,000 square feet installed. No sharp probes will be used.

D. Hydraulic conductivity testing of the drainage layer and gravel envelope, at a minimum frequency of one test per 22,000 square feet of layer at locations selected by the ENGINEER. The ENGINEER shall have the authority to request additional permeability tests in areas which, in his judgement, may be suspect or deficient.

E. A remolded sample will be acceptable for the hydraulic conductivity testing for the drainage layer.

F. Any sample or area tested shall be rejected, removed and replaced within the 22,000 square foot area or as directed by the ENGINEER, if it does not meet the requirements of the technical specifications. Reconstructed areas shall have feathered, overlapping edges that tie into adjacent areas.

SECTION 02215

LINER SUBBASE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes construction of the liner subbase soil layer as part of landfill liner construction.

1.02 QUALITY ASSURANCE

A. OWNER will retain the services of an independent testing firm to determine conformance of soils and conformance of the constructed work, with the specifications. Laboratory testing to determine acceptable zone for liner subbase soil compaction will be performed by the independent testing facility.

1.03 SUBMITTALS

A. Submit samples of the proposed materials to the testing firm for analysis, as directed by the ENGINEER.

PART 2 - PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. The clayey soil material shall be provided by one supplier.

B. Proposed materials and source of supply shall be approved for use on this project by the ENGINEER as specified, prior to use of the material in the construction.

2.02 LINER SUBBASE SOIL

A. Shall have a minimum of 20 percent passing the No. 200 sieve, and a plasticity index in the range of 20 - 50 percent.

B. Shall be free from rocks larger than one-quarter inch in greatest dimension, surface litter and roots. Rock sizes up to three inches in greatest dimension may be allowed, as approved by ENGINEER, for liner subbase soil lifts greater than six inches below the geomembrane, provided compliance with permeability requirements is demonstrated.

C. The soil shall have characteristics consistent with SC, ML-CL, or CL soils as defined by USCS.

D. The hydraulic conductivity of water through the soil shall be equal to or less than 1×10^{-5} centimeters per second (cm/sec) when compacted to at least 95 percent of

the material's maximum dry density, as determined by the Standard Proctor Test (ASTM D 698).

E. Obtain samples of all proposed liner subbase soil materials for analysis within the time limit agreed to in the Preconstruction Conference. The samples shall be obtained in the presence of the ENGINEER from each proposed borrow source and for each soil type.

F. Pre-Construction Material Evaluation:

1. The acceptable zone for compacted in-place dry density and moisture content of the liner subbase soil material required to achieve the specified hydraulic conductivity will be estimated using the following procedure to be performed by the testing facility retained by the OWNER:

   a. Each type of soil from each borrow source will be compacted over a range in water content using modified Proctor (ASTM D 1557), Standard Proctor (ASTM D 698), and reduced Proctor (Standard Proctor, except that 15 drops of the hammer per lift are used instead of the usual 25 drops). These three compactive efforts typically represent the maximum, typical, and minimum compactive effort expected in the field.

   b. Compacted specimens will be permeated to determine the hydraulic conductivity (k) using the U.S. Army Corps of Engineers, EM 1110-2-1906, back pressure saturated, falling head test method, or other suitable test acceptable to the ENGINEER.

   c. Compaction data for each borrow soil type will be plotted on a graph of dry density versus water content with different symbols used for each compaction effort.

   d. The ENGINEER will delineate an acceptable zone for each soil type on the graph which encompasses the test results meeting or exceeding the design criteria. The acceptable zone for each soil type will account for relevant factors, such as shear strength, shrink/swell, cracking, and constructability.

2. The resulting graphs will be used by the ENGINEER and independent testing facility during construction to determine compliance with the specifications.

G. Testing of Soil by Independent Testing Firm (after ENGINEER's approval of borrow source):

1. Organic Content (ASTM D 2974): Initially and whenever organics are visually evident (as determined by the ENGINEER).

2. Sieve Analysis (ASTM D 422) and Soil Classification (ASTM D 2487): Minimum of one test from borrow source for every 1000 cubic yards of loose soil and for each change in material.

3. Moisture Content (ASTM D 2216) Minimum of one test from borrow source for every 1000 cubic yards of loose soil and for each change in material.

4. Proctor Moisture - Density Curve (ASTM D 698): Minimum of one test from borrow source for every 5000 cubic yards of loose soil and for each change in material.

5. Atterberg Limits (ASTM D 4318): Minimum of one test from borrow source for every 5000 cubic yards of loose soil and for each change in material.

6. Permeability of remolded samples (COE EM 1110-2-1906, Appendix VII, Section 1, or ASTM D 5084): Minimum of one test from borrow source for every 10,000 cubic yards of loose soil.

PART 3 - EXECUTION

3.01 PREPARATION

A. The ENGINEER will inspect and approve the subgrade before installation of the subbase can proceed. It shall be the CONTRACTOR's responsibility to properly prepare the subgrade for the subbase installation.

B. If the installation CONTRACTOR damages the compacted subgrade, he shall restore, recompact and have the OWNER's testing service retest it prior to installing the subbase. All costs related to the repair and retest of the subgrade shall be paid for by the CONTRACTOR.

C. The installation CONTRACTOR shall provide adequate protection of the clayey materials delivered to the site from inclement weather conditions and any traffic that may occur near the storage area.

3.02 FIELD QUALITY CONTROL

A. Tests specified below will be performed by the independent testing firm during construction of the liner subbase soil layer.

B. Testing of Liner Subbase Soil Layer

1. Compaction/Density tests, (using ASTM D 2922 or D 1556) and Moisture Content (using ASTM D 3017): Minimum of one test per 10,000 square feet for each compacted lift on a maximum 100-foot grid pattern that includes the disposal area side slopes, and a minimum of one test per 200 linear feet of side slope for each compacted lift.

a. The results of each test will be compared to the most recent moisture-density curve for the soil to check that the proper percent compaction is being obtained and to the most recent hydraulic conductivity-density curve to check that the proper hydraulic conductivity is being obtained.

2. Atterberg Limits (ASTM D 4318): Minimum of one test per 40,000 square feet for each compacted lift on a 200-foot grid pattern that includes disposal area side slopes, and one sample per 800 linear feet of side slope for each compacted lift.

3. Undisturbed samples will be taken, using a thin-walled tube sampler, at a minimum frequency of one sample per 40,000 square feet for each compacted lift on a 200-foot grid pattern that includes disposal area side slopes, and one sample per 800 linear feet of side slope for each compacted lift. Samples shall not be collected at the same location on succeeding lifts. The following laboratory tests will be performed on the undisturbed samples by the independent testing firm:

   a. Permeability (COE EM 1110-2-1906, Appendix VII, Section 1, or ASTM D 5084)

   b. Dry Density (ASTM D 2922)

   c. Moisture Content (ASTM D 2216)

4. If selected for compaction/density testing, the calibration of each nuclear densitometer will be checked daily by comparison to the density measured on the same material by the other methods. Wherever a conflict exists, sand-cone results will be accepted over nuclear density results.

C. Repair of Undisturbed Sample Location:

1. Upon extraction of an undisturbed sample, the sidewalls of the remaining hole shall be scored and the hole properly filled with liner subbase soil or a soil/bentonite mixture, and hand-tamped.

2. Compaction/Density testing, using ASTM D 2922, will be performed by the independent testing firm at the sample location. Resulting density shall be at least as high as the surrounding liner subbase soil layer.

3. The repaired hole shall be void of any obvious flaws detrimental to permeability such as gaps, cracks, rocks, roots and miscellaneous debris.

D. Repair of Compaction/Density Testing Locations:

1. At locations where the ASTM D 1556 procedure is used to measure compaction/density, all sand remaining in the test location shall be removed. The side walls of the remaining hole shall be scored and the

hole properly filled with a liner subbase soil or a soil/bentonite mixture, and hand-tamped.

2. At locations where the ASTM D 2922 procedure is used to measure compaction/density, if the liner subbase soil layer is sufficiently plastic, as determined by the ENGINEER, test holes shall be closed by reworking the surface of the liner subbase soil with the compaction equipment to remold the surface of the layer. If not sufficiently plastic, or as an alternate to reworking, the test holes shall be filled with a dry bentonite powder.

E. Materials not meeting density and moisture content specifications shall be scarified, the moisture content adjusted, and the area recompacted and re-tested at CONTRACTOR's expense.

F. Surveying will be performed by a qualified land surveyor retained by the ENGINEER to monitor as-built soil layer elevations.

3.03 PLACEMENT AND COMPACTION OF LINER SUBBASE SOIL LAYER

A. The liner subbase soil layer shall be placed in lifts not exceeding eight inches in thickness, loose measure.

B. The measured in-place dry density and moisture content immediately after line subbase soil compaction shall fall within the acceptable zone determined by the ENGINEER as described in subsection 2.02 of this Section.

C. Place in uniform layers no less than ten feet wide, compacted full width to the lines and grades shown.

D. Compaction shall be obtained using non-vibratory self-propelled or towed sheeps-foot or pad type rollers with foot length equal to or greater than loose lift thickness. The compaction equipment shall be heavy enough to achieve the required compaction, and provide adequate kneading action to reduce clod sizes. The weight of all roller drums during compaction of material shall be not less than 4000 pounds per foot of drum length.

E. Contact surfaces shall be scarified to a depth of approximately one inch prior to placing the next lift of liner subbase soil if the compaction results in a smooth surface not conducive to good bonding between lifts, as determined by the ENGINEER. Contact surfaces requiring critical attention include locations where new soil is placed several hours after the previous lift is completed and when liner subbase soil from one borrow source touches soil from another borrow source.

F. Intermediate lifts shall be rolled to seal when subsequent lifts will not be placed within two calendar days. The sealed surface of the intermediate lifts shall be scarified, moistened if required to aid compaction, and prepared to receive subsequent lifts prior to placement of liner subbase soil.

G. Compaction of fill material that contains excessive moisture shall not be attempted. The material shall be aerated by blading, disking, harrowing, or other methods,

to hasten the drying process and mixed thoroughly within the loose lift to ensure an even distribution of moisture within the loose lift prior to compaction.

H. During clayey soil compaction and until the surface is covered, the moisture content of the soil shall be maintained within the acceptable zone.

I. The top surface of the completed liner subbase soil layer shall be smooth and the upper three inches shall be free of stones at locations where the geomembrane will be installed.

3.04 MAINTENANCE AND REPAIR OF LINER SUBBASE SOIL LAYER

A. Rutting due to hauling equipment shall be minimized as much as possible by reducing speed and travel frequency.

B. Damage to any compacted lift at any time during the course of construction, such as rutting under the loads imposed by earth-moving or hauling equipment, shall be fully repaired prior to placement of any overlying materials.

C. Whenever moisture content, density or hydraulic conductivity are out of the ranges specified, an area at least one-half the distance in all directions to the nearest passed test shall be scarified, the moisture content adjusted, and the area recompacted and retested.

D. In the event that the moisture content is not properly maintained and desiccation cracks develop on the clayey soil surface, the following corrective procedures shall be followed:

1. For cracks measuring two inches in depth or less, dry powder bentonite shall be used for repair, or the surface shall be rewetted.

2. For cracks greater than two inches but less than the depth of the disking blade (measured from the axle to the edge of blade), bentonite will not be accepted. The surface shall be rewetted, disked, recompacted and retested.

3. For cracks greater than the depth of the disking blade, the lift shall be removed.

4. The method for measuring crack depth shall be the insertion of a circular rod that is sufficiently small in size to accurately measure the actual depth of the crack. This method, and rod diameter, shall remain consistent throughout the liner subbase soil layer construction.

3.05 AS-BUILT TOPOGRAPHY

Prior to placing the liner on top of the subbase, the CONTRACTOR shall submit three sets of As-Built Topography of Prepared Surface, with the completed elevations and contours placed on the drawing (Scale 1"=100') for ENGINEER's review. The CONTRACTOR will not be allowed to continue the construction until the ENGINEER has reviewed and

responded with comments on the submitted information. The CONTRACTOR shall immediately commence placement of the liner system after the ENGINEER has acknowledged there are no exceptions to the proposed topography.

SECTION 02277

GEOSYNTHETIC CLAY LINER

PART 1 - GENERAL

1.01 SCOPE

A. This section includes furnishing and installing a geosynthetic clay liner (GCL) as part of landfill liner construction within the sump and beneath the leachate header pipes.

1.02 QUALITY ASSURANCE

A. OWNER will retain the services of an independent quality assurance laboratory (QA Laboratory) to determine conformance of the materials and field seaming with the specifications.

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

C. Furnish all labor, materials, equipment, services, incidentals and other items necessary for the placement and installation of GCL, as shown on the Contract Drawings and as specified herein.

D. Manufacturer's Qualifications: The manufacturer shall be a specialist in the manufacture of GCL and shall have at least five years experience in the manufacture of GCL.

E. Installer's Qualifications.

1. The GCL Installer shall be the manufacturer or an approved CONTRACTOR trained and licensed to install the manufacturer's GCL.

2. The GCL Installer shall be a specialist in the installation of GCL and shall have at least five years experience in the installation of GCL. The installer shall have installed at least 10,000,000 square feet of GCL during the last five years.

3. Installation shall be performed under the constant direction of a single Field Installation Supervisor who shall remain on site and be in responsible charge, throughout the installation, for layout, seaming, patching, testing, repairs, and all other activities by the Installer. This Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 30,000 square feet of GCL.

4. The qualifications shall be submitted to the ENGINEER for prior approval.

F. Manufacturing Plant Visit

1. If determined necessary by the ENGINEER and OWNER, a qualified representative of the ENGINEER or QA Laboratory shall visit the Manufacturer's plant during the manufacturing of the GCL rolls for the project.

2. The Manufacturer shall agree to allow the plant visit by the representative.

3. The representative, during his visit, shall review the manufacturing process, quality control, laboratory facilities and testing procedures.

G. Conformance Testing

1. Upon the delivery of the rolls to the project site, a qualified representative of the QA Laboratory shall obtain samples of the material at a frequency of one per 100,000 square feet, and forward the samples to the QA Laboratory for conformance testing.

2. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. The QA Laboratory representative shall mark the machine direction on the samples.

3. Conformance testing shall include all tests listed under subsection 2.01.F.

1.03 DELIVERY, STORAGE AND HANDLING

A. Each roll of GCL delivered to the site shall be labeled by the manufacturer. The label shall clearly state the manufacturer's name, product identification, batch number, roll number and roll dimensions.

B. GCL shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

C. Provide all labor and equipment required to assist the ENGINEER in the observation of materials delivered to the site. Generate, update and submit to the ENGINEER an inventory of rolls received on-site from the manufacturer/distributor. The inventory shall include all the information appearing on the label of each roll.

D. Rolls shall be stored in a manner which protects them from the elements. Rolls shall be stored on a prepared surface (not wooden pallets) and shall not be stacked more than two rolls high.

1.04 SUBMITTALS

A. Manufacturer

1. Submit manufacturer's qualifications, certifications, data, Specifications, installation instructions and dimensions.

2. Information provided by the manufacturer shall include the following:

   a. Quality control program and manual, or descriptive documentation.

   b. List of material properties and samples of liner.

   c. Origin of raw materials used to manufacture the liner.

   d. Certification that all resin used in the manufacture of GCL for this job meets the requirements specified herein.

   e. Quality control certificates issued by the resin supplier.

   f. Quality control certificates and certification that the GCL furnished complies with all requirements specified herein.

   g. Certification that the GCL and extrudate produced have the same properties.

3. No GCL shall be shipped until the certifications and quality control certificates are submitted to the ENGINEER.

B. Installer

1. Submit background information and qualifications of the Installer.

2. Information provided by the installer shall include the following:

   a. Certification that both the Installation Supervisor and the Master Seamer have reviewed the Quality Assurance Plan and the Contract Documents for the project.

   b. Brief historical background, installation capabilities and information on the personnel.

   c. Reference at least 10 completed facilities for which the Installer has installed a GCL. For each installation, the installer shall provide the name and purpose of the facility, its location, the date of installation, name of OWNER, Design Engineer, Manufacturer, Fabricator, if applicable, name and telephone number of contact at the facility; thickness of geomembrane and surface area of the installed geomembrane; type of seaming, patching, and tacking

equipment; a copy of the Manufacturer's and/or Fabricator's approval letter(s) and/or license(s), if applicable; resume of the qualifications of the Installation Supervisor and Master Seamer to be assigned to this Project.

C. Shop Drawings

1. Submit shop drawings for approval as soon as possible after award of contract.

2. Shop Drawings shall show a proposed installation panel layout identifying seams and details. The layout diagram shall indicate the location of pre-assembled panels and shall identify each sheet and panel by number.

3. Shop drawings shall include a complete description of field seaming procedures, a work plan for liner installation including manpower and equipment, and a detailed description of field testing methods to be performed.

4. Any proposed deviation from these documents shall be submitted in writing to the ENGINEER a minimum of seven working days prior to the scheduled start of geomembrane installation and will be accepted/rejected by the ENGINEER prior to start of installation activities.

1.05 MATERIAL WARRANTY

A. Membrane manufacturer shall warrant the membrane material against manufacturing defects and material degradation in the outdoor exposure for a period of 20 years from the date of installation.

B. The membrane manufacturer shall warrant the membrane against degradation due to exposure to sunlight for a period of three years.

C. The manufacturer shall provide new material to replace on a prorated basis over the remaining life of the membrane any material which fails from the above causes within the warranty period.

D. The manufacturer shall furnish the ENGINEER with a written warranty covering the requirements of this paragraph.

1.06 LINER INSTALLATION GUARANTEE

A. Guarantee the membrane installation against defects in installation and workmanship for one year commencing with the date of final acceptance.

B. The guarantee shall include the services of qualified service technicians and all material required for the repairs at no expense to the ENGINEER.

PART 2 - PRODUCTS

2.01 MANUFACTURING

A. Raw Materials

1. The clay shall meet the GCL manufacturer's specification for quality control purposes. A certificate of analysis should be submitted by the vendor for each lot of clay supplied. The certificate will include the various compounds of the clay, per x-ray diffraction or methylene-blue absorption, particle size per ASTM D-422 or C-136, moisture content per ASTM D-2216 or D-4643, bulk density per ASTM B-417, and free swell.

2. The GCL manufacturer shall have a MQC plan which describes the procedures for accomplishing quality in the final product, various tests to be conducted and their frequency. This MQC document shall be fully implemented and followed.

3. The MQC test methods that the GCL manufacturer performs on the clay component shall include the following; free swell per USP-NF-XVIII or ASTM draft standard, "Determination of Volumetric Free Swell of Powdered Bentonite Clay," plate water absorption per ASTM E-946, moisture content per ASTM D-2216 or D-4643 and (sometimes) particle size per ASTM D-422, fluid loss per API 13B, pH per ASTM D-4972, and liquid/plastic limit per ASTM D-4318.

4. If an adhesive is used, the statement shall signify that the adhesive selected has been successfully used in the past and to what extent.

5. A statement shall be included indicating that the geotextiles used as the substrate or the superstate, and the geomembrane the products selected have been successfully used in the past and to what extent.

B. Manufacturing

1. There shall be verification provided by the manufacturer indicating that the actual geotextiles or geomembrane used meet the manufacturer's specification for that particular type and style.

2. A statement shall be included that the geotextile property values are based on the minimum average roll value (MARV) concept.

3. A statement shall be included indicating that there was verification that needle punched nonwoven geotextiles have been inspected continuously for the presence of broken needles using an in-line metal detector. There shall also be a magnet, or other device, for removal of broken needles.

4. Verification that the proper mass per unit area of bentonite clay has been added to the product shall be provided. At a minimum, this shall consist of providing a calculated value based on the net weight of the final roll

divided by its area (with deduction for the mast per unit area of the geosynthetics and the adhesive, if any).

5. The overlap distance on both sides of the GCL shall be marked with two continuous waterproof lines guiding the minimum overlap distances.

6. The product shall be wrapped around a core which is structurally sound such that it can support the weight of the roll without excessive bending or buckling under normal handling conditions, as recommended by the manufacturer.

7. The GCL manufacturer shall have a MQC plan for the finished product, which includes sampling frequency, and it should be implemented and followed.

8. The manufacturer's quality control tests on the finished product shall be stipulated and followed. Typical tests include thickness per ASTM D-1777 or ASTM D-5199, total product mass per unit area per ASTM D-5261, clay content mass per unit area per ASTM D-5261, hydraulic conductivity (permeability) per ASTM D-5084 or GRI GCL2 and sometimes shear strength at various locations such as top, mid-plane and bottom per ASTM D-5321. Other tests, as recommended by the manufacturer, are also acceptable.

C. Covering of the Rolls

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

2. The covering shall 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 shall be accessible for handling by fork lift vehicles fitted with a long pole (i.e., a "stinger") attached. For wide GCLs, e.g., wider than approximately 3.5 m (11.5 feet), handling shall be by overhead cranes utilizing two dedicated slings provided on each roll at approximately the one-third points.

4. Clearly visible labels shall identify the name and address of the manufacturer, trademark, date of manufacture, location of manufacture, style, roll number, lot number, serial number, dimensions, weight and other important items for proper identification. Refer to ASTM D-4873 for proper labeling in this regard.

PART 3 - EXECUTION

3.01 HANDLING

A. Storage at the Manufacturing Facility

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

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

3. Placement and stacking of rolls shall be done in a manner so as to prevent thinning of the product at the points of contact with the storage frame or with one another. Storage in individually supported racks is common so as to more efficiently use floor space.

B. Shipment

1. The GCLs shall be shipped by themselves with no other cargo which could damage them in transit, during stops, or while offloading other materials.

2. The method of loading the GCL rolls, transporting them and offloading them at the job site shall not cause any damage to the GCL, its core, nor its protective wrapping.

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

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

C. Storage at the Site

1. Handling of rolls of GCLs shall be done in a competent manner such that damage does not occur to the product nor to its protective wrapping. In this regard, ASTM D-4873, "Identification, Storage and Handling of Geotextiles", shall be followed.

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

3. The rolls shall not be stacked so high as to cause thinning of the product at points of contact. Furthermore, they shall 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 tarpaulins, be taken to minimize moisture pickup or accidental damage. For storage periods longer than one season, a temporary enclosure should be placed over the rolls, or they shall be moved within an enclosed facility.

D. Acceptance and Conformance Testing

1. The samples shall be identified by type, style, lot and roll numbers. The machine direction should be noted on the sample(s) with a waterproof marker.

2. A lot is defined as a group of consecutively numbered rolls from the same manufacturing line.

3. Sampling shall be based on a lot basis.

4. Testing at the CQA laboratory shall include mass per unit area per ASTM D-5261, and free swell of the clay component per GRI-GCL1. The sampling frequency for these index tests should be based on ASTM D-4354. Other conformance tests, which are more performance oriented, could be required by the project ENGINEER, but at a reduced frequency compared to the above-mentioned index tests. Examples are hydraulic conductivity (permeability) ASTM D-5084 (mod.) or GRI GCL2 and direct shear testing per ASTM D-5321. The sampling frequency for these performance tests might be based on area, e.g., one test per 10,000 m^2 (100,000 $feet^2$).

5. Peel testing of needle punched or stitched bonded GCLs shall be done in accordance with ASTM D-413 (mod.). The sampling frequency is recommended to be one test per 2,000 m^2 (20,000 $feet^2$).

6. Conformance test results shall be sent to the ENGINEER prior to installation of any GCL from the lot under review.

7. The ENGINEER will review the results and will report any nonconformance to the OWNER/Operator's Project Manager.

8. The resolution of failing conformance tests shall be based upon ASTM D-4759 entitled, "Determining the Specification Conformance of Geosynthetics."

3.02 INSTALLATION

A. Placement

1. The installer shall take the necessary precautions to protect materials underlying the GCL. If the substrate is soil, construction equipment can be used to deploy the GCL providing excessive rutting is not created. 25 mm (1.0 inch) is the maximum rut depth allowed. If the ground freezes, the depth of ruts shall be further reduced to a value specified by the ENGINEER. If the substrate is a geosynthetic material, GCL deployment shall be by hand, or by use of small jack lifts or light weight equipment on pneumatic tires having low ground contact pressure.

2. The minimum overlap distance (which is 12 inches) shall be verified.

3. Manufacturer's recommendations on type and quantity of clay to be added shall be followed.

4. During placement, care shall be taken not to entrap in or beneath the GCL, fugitive clay, stones, or sand that could damage a geomembrane, cause clogging of drains or filters, or hamper subsequent seaming of materials either beneath or above the GCL.

5. On side slopes, the GCL shall be anchored at the top and then unrolled so as to keep the material free of wrinkles and folds.

6. Trimming of the GCL shall be done with great care so that fugitive clay particles do not come in contact with drainage materials such as geonets, geocomposites or natural drainage materials.

7. The deployed GCL shall be visually inspected to ensure that no potentially harmful objects are present, e.g., stones, cutting blades, small tools, sandbags, etc.

B. Joining

1. The amount of overlap for adjacent GCLs shall be 12 inches or the manufacturer's recommendation, whichever is larger.

2. If dry or moistened bentonite clay (or other material) is to be placed in the overlapped region, the type and amount shall be stated in accordance with the manufacturer's recommendations and/or design considerations. Index testing requirements for proper verification of the clay shall be specified accordingly, by the manufacturer. Furthermore, the placement procedure should be clearly outlined so as to have enough material to make an adequately tight joint and yet not an excessive amount which could result in fugitive clay particles.

C. Repairs

1. For the geotextile-related GCLs, holes, tears or rips in the covering geotextiles made during transportation, handling, placement or anytime before backfilling shall be repaired by patching using a geotextile. If the bentonite component of the GCL is disturbed either by loss of material or by shifting, it should be covered using a full GCL patch of the same type of product.

   a. Any patch, used for repair of a tear or rip in the geotextile, shall be done using the same type as the damaged geotextile or other approved geotextile by the ENGINEER.

   b. The size of the geotextile patch shall extend at least 12 inches beyond any portion of the damaged geotextile and be adhesive or heat bonded to the product to avoid shifting during backfilling with soil or covering with another geosynthetic.

   c. If bentonite particles are lost from within the GCL or if the clay has shifted, the patch shall consist of the full GCL product. If shall extend at least 30 cm (12 inches) beyond the extent of the damage at all locations. For those GCLs requiring additional bentonite clay in overlap seaming, the similar procedure shall be used for patching.

   d. Particular care shall be exercised in using a GCL patch since fugitive clay can be lost which can find its way into drainage materials or onto geomembranes in areas which eventually are to be seamed together.

D. Backfilling or Covering

1. The GCL shall be covered with its subsequent layer before a rainfall occurs.

2. The GCL shall not be covered before observation and approval by the Quality Assurance personnel. This requires close coordination between the installation crew and the Quality Assurance personnel.

3. If soil is to cover the GCL, it shall be done such that the GCL or underlying materials are not damaged. Unless otherwise specified, the direction of backfilling shall proceed in the direction of downgradient shingling of the GCL overlaps. Quality Assurance personnel will perform continuous observation of the soil placement.

4. If a geosynthetic is to cover a GCL, both underlying and the newly deployed material shall not be damaged.

5. The overlying material shall not be deployed such that excess tensile stress is mobilized in the GCL. On side slopes, this requires soil backfill to proceed from the bottom of the slope upward. Other conditions are site specific and material specific.

SECTION 02278

NON-WOVEN NEEDLE PUNCHED GEOTEXTILE

PART 1 - GENERAL

1.01 SCOPE

A. The work specified in this section covers furnishing all labor materials, equipment and incidentals required and complete installation and ready for use of the geotextile fabric as shown in the drawings and specified herein.

PART 2 - PRODUCTS

2.01 NON-WOVEN NEEDLE PUNCHED GEOTEXTILE

A. The geotextile shall be a non-woven needle punched polyester or polypropylene and shall meet the following minimum average roll specifications:

1.	Grab Strength, LBS ASTM D-4632	375
2.	Burst Strength, psi ASTM D-3786	650
3.	Trapezoidal Tear Strength, LBS ASTM D-4533	135
4.	Puncture Strength, LBS ASTM D-4833	195
5.	Apparent Opening Size (AOS), [U.S. Std. Sieve] ASTM D-4751	100
6.	Permeability, Cm/Sec ASTM D-4491	^{k}Fabric > ^{k}Soil
7.	Ultraviolet Degradation at 500 Hours ASTM D-4355	70% Strength Retained
8.	Fabric Weight, Oz/yd^2 ASTM D-5261	12

2.02 QUALITY CONTROL

A. The manufacturer shall certify the quality of the geotextile rolls. As a minimum, the manufacturer shall provide quality control certificates for each shift's production of geotextile. The quality control certificates shall be signed by responsible parties employed by the manufacturer, such as the production manager, shall be notarized, and supplied to the OWNER. The quality control certificate shall include:

1. Roll numbers and identifications.

2. Sampling procedures and results of quality control tests.

3. Verification that a needle removal system was used during the manufacturing process and verification that non-woven needle punched geotextiles have been inspected continuously for the presence of broken needles using an in-line metal detector with an adequate sweep rate.

4. A statement of the amount of reworked polymer or fibers that were added during manufacture. If the amount is greater than zero, then the statement should also verify that the rework polymer or fibers were of the same composition as the product.

2.03 PROTECTIVE WRAPPING, STORAGE AND SHIPMENT

A. All rolls at geotextiles shall be enclosed in a protective wrapping that is opaque and water proof.

1. The protective wrapping shall be placed around the geotextile in the manufacturing facility as the final step in the manufacturing process.

2. The packaging shall not interfere with the handling of the rolls either by slings or by the utilization of the central core upon which the geotextile is wound.

3. The protective wrapping shall prevent exposure at the geotextile to ultraviolet light, prevent it from moisture uptake and limit minor damage to the roll.

B. Every roll shall be labeled with the manufacturers name, geotextile style and type, lot and roll numbers, and roll dimensions (length, width and gross weight). Details shall conform to ASTM-D-4873.

C. Handling of rolls of geotextiles shall be done in a manner such that damage does not occur to the geotextile nor to its protective wrapping.

1. Rolls of geotextiles shall not be stacked upon one another to the extent that deformation of the core occurs or to the point where accessibility can cause damage in handling.

2. Outdoor storage of rolls at the manufacturer's facility shall not be longer than six months.

3. Any protective wrapping that is accidentally damaged or stripped off of the rolls during transportation 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 Construction ENGINEER.

2.04 STORAGE AT CONSTRUCTION SITE

A. Handling of rolls of geotextiles should be done in a competent manner such that damage does not occur to the geotextile nor to its protective wrapping. In this regard, ASTM-D-4873 should be referenced and followed.

B. The location of field storage should not be in areas where water can accumulate. The rolls should be elevated off of the ground so as not to form a dam creating the ponding of water.

C. The rolls should be stacked in such a way that cores are not crushed nor is the geotextile damaged. Furthermore, they should be stacked in such a way that access for conformance testing is possible.

D. Outdoor storage of rolls should not exceed manufacturers recommendations or longer than six months, whichever is less. For storage periods longer than six months, a temporary enclosure should be placed over the rolls, or they should be moved within an enclosed facility.

2.05 ACCEPTANCE AND CONFORMANCE TESTING

A. Upon delivery of the rolls of geotextiles to the project site, and temporary storage thereof, samples of the geotextiles shall be provided to the ENGINEER. A sample shall be taken by removing the protective wrapping and cutting full width, a three-foot long sample off of the outer wrap of the selected roll(s). The samples shall be relabeled for identification.

1. The samples shall be identified by type, style or, lot and roll numbers. The machine direction shall be noted on the sample(s) with a waterproof marker.

2. A lot is defined as a unit of production, or a group of other units or packages having one or more common properties and being readily separable from other similar units.

3. Unless otherwise required by the ENGINEER, sampling should be based on one per lot. Note that a lot is defined as 10,000 m^2 (100,000 ft^2) of geotextile.

B. Testing

1. Conformance test results will be reviewed by the ENGINEER prior to deployment of any geotextile from the lot under review.

2. The ENGINEER will review the results and will report any nonconformance to the OWNER.

3. The resolution of failing conformance tests shall be based upon ASTM D-4759 entitled "Determining the Specification Conformance of Geosynthetics".

4. The geotextile rolls which are sampled should be immediately rewrapped in their protective covering to the satisfaction of the ENGINEER.

PART 3 - EXECUTION

3.01 PLACEMENT

A. The geosynthetic installation CONTRACTOR shall remove the protective wrappings from the geotextile rolls to be deployed only after the substrate layer, soil or other geosynthetic, has been documented and approved by the ENGINEER.

B. The installer shall take the necessary precautions to protect the underlying layers upon which the geotextile will be placed. If the substrate is soil, construction equipment can be used provided that excess rutting is not created. 25 mm (1.0 in.) is the maximum rut depth allowed unless otherwise specified by the project manager.

C. During placement, care must be taken not to entrap (either within or beneath the geotextile) stones, excessive dust or moisture that could damage a geomembrane, cause clogging of drains or filters, or hammer subsequent seaming.

D. On side slopes, the geotextiles shall be anchored at the top and then unrolled so as to keep the geotextile free of wrinkles and folds.

E. Trimming of the geotextiles shall be performed using only an upward cutting hook blade.

F. If a thin sheet of plastic on the geomembrane is used during deployment of the geotextile, it shall be removed after correct positioning of the geotextile.

G. The geotextile shall be weighted with sandbags, or the equivalent, to provide resistance against wind uplift. Uplifted and moved geotextiles can be reused only after approval by the OWNER and observation by the ENGINEER.

H. A visual examination of the deployed geotextile shall be carried out to ensure that no potentially harmful objects are present, e.g., stones, sharp objects, small tools, sandbags, etc.

3.02 GEOTEXTILE EXPOSURE FOLLOWING PLACEMENT

A. Exposure of geotextiles to the elements between lay down and cover shall be a maximum of 14 days to minimize damage potential.

3.03 SEAMS

A. Geotextile used between geomembrane and gravel shall be continuously joined by either sewing or overlapping; minimum overlap shall be 12 inches. All seams shall be subject to the approval of the ENGINEER. Refer to geonet specification for seaming geotextile bonded to geonet.

B. On slopes greater than 5 to 1, seams shall be placed parallel to the slope gradient.

3.04 REPAIR

A. Any material damaged or displaced before or during placement of overlying layers shall be replaced or repaired to the satisfaction of the ENGINEER and at the CONTRACTOR's expense. A geotextile patch shall be placed over the damaged area and extend 3 feet beyond the perimeter of the tear or damage.

3.05 COVERING

A. Fill material covering the geotextile shall be placed such that the geotextile is not shifted from its intended position and underlying materials are not exposed or damaged.

B. The overlying material shall not be deployed such that excess tensile stress is mobilized in the geotextile.

C. Coverings shall be placed upon the geotextile within the time frame specified by the manufacturer or within 14 days, whichever is less.

SECTION 02279

GEONET

PART 1 - GENERAL

1.01 SCOPE

A. The work specified in this section covers furnishing all labor, materials, equipment and incidentals and complete installation ready for use of the geonet between the primary and secondary liner for the double liner system as shown in the Drawings and as specified herein.

PART 2 - PRODUCTS

2.01 GEONET

A. The geonet for this application shall be manufactured of polyethylene with the following properties:

1.	Thickness, inches ASTM D-5199	0.200 to 0.265
2.	Weight per square foot, lbs/ft^2 ASTM D-5261	0.180 $\pm$0.018
3.	Carbon Black Content, percent ASTM D-1603	2.5 $\pm$0.5
4.	Polymer Density, g/cm^3 ASTM D-1505	0.937 $\pm$0.002
5.	Melt Flow Index, g/10 min. ASTM D-1238 (condition E)	1.0
6.	Tensile Strength, ppi (Machine Direction) ASTM D-1682	50 $\pm$10
7.	Transmissivity, M^2/sec (min) ASTM D-4716	1 x 10^{-3}
8.	Extruded Solid Ribs	_____
9.	Ply Adhesion of Geotextile (pounds/inch) ASTM F904	1.0 Minimum 2.0 Average

2.02 QUALITY CONTROL

A. The manufacturer shall certify the quality of the geonet rolls. As a minimum, the manufacturer shall provide quality control certificates for each shift's production of geonet. The quality control certificates shall be signed by responsible parties employed by the manufacturer, such as the production manager, shall be notarized, and supplied to the OWNER. The quality control certificate shall include:

1. Roll numbers and identifications.

2. Sampling procedures and results and frequency of quality control tests: as a minimum, the tests indicated above, conducted with the methods indicated in the specifications.

2.03 ACCEPTED SUPPLIERS

A. Fluid systems, Inc. (Polynet) and Gundle.

2.04 PACKAGING

A. The manufacturer shall identify all rolls with the manufacturers name, product identification, roller number, roll dimensions, and date manufactured.

B. The core of the geonet roll must be stable enough to support the geonet roll while it is handled by either slings around it or from a fork lift "slinger" inserted in it.

C. The core shall have a minimum 4.0-inch inside diameter.

D. The banding straps around the outside of the roll shall be made from materials with adequate strength yet shall not damage the outer wrap(s) of the roll.

2.05 STORAGE AND SHIPMENT

A. If storage is for longer than six months, the rolls shall be covered by a sacrificial covering for protection against ultraviolet exposure, precipitation and accidental damage.

B. The stacking of rolls shall not cause buckling of cores nor flattening of the rolls.

C. Movement of rolls shall be such that no damage to the geonet occurs. Pushing, sliding or dragging of rolls shall not be permitted.

D. Temporary storage shall be in an area where standing water cannot occur.

E. The ground surface at the job site shall be suitably prepared such that no stones or other rough objects which could damage the geonet are present.

F. Suitable means of securing the rolls shall be used such that shifting, abrasion or other adverse movement does not occur.

G. Geonet shall not be stored in direct contact with the ground surface. A ground cloth shall be placed under the geonets to prevent weeds from growing into the lower rolls. If weeds do grow in the geonet, then the broken pieces must be removed by hand on the job when the geonet is deployed.

2.06 QUALITY CONTROL/QUALITY ASSURANCE

A. The following acceptance testing shall be performed.

1. Thickness, ASTM D-5199
2. Transmissivity, ASTM D-4716
3. Density per ASTM D-1505
4. Mass per unit area, ASTM D-5261
5. Compression ASTM D-1621

B. Samples shall be taken based on one sample per 100,000 ft^2. A sample shall consist of a 3-foot strip from the entire width of the roll on the outermost wrap.

C. Any nonconformance of test results shall be reported to the ENGINEER and the OWNER. The resolution of differences shall be specified by the ENGINEER with the approval of the OWNER.

PART 3 - EXECUTION

3.01 GEONET EXPOSURE FOLLOWING PLACEMENT

A. Exposure of geonet to the elements between lay down and cover shall be a maximum of 14 days.

3.02 SEAMS

A. The CONTRACTOR shall submit the proposed method of seaming panels together to the ENGINEER for review and comment prior to beginning work (metal hog rings shall not be used). As a minimum, overlap tying devices and tying interval shall be specified. Horizontal seams shall not be allowed on the side slopes.

B. In difficult areas, such as corners of side slopes, double layers of geonets shall be used.

C. Where double geonets are used, they shall be layered on top of one another such that interlocking does not occur.

D. Where double geonets are used, roll edges and ends shall be staggered so that the joints do not lie above one another.

E. Holes or tears in the geonet shall be repaired by placing a geonet patch extending a minimum of 0.3 m (12 in.) beyond the edges of the hole or tear. The patch should be tied to the underlying geonet at 0.15 m (6.0 in.) spacings.

F. Holes or tears along more than 50% of the width of the geonet on side slopes require the entire length of geonet to be removed and replaced.

3.03 REPAIR

A. Any material damaged or displaced before or during placement of overlying layers shall be replaced or repaired to the satisfaction of the ENGINEER and at the CONTRACTOR's expense.

B. Recycled or reclaimed material which has seen prior use in another project shall not be used in manufacture of the geonet. Regrind or reworked polymer may be added if it is the same formulation as the geonet being produced. No fillers, extenders, or other materials shall be mixed into the formulation.

SECTION 02280

GEOMEMBRANE

PART 1 - GENERAL

1.01 SCOPE

A. Included in this section of these specifications are the requirements for furnishing all labor materials, equipment and incidentals and complete installation and ready for use of the High Density Polyethylene (HDPE) geomembrane for the solid waste disposal cell as shown on the Drawings and as specified herein.

1.02 EXPERIENCE

A. Manufacturer - The manufacturer of the lining material described hereunder shall have previously demonstrated his ability to produce this membrane by having successfully manufactured a minimum of one hundred million square feet of similar liner material for hydraulic lining installations. The manufacturer must be listed by the NSF (National Sanitation Foundation) Standard 54.

B. Installer - The Installer shall demonstrate previous experience in similar liner installations. The Installer shall have installed at least fifty million square feet of liner and shall meet the requirements outlined in subsequent sections of these specifications.

PART 2 - PRODUCTS

2.01 LINING MATERIAL

A. The new membrane liner shall be comprised of HDPE material manufactured of VIRGIN, first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures. Manufacturer shall, as a minimum, perform density (ASTM D-792 or D-1505) and melt flow index tests (ASTM D-1238) tests on the incoming resin.

B. The CONTRACTOR shall, at the time of bidding, submit a certification from the manufacturer of the sheeting, stating that the sheeting meets physical property requirements stated in these specifications.

C. The liner material shall be so produced as to be free of holes, surface blemishes, scratches, blisters, undispersed raw materials, or any sign of contamination by foreign matter (e.g., nonuniform color, streaking, roughness, carbon black agglomerates, visually discernible regrind, etc.).

D. The lining material shall be manufactured a minimum of 15 feet seamless widths. Labels on the roll shall identify the thickness, length, and manufacturer's roll number. There shall be no factory seams.

E. The manufacturer shall provide quality control certificates for each batch of resin and each shift's production of geomembrane. These quality control certificates shall be signed by responsible parties employed by the manufacturer, such as the production manager, shall be notarized, and supplied to the ENGINEER. The quality control certificate shall include:

1. Roll numbers and identification.

2. Sampling procedures and results of quality control tests: as a minimum, the tests indicated in Table 1 (located at the end of this section) conducted with the methods indicated in the specifications or equivalent methods.

F. The liner material shall meet the specification values listed in Table 1.

G. The geomembrane formulation shall consist of at least 97% of polyethylene resin. No fillers, extenders, or older materials shall be mixed into the formulation.

H. Reclaimed material that has seen previous service life and is recycled shall not be allowed in the formulation.

I. The carbon black used in the geomembrane shall be a Group 3 category or lower, as defined in ASTM D-1765.

J. In the event that carbon black is mixed into the formulation in the form at a concentrate rather than a powder, the carrier resin of the concentrate shall be the same generic type as the base polyethylene resin.

K. The maximum amount of additives in a particular formulation shall not exceed 1.0% by weight.

L. The width of finished sheets shall be uniform within $\pm 2\%$.

M. The core shall be stable enough to support the roll without buckling or otherwise failing during handling, storage and transportation.

2.02 SUPPLIERS

A. PolyAmerica, Gundle, and National Seal.

2.03 PACKAGING

A. The cores on which the rolls of geomembranes are wound shall be at least 150 mm (6.0 in.) outside diameter.

B. The cores shall have a sufficient inside diameter such that fork lift stingers can be used for lifting and movement.

C. The cores shall be sufficiently strong that the roll can be lifted by a stinger or with slings without excessively deflecting, nor structurally buckling the roll.

D. The maximum stacking limit of rolls is five rolls high.

E. If storage is for longer than six months, the rolls shall be covered by a sacrificial covering, or placed within a temporary or permanent enclosure.

F. The manufacturer shall identify all rolls with the manufacturer's name, product identification, thickness, roller number, roll dimensions and date manufactured.

G. Palleted geomembranes shall be stored only on level surfaces.

H. The stacking of palleted geomembrane panels on top of one another is not permitted.

I. If storage at the fabricator's facility is for longer than six months, the palleted panels shall be covered with a sacrificial covering, temporary shelter or placed within a permanent enclosure.

J. The fabricator shall identify all panels with the manufacturers name, product information, thickness, panel number, panel dimensions and date manufactured.

2.04 SHIPMENT HANDLING AND SITE STORAGE

A. Unloading of rolls or pallets at the job site's temporary storage location shall be such that no damage to the geomembrane occurs.

B. Pushing, sliding or dragging of rolls or pallets of geomembranes shall not be permitted.

C. Offloading at the job site shall be performed with cranes or fork lifts in a workmanlike manner such that damage does not occur to any part of the geomembrane.

D. Temporary storage at the job site shall be in an area where standing water cannot accumulate at any time.

E. The ground surface shall be suitably prepared such that no stones or other rough objects which could damage the geomembranes are present.

F. Temporary storage of rolls of geomembranes in the field shall not be so high that crushing of the core or flattening of the rolls occur. This limit is typically five rolls high.

G. Suitable means of securing the rolls shall be used such that shifting, abrasion or other adverse movement does not occur.

H. If storage of rolls or pallets of geomembranes at the job site is longer than six months, a sacrificial covering or temporary shelter shall be provided for protection against precipitation, ultraviolet exposure and accidental damage.

2.05 QUALITY ASSURANCE

A. The tests listed in the table at the end of this section shall be performed on the geomembrane.

B. All conformance test results shall be reviewed, accepted and reported by the ENGINEER before deployment of the geomembrane.

C. Any nonconformance of test results shall be reported to the OWNER. The method of a resolution of such differences shall be as specified by the ENGINEER with the approval of the OWNER.

PART 3 - EXECUTION

3.01 SUBBASE

A. Refer to Section 02215, Liner Subbase Preparation, Surfaces to be lined shall be smooth and free of all rocks, stones, sticks, roots, sharp objects, or debris of any kind. The surface should provide a firm, unyielding foundation for the membrane (refer to specifications for earth work and grading, Section 02200) with no sudden, sharp or abrupt changes or break in grade. No standing water or excessive moisture shall be allowed. The installation CONTRACTOR shall certify in writing that the surface on which the membrane is to be installed is acceptable before commencing work.

3.02 PLACEMENT

A. Construction equipment deploying the rolls or pallets shall not deform or rut the soil subgrade excessively. Tire or track deformations beneath the geomembrane shall not be greater than 25 mm (1.0 in.) in depth.

B. When placing the geomembrane on another geosynthetic material (geotextile, geonet, etc.), construction equipment shall not be permitted to ride directly on the lower geosynthetic material. In cases where rolls must be moved over previously placed geosynthetics it is necessary to move materials by hand or by using small pneumatic tired lifting units. Tire inflation pressures should be limited to a maximum value of 40 kPa (6 lb/in^2).

C. Underlying geosynthetic materials (such as geotextiles or geonets) shall have all folds, wrinkles and other undulations removed before placement of the geomembrane.

D. Care, and planning, should be taken to unroll or unfold the geomembrane close to its intended, and final, position.

E. Geomembranes, when unrolled or unfolded, shall not stick together to the extent where tearing, or visually observed straining of the geomembrane occurs. The upper temperature limit is very specific to the particular type of geomembrane. A sheet temperature of 50°C (122°F) is the upper limit that a geomembrane shall be unrolled or unfolded unless it is shown otherwise to the satisfaction of the ENGINEER.

F. Geomembranes which have torn or have been excessively deformed shall be rejected or repaired to the satisfaction of the ENGINEER.

G. Sufficient slack shall be placed in the geomembrane to compensate for the coldest temperatures envisioned so that no tensile stresses are generated in the geomembrane or in its seams either during installation or subsequently after the geomembrane is covered.

H. The geomembrane shall have adequate slack such that it does not lift up off of the subbase or substrate material at any location within the facility, i.e., no "trampolining" of the geomembrane shall be allowed to occur at any time.

I. The geomembrane shall not have excessive slack to the point where creases fold over upon themselves, either during placement and seaming, or when the protective soil or drainage materials are placed on the geomembrane.

J. Permanent (fold-over type) creases in the covered geomembrane shall not be permitted at any time.

K. Spotting of deployed geomembranes shall be done with no disturbance to the soil subgrade or geosynthetic materials upon which they are based.

L. Spotting shall be done with a minimum amount of dragging of the geomembrane on soil subgrades.

M. Temporary tack welding (usually with a hand held hot air gun) of all types of thermoplastic geomembranes will be allowed at the installers discretion.

N. When temporary tack welds of geomembranes are utilized, the welds shall not interfere with the primary seaming method, or with the ability to perform subsequent destructive seam tests.

3.03 FIELD SEAMING PROCEDURES

A. CONTRACTOR Experience - The installation of the HDPE must be done by the manufacturer or authorized representative using the manufacturer's extrusion or hot double wedge welding equipment and installation methods. All supervisors overseeing the liner installation must have ten million square feet of supervisory liner experience. All field technicians must have over one million square feet of seaming experience.

B. The Installer shall produce layout drawings of the proposed placement pattern and seams prior to geomembrane placement. The drawings shall indicate the panel

configuration and location of seams. The layout drawings must be approved by the OWNER, prior to the installation of any geomembrane. The layout shall be suitable for use as construction drawings and shall include dimensions, details, etc. The installer shall use these drawings as a base for providing record drawings at the completion of the project.

C. Panel Identification - Each roll shall be redesignated with a panel number ("identification code") which is consistent with the layout plan. A panel is the unit area of in-place geomembrane which is to be seamed in the field (i.e., one roll may be cut into several panels). The geomembrane shall be positioned on the site as shown in the layout drawings. Instructions on the boxes or wrapping containing the geomembrane materials shall be followed to assure the panels are unrolled in the proper direction for seaming.

D. Panel Placement - Individual panels of liner materials shall be laid out and overlapped by a maximum of four inches (101 millimeters) for extrusion welding or five inches (127 millimeters) for hot wedge welding. Extreme care shall be taken by the installer in the preparation of the areas to welded. The area to be welded shall be cleaned and prepared according to the procedures laid down by the material manufacturer. All sheeting shall be welded together by means of integration of the extrudate bead with the lining material or the sheeting shall be welded together using the double hot wedge welding system. The composition of the extrudate in the extrusion welding process shall be identical to the lining material.

E. Weather Conditions - Geomembrane placement shall not proceed at an ambient temperature below 5°C (40°F). Geomembrane placement shall not be done 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.

F. Temperature Control - The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the lining material so as to ensure that changes in environmental conditions will not affect the integrity of the weld.

G. Fish Mouths - No "fish mouths" shall be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped, and an overlap extrusion weld shall be applied.

3.04 ON-SITE FIELD SEAM TESTING

A. The installer shall employ on-site physical non-destructive testing on all welds at sample locations designated by the ENGINEER.

B. The ENGINEER shall inspect each seam. Any area showing a defect shall be marked and repaired in accordance with HDPE repair procedures.

C. A test weld three (3) feet long [one (1) meter] long from each welding machine shall be run at least at the beginning of each day, and after the noon break, prior to liner welding and under the same conditions as exist for the liner welding. No

welder may start work until the sample weld has been approved by the ENGINEER. The test weld shall be marked with date, ambient temperature, and welding machine number. Samples of weld 1/4" to 1/2" (10mm to 20mm) wide shall be cut from the test weld and tested using a tensiometer. The weld should not peel. Seams should exhibit a film tear bond (a pass result occurs when the sheeting yields. A fail result occurs when the weld peels). The weld sample shall be kept for subsequent testing on laboratory tensiometer equipment in accordance with the applicable ASTM standards. In addition, the ENGINEER shall have the option of requesting test strips of any field seaming crew or device at any time.

D. The fabrication of field test strips and the testing of the test specimens shall be observed by field quality assurance personnel. Field test strips may be discarded after the destructive test specimens are removed and tested.

E. Non-destructive Seam Continuity Testing: The installer shall non-destructively test all field seams over their full length using a vacuum test unit (extrusion process) or air pressure (hot double wedge process). Continuity testing shall be done as the seaming work progresses, not at the completion of all field seaming.

F. The following procedures shall apply to locations where seams cannot be non-destructively tested, as determined by the ENGINEER.

1. All such seams shall be cap-stripped with the same geomembrane.

2. If the seam cannot be tested prior to final installation, the seaming and cap-stripping operations shall be observed by the ENGINEER for uniformity and completeness.

G. Test Condition - The following test conditions shall be followed for each test listed below:

1. Air Pressure Test - pressure held 30 psig for 5 minutes with maximum loss of 2 psig.

2. Vacuum Box Test - Hold vacuum in box of at least 3 psi for 15 seconds for each section of seam. (Visual inspection of seam for air bubbles during vacuum box testing is required)

3. Quality assurance personnel shall observe all nondestructive testing procedures. The location, data, test number, name of test person and outcome of tests shall be recorded. The OWNER shall be informed of any deficiencies.

3.05 LABORATORY TESTS OF FIELD SEAMS

A. Location of Samples - Destructive shear and peel tests shall be done by random selection of an actual field weld no less than one sample per 500 feet (150 meters) of weld.

1. ENGINEER shall observe all production seam sample cutting.

2. All samples shall be adequately numbered and marked with permanent identification.

3. All sample locations shall be indicated on the geomembrane layout (and record) drawings.

4. The reason for taking the sample shall be indicated, e.g., statistical routine, suspicious feature, change in sheet temperature, etc.

5. The sample dimensions shall be given insofar as the length of sample and its width. The seam will generally be located along the center of the length of the sample.

6. The distribution of various portions of the sample (if more than one) shall be specified.

7. The following ASTM test methods shall be used.

Geomembrane	Seam Shear Test	Seam Peel Test	Sheer Test
HDPE	D-4437	D-4437	D-638

8. The ENGINEER shall witness all field tests and will observe that proper identification and details accompany the test results. Details, as follows, are required.

   a. Date and time.

   b. Ambient temperature.

   c. Identification of seaming unit, group or machine.

   d. Name of master seamer.

   e. Welding apparatus temperature and pressure, or chemical type and mixture.

   f. Pass or fail description.

   g. A copy of the report shall be attached to the remaining portion of the sample.

9. The ENGINEER will verify that samples sent to the testing laboratory are properly marked, packaged and shipped so as not to cause damage.

10. Results of the laboratory tests shall come to the ENGINEER in a stipulated time agreed upon by the Project Manager. For extrusion and thermally

bonded seams, verbal test results are required within 24 to 72 hours after the laboratory receives the samples. The ENGINEER will inform the OWNER's representative of the results and make appropriate recommendations.

11. Each repair of a patched seam where a test sample had been removed shall be verified. This shall be done by a nondestructive test. If, however, the sampling strategy selected calls for a destructive test to be made at the exact location of a patch, it shall be accommodated. Thus, the final situation will require a patch to be placed on an earlier patch.

B. Size of Samples - The samples shall be 0.4 m (15 in.) wide by (44 in.) long with the seam centered lengthwise. One 20 mm (1 in.) wide strip shall be cut from each end of the sample and these shall be tested by the Installer in the field, by tensiometer, for peel and shear respectively and shall not fail in the seam. The remaining sample shall be cut into three parts and distributed as follows:

1. One portion to the Installer for laboratory testing (15" x 15").

2. One portion for independent laboratory testing (15" x 15").

3. One portion to the OWNER for archive storage (15' x 12").

C. Installer's Laboratory Testing - All test results from the Installer's laboratory shall be submitted to the OWNER as soon as they become available. Test method details are given in Table 2 (located at the end of this section).

D. Independent Laboratory - An independent laboratory employed by the OWNER will test each sample. It is the responsibility of the CONTRACTOR to package and send the samples to the independent laboratory. Test method details are given in Table 2 (located at the end of this section).

E. Procedures for Destructive Test Failure - The following procedures shall apply whenever a sample fails the field destructive test. The Installer shall have two options:

1. The Installer shall reconstruct the seam between the failed location and the last passed location.

2. The Installer shall retrace the welding path to an intermediate location (at least ten feet) and take a small sample for an additional field test. If this additional sample passes, then the seam shall be reconstructed from that point onward. If this sample fails, then the process shall be repeated except that a full laboratory sample shall be taken and the sample must pass the laboratory tests.

F. In any case, all acceptable seams shall be bounded by two fully passed test locations, and one test shall be taken within the reconstructed area.

G. In the event that a laboratory sample fails a destructive test, then the above procedures shall be followed, but in both directions from the failure location. The final seam must be bounded by two fully passed test locations, the Installer shall take one or more new laboratory samples in addition to the one required in the reconstructed seam area.

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

3.06 DEFECTS AND REPAIRS

A. Identification - The geomembrane surface shall be broomed or washed by the Installer if the amount of dust or mud inhibits inspections.

B. Evaluation - Each suspect location in seam and non-seam areas shall be non-destructively tested. Each location which fails the non-destructive testing shall be repaired by the Installer, at no additional cost to the OWNER.

C. Repair Procedures:

1. Defective seams shall be repaired by reconstruction.

2. Tears or pinholes shall be repaired by seaming or patching.

3. Blisters, larger holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches.

4. Surfaces of HDPE which are to be patched shall be abraded no more than one hour prior to the repair.

5. All seams used in repairing patches must be approved extrusion welded seams; and shall be subjected to the same destructive test procedures outlined for other seams.

D. Patches shall be round or oval in shape, made of the same geomembrane, and extend a minimum of 150 mm (6 in.) beyond the edge of defects.

E. Patches shall be applied using approved welding methods described above.

F. Seam Reconstruction Procedures - Seam reconstruction for the extrusion welding process shall be achieved by grinding the existing seam and rewelding a new seam.

G. Seam reconstruction for the hot double wedge process shall be achieved by cutting out the existing seam, welding in a replacement strip and cap stripping the new seam.

H. Verification of Repairs - Each repair shall be non-destructively tested using the methods described in a previous Section, as appropriate. Repairs which pass the

non-destructive test shall be taken as an indication of an adequate repair. Failed tests shall indicate that the repair shall be redone and retested until a passing test results.

3.07 BACKFILL

A. Backfilling of Anchor Trench - The anchor trench, if any, shall be backfilled and compacted by the Installer to the specifications noted on the design drawings. Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane.

B. Backfill Over Liner - Backfill over the liner cannot commence until the ENGINEER has reviewed the satisfactory laboratory tests and authorizes the CONTRACTOR to proceed. The CONTRACTOR shall place backfill over the geomembrane in such a way as to avoid creating a "wave" of liner ahead of the filling operation. The CONTRACTOR shall submit a proposed procedure for backfill for review by the ENGINEER for review and approval prior to beginning placement of the backfill material. Only light weight, low ground pressure equipment will be allowed to spread backfill over the liner. The equipment shall not make sharp turns or twisting motions in the backfill over the liner. The equipment shall operate in general back and forth patterns with only slight turning motions when necessary.

3.08 PROTECTION FROM WIND DAMAGE

A. The CONTRACTOR shall place sand bags on the liner as the installation proceeds in accordance with the liner manufacturer's recommendations.

1. Geomembrane rolls or panels which have been displaced by wind shall be inspected and approved by the ENGINEER before any further field operations commence.

2. Geomembrane rolls or panels which have been damaged (torn, punctured, or deformed excessively and permanently) shall be rejected and/or repaired as approved by the ENGINEER.

3. Permanent crease marks, or severely folded (crimped) locations, in geomembranes shall not be permitted unless it can be shown that such distortions have no adverse effect on the properties of the geomembrane. If this cannot be done, these areas shall be cut out and properly patched as per the contract documents and approved by the ENGINEER.

4. If patching of wind damaged geomembranes becomes excessive, the entire roll or panel shall be rejected.

3.09 INSTALLATION OF MATERIALS IN CONTACT WITH THE GEOMEMBRANE

A. The geomembrane shall be installed around any pipes, piers, concrete pits (or other appurtenances protruding through the geomembrane) as detailed on the design drawings. Unless otherwise specified, a geomembrane sleeve or shield shall

initially be installed around each appurtenance, prior to the geomembrane installation. After the material has been placed and seamed, the final field seam connection between the appurtenance sleeve or shield and the geomembrane shall be completed. A sufficient initial overlap of the appurtenance sleeve shall be maintained so that shifts in location of the geomembrane can be accommodated.

B. Installation on rough surfaces such as concrete shall be carefully performed to minimize damage. Additional loosely placed geotextile sections may be used by the Installer as protection for geomembrane, if approved by the ENGINEER.

C. All clamps, clips, bolts, nuts or other fasteners used to secure the geomembrane to each appurtenance shall have a life-span equal to or exceeding the geomembrane.

D. Quality assurance personnel shall be available at all times during backfilling of the geomembrane.

E. Granular Materials - The following shall be carefully complied with:

1. Placement of granular materials on the geomembrane shall not proceed at an ambient temperature below 5°C (40°F).

2. Personal vehicles, material vehicles or equipment used for placing granular material shall not be driven directly on the geomembrane.

3. Placement of granular material shall be done in such a manner that geomembrane damage is unlikely.

4. If excessively high temperatures cause the membrane to fold over on itself, then placement of granular materials shall cease and work hours rescheduled to allow placement at night or during cooler periods during the day.

F. Concrete - Construction methods used to place concrete shall not damage the geomembrane.

1. A double liner thickness shall be installed in areas where the concrete is on top of geomembrane.

2. Consideration should be given to add geotextiles to protect liners beneath concrete.

G. Sumps and Appurtenances

1. Extreme care shall be taken while welding around appurtenances since both non-destructive and destructive testing might not be feasible.

2. The geomembrane shall not be damaged while making connections to sumps and appurtenances.

H. Documentation shall include the soil type, lift thickness, total thickness, density and moisture conditions.

3.10 ACCEPTANCE

A. The Installer shall retain all ownership and responsibility for the geomembrane until acceptance by the OWNER. This geomembrane liner will be accepted by the OWNER when:

1. Written certification letter sealed by the OWNER's registered professional ENGINEER has been received by the OWNER.

2. The installation is finished.

3. All documentation of installation is completed.

4. Verification of the adequacy of all field seams and repairs, including associated testing, is complete.

3.11 WARRANTY

A. The CONTRACTOR shall warranty the liner to be free of defects for a period of 20 years.

TABLE 1. HDPE LINER PROPERTIES - SMOOTH SHEET

TYPICAL PROPERTIES	TEST METHOD	VALUE	TESTING FREQUENCY
Gauge Thickness, mils min. ±10%	ASTM D1593	60 mil nominal 54 mil minimum	once/sht.
Density g/cc. (Min)	ASTM D1505	0.93 minimum	once/batch
Melt Flow Index g/10 min.	ASTM D1238 Condition E (190°C, 2.16kg.)	1.0 maximum 0.1 minimum	once/batch
Tensile Properties			
1. Tensile Strength at Break (Pounds/inch width)	ASTM D638 Type IV Dumb-bell at 2 ipm.	190 minimum	1/50,000 ft²
2. Tensile Strength at Yield (Pounds/inch width)		120 minimum	1/50,000 ft²
3. Elongation at Break (%)		600 maximum	1/50,000 ft²
4. Elongation at Yield (%)		13 maximum	1/50,000 ft²
Puncture Resistance Pounds.	FTMS 101 Method 2065	80 minimum	1/50,000 ft²
Tear Resistance Initiation lbs.	ASTM D1004 Die C	30 minimum	1/50,000 ft²
Low Temperature Brittleness °F	ASTM D746 Procedure B	-40 minimum	1/50,000 ft²
Dimensional Stability. % Change Each Direction	ASTM D1204 212°F 1 hr.	±2 maximum	1/50,000 ft²
Resistance to Soil Burial. Percent change in original value.	ASTM D3083 using ASTM D638 Type IV Dumb-bell at 2 ipm.		1/50,000 ft²
Tensile Strength at Break and Yield.	% Change	±10 maximum	
Elongation at Break & Yield	% Change	±10 maximum	
Environmental Stress Crack. Hours.	ASTM D1693	500 minimum	1/50,000 ft²
Carbon Black	ASTM D1603	2% minimum 3% maximum	once/shtl
Max. Vapor Transmission Rate	E96-80	0.24 g/m² minimum	1/50,000 ft²

TABLE 2. TEST METHOD DETAILS FOR GEOMEMBRANE SEAMS IN SHEAR AND IN PEEL AND FOR UNSEAMED SHEET

TYPE OF TEST	HDPE	VALUE
Shear Test on Seams		
ASTM Test Method	D4437	
Specimen Shape	Strip	
Specimen Width (in.)	1.00	
Specimen Length (in.)	6.00 + seam	
Gage Length (in.)	4.00 + seam	
Strain Rate (ipm)	2.0	
Strength (psi) or (ppi)	Force/(1.00xt)	120 lbs/ in width
Peel Test on Seams		
ASTM Test Method	D4437	
Specimen Shape	Strip	Film Tear Bond and 78
Specimen Width (in.)	1.00	
Specimen Length (in.)	4.00	
Gage Length (in.)	n/a	
Strain Rate (ipm)	2.0	
Strength (psi) or (ppi)	Force/(1.00xt)	Film Tear Bond and 78
Tensile Test on Sheet		
ASTM Test Method	D638	
Specimen Shape	Dumbbell	
Specimen Width (in.)	0.25	
Specimen Length (in.)	4.50	See Table 1
Gage Length (in.)	1.30	
Strain Rate (ipm)	2.0	
Strength (psi) or (lb)	Force/(0.25xt)	
Strain (in./in.)	Elong./1.30	
Modulus (psi)	From Graph	

where n/a = not applicable
t = geomembrane thickness
psi = pounds/square inch of specimen cross section
ppi = pounds/linear inch width of specimen
ipm = inches/minute
Force = maximum force attained at specimen failure (yield or break)

SECTION 02485

SODDING AND SEEDING

PART 1 - GENERAL

1.01 SCOPE

A. The CONTRACTOR shall furnish all materials and labor necessary for establishing grass as shown on the drawings. It is the intent of this specification that all disturbed areas, not otherwise protected, or located with the ash disposal unit area, be sodded or seeded (with mulching). Sodding shall be used on all slopes 3:1 on steeper and the remaining areas shall be seeded unless otherwise noted in drawings.

1.02 STORAGE OF MATERIALS

A. The CONTRACTOR shall provide space for storage of sod prior to placement in a manner that will not endanger or restrict pedestrian or vehicular traffic.

PART 2 - PRODUCTS

2.01 SOD

A. Sod shall be in accordance with section 575-1 through 575-2 of the FDOT Specifications. Sod being replaced in existing sodded areas shall be replaced in kind. Sod in new areas shall be Argentina Bahia.

2.02 SEED

A. Seed shall be in accordance with Section 570-1 through 570-3 of the FDOT Specifications and shall be Argentina Bahia.

2.03 MULCH

A. Mulch shall be in accordance with Section 570-1 through 570-3 of the FDOT Specifications.

PART 3 - EXECUTION

3.01 SODDING

A. Sodding shall be in accordance with Section 575-3 of the DOT Specifications.

3.02 SEEDING

A. Seeding shall be in accordance with Section 570-4 through 570-5 of the DOT Specifications.

3.03 MULCHING

A. Mulching shall be in accordance with Section 570-4 of the DOT Specifications.

3.04 MAINTENANCE

A. Sodding and seeding shall be maintained in accordance with Section 570-5 and 575 of the Florida DOT Specifications.

3.05 REPAIRS TO GRASSED AREAS DISTURBED BY CONTRACTOR'S OPERATIONS

A. Grassed areas established under this contract and all grassed areas damaged by the CONTRACTOR's operation shall be repaired at once by proper soil preparation, fertilizing, and resodding or reseeding, in accordance with these Specifications.

3.06 GUARANTEE PERIOD AND FINAL ACCEPTANCE

A. All grassed areas shall be guaranteed by the CONTRACTOR for the period from installation to one year past provisional acceptance and the CONTRACTOR obtain a maintenance bond for that period.

B. During this guarantee period the CONTRACTOR shall be responsible for watering, fertilizing, mulching, erosion control, etc. The CONTRACTOR shall inspect the grassed areas no less than once per month and shall submit a written report to the OWNER concerning the condition of these areas. At any time during the guarantee period, if erosion is reported, the OWNER will contact the CONTRACTOR. The CONTRACTOR shall respond immediately and repair the eroded surfaces.

C. At the end of the guarantee period, inspection will be made by the OWNER upon written request submitted by the CONTRACTOR at least ten (10) days before the anticipated date. Grassed areas not demonstrating satisfactory stands as outlined above, as determined by the OWNER, shall be renovated, resodded or reseeded, and maintained meeting all requirements as specified herein.

D. After all necessary corrective work has been completed, the ENGINEER will certify in writing the final acceptance of the sodded areas.

SECTION 02715

POLYETHYLENE LEACHATE PIPE

PART 1 - GENERAL

1.01 SCOPE

A. This section refers to leachate collection pipes and forced main. The CONTRACTOR shall furnish all labor, materials, equipment and main incidentals required for complete installation of polyethylene pipe, fittings and all appurtenances as shown on the Drawings and as specified herein.

1.02 SUBMITTALS

A. The CONTRACTOR shall submit to the ENGINEER within ten days after signing the contract, a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.

B. The CONTRACTOR shall submit for approval, as provided in the general Conditions, complete, detailed shop drawings of all polyethylene pipe and fittings.

C. The CONTRACTOR shall submit and shall comply with pipe manufacturer's recommendations for handling, storing and installing pipe and fittings.

D. The CONTRACTOR shall submit pipe manufacturer's certification of compliance with these specifications.

E. The CONTRACTOR shall submit a manufacturer's certification that the pipe was manufactured from resins in compliance with these specifications. The certificate shall state the specific resin, its source and the specific information required by ASTM 1248. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogenous throughout and free of visible cracks, holes (other than leachate manufactured perforation), foreign inclusions, or other deleterious defects and shall be identical in color, density, melt index and other physical properties.

F. The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific product. This stress regression testing shall have been done in accordance with ASTM D2837, and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi, as determined in accordance with ASTM D2837.

1.03 WARRANTY

A. The manufacturer must warrant the pipe to be free from defects in material and workmanship in accordance with ASTM D3350 and F714, latest editions.

1.04 EXPERIENCE

A. The CONTRACTOR shall have installed at least one mile of polyethylene pipe over a liner.

PART 2 - PRODUCTS

2.01 POLYETHYLENE (PE) PIPE

A. Polyethylene (PE) leachate pipe resins shall be high performance, high molecular weight, high density polyethylene conforming to ASTM D-1248 (Type III, Class C, Category 5, Grade P34), and ASTM D-3350 (Cell Classification PE 355434C). The pipe and fittings shall be manufactured with a minimum of 2 percent carbon black to withstand outdoor exposure with out loss of properties. All polyethylene pipe shall meet the requirements of ASTM F714. Manufacturer shall provide a certification of the type and amount of carbon black used. The amount of additives used shall also be reported. Each pipe length shall be marked with the manufacturer's name or trademark, size, material code and standard dimension ratio.

2.02 JOINTS

A. The pipe shall be butt fusion joints. All joints shall be made in strict compliance with the manufacturer's recommendations. Where required, flange connections shall be provided. Pipe shall be furnished non-perforated or perforated, as specified in the drawings.

2.03 PERFORATIONS

A. The perforations shall be drilled into the pipe after manufacture, prior to deliver at job site. The perforated pipe shall have holes, as shown in the drawings, with allowable tolerances 1/16 inch on the diameter and plus 1/4 inch on the spacing and the rows shall be parallel to the axis of the pipe and within plus or minus 5 degrees of location shown in drawings.

2.04 LENGTH

A. Pipe shall be furnished in standard laying length not exceeding 50 feet.

2.05 CONNECTIONS

A. Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, pumps and tanks shall be through flanged connections which shall consist of the following:

1. All polyethylene flange connections called a "stub end" shall be thermally butt-fused to the ends of the pipe.

2. A metal back-up flange shall be 316 stainless steel and be sized to ANSI B16.6 outside diameter and drillings.

3. Other mechanical couplings such as 360 degree full circle clamps can be used as approved by the ENGINEER only.

2.06 STANDARD DIMENSION RATIO (SDR)

A. The SDR for various pipe applications is:

1. 6" Perforated - SDR-17
2. 8" Perforated - SDR-17
3. 4" Leachate Main - SDR-17
4. Side slope riser pipe - SDR-13.5
5. 6" Solid - SDR-17
6. 8" Solid -SDR-17
7. 6" Containment - SDR-21

2.07 PACKAGING

A. Pipes shall be packaged such that either fork lifts or cranes using slings can be used for handling and movement.

2.08 QUALITY ASSURANCE

A. The pipe should be identified according to ASTM D-1248 and ASTM F-7H.

B. The conformance test samples shall make use of the same identification system as the appropriate ASTM standard, if one is available.

C. A lot will be defined as a group of consecutively numbered pipe sections from the same manufacturing line.

D. Sampling will be based on one sample per lot, not to exceed one sample per 300 m (1,000 feet) of pipe.

E. Conformance tests at the CQA Laboratory will include the following:

1. Physical dimensions according to ASTM D-2122, density according to ASTM D-1505, plate bearing test according to ASTM D-2412 and impact resistance according to ASTM D-2444.

F. Conformance test results shall be sent to the ENGINEER prior to deployment of any pipe from the lot under review.

G. The ENGINEER will review the results and report any non-conformance to the Project Manager.

H. Pipe failing to meet conformance tests will not be considered acceptable for use unless specified otherwise by the Project Manager.

PART 3 - EXECUTION

3.01 STORAGE AND HANDLING

A. The CONTRACTOR shall use care in handling, in storage and installation of the pipe. Storage of pipe on the job site shall be done in accordance with the pipe manufacturer's recommendation. Under no circumstances shall pipe be dropped into the trench. Pipe perforations shall be drilled prior to delivery at job site.

B. Pipe shall be laid to line and grade shown on the drawings with bedding and backfill as shown on the drawings.

C. The CONTRACTOR shall minimize the amount of sand and debris collected on the inside of the perforated pipe while handling, prior to placement of granite rock.

D. Pipe shall be stored on clean, level ground to prevent undue scratching or gouging. The location of field storage shall not be in areas where water can accumulate. The pallets shall be oriented so as not to form a dam, creating the ponding of water.

E. The pallets shall not be stacked more than three high. Furthermore, they shall be stacked in such a way that access for conformance testing is possible.

F. Outdoor storage of plastic pipe shall not be longer than 12 months. For storage periods longer than 12 months a temporary covering shall be placed over the pipes, or they shall be moved to within an enclosed facility.

G. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 10% of wall thickness. The interior pipe surface shall be free of cuts, gouges or scratches.

H. Sections of pipe with cuts, scratches or gouges shall be removed completely and the ends of the pipeline rejoined at the CONTRACTOR's expense.

3.02 INSTALLATION LEACHATE FORCE MAIN

A. The dual containment polyethylene (PE) leachate pipes shall be installed in accordance with the instructions of the manufacturer, as shown on the drawings and as specified herein. All heat fusion joints shall be done by factory certified fusion technician as designated by the pipe manufacturer.

B. The CONTRACTOR shall provide adequate equipment for the removal of storm or subsurface waters which may accumulate in the excavated areas. CONTRACTOR is responsible for obtaining any permits for dewatering. If subsurface water is encountered, the CONTRACTOR shall utilize approved means

to adequately dewater the excavation so that it will be dry for working and pipe laying. A wellpoint system or other approved dewatering method shall be utilized if necessary to maintain the excavation in a dry condition for preparation of the trench bottom and for pipe laying. All existing improvements such as pavements, conduits, poles, pipes and other structures shall be carefully supported and fully protected from injury and, in case of damage, they shall be restored without compensation. Existing utilities and other underground obstructions are shown on the plans but the accuracy of the locations and depths is not guaranteed. The CONTRACTOR shall be responsible for damages to these existing utilities and shall, in case they are damaged, restore them to their original condition at his own expense.

C. Trench Excavation: Trenches shall be excavated to such width as may be necessary for proper laying of the pipe with banks as nearly vertical as practicable. The bottom of trenches shall be accurately graded to provide uniform bearing on undisturbed soil for the entire length of each section of pipe. Depressions shall be excavated after the trench bottom has been graded and such holes and depressions shall not be made larger than is necessary for properly making the particular type of joint. The width of the trench at and below the top of the pipe shall not be greater than necessary to permit jointing and thorough tamping of the backfill around the pipe. The width of the trench above the level may be as wide as necessary for sheeting and bracing and the proper performance of the work. The bottom of the trench shall be rounded so that the bottom quadrant of the pipe will rest firmly on undisturbed soil for as nearly the full length of the barrel as proper jointing operations will permit. This part of the excavation shall be done manually only a few feet in advance of the pipe laying by men skilled in this type of work. Unauthorized overdepths shall be backfilled with loose, granular, moist earth, thoroughly tamped. Whenever the presence of incipient slides is noted during excavation, the trench walls shall be restrained with adequate sheeting, shoring and bracing. The CONTRACTOR shall be responsible for the safety of his men working in the trench. The CONTRACTOR is cautioned to take adequate safety measures and give appropriate personnel training with respect to trench side wall stability.

D. Removal of Unstable Material: It is the intent of this specification that all pipe and other structures shall be provided with a stable foundation and that any material which by reason of kind or condition is not or cannot be made stable by drainage or compaction shall be removed and replaced. Therefore, any material encountered at the elevation shown on the drawings or specified for pipe, that will not or cannot be improved to provide a stable foundation for the pipe shall be removed and replaced. All unstable material below the grade line of the pipe shall be removed for the full width of the trench and replaced with suitable selected material and compacted. For the purpose of this specification, muck, peat and other highly organic soils shall be considered to be unstable materials. Also, any fine-grained soil which is or might become wet to such a degree that its moisture content is equal to or greater than 90 percent of its liquid limit will have to be specifically approved by the ENGINEER with regard to stability or shall be considered to be an unstable material requiring removal and replacement.

E. Bedding: The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. The pipe shall be carefully bedded in a soil foundation that has been accurately shaped and rounded to conform to the lowest 1/4 of the outside circular portion of the pipe for its entire length, and when necessary, shall be tamped to secure uniform, firm support. Where bell and spigot pipe is used, the bell holes shall be deep enough to ensure that the bell does not bear on the bottom of the excavation, and shall not be excessively wide in the longitudinal direction of the culvert or storm drain. Bedding shall be Class C or better.

F. Anchors: Concrete weights shall be installed in accordance with Contract Drawings. Exact support assembly shall be as recommended by the pipe manufacturer.

G. Backfilling: Refer to Section 02200.

H. Polyethylene stub ends and flanges must be at the ambient temperature of the surrounding soil at the time they are bolted tight to prevent relaxation of the flange bolts and loosening of the joint due to Thermal Contraction of the polyethylene.

3.03 INSTALLATION OF LEACHATE COLLECTION PIPES

A. Trenches for the leachate collection shall be excavated within the drainage where shown on the Drawings. The CONTRACTOR shall exercise special care not to disturb or damage the geomembrane. If a backhoe is used to construct the trench a rubber modification will be installed on the bucket. All areas of the liner damaged shall be immediately repaired as directed by the ENGINEER.

B. The CONTRACTOR shall inform the ENGINEER when this trenching occupation is to the place and shall not proceed without the ENGINEER or authorization representative present. A 2-inch minimum layer of sand shall be placed in the bottom of the trench followed by geotextile strip. The leachate piping shall be installed, and shall be backfilled with river rock or crushed granitic rock to the depth and width shown on the Drawings. Care shall be taken during backfilling of the pipe to assure the pipe will not be crushed or otherwise damaged.

C. Following installation of the leachate collection piping, the drainage layer shall be brought to final grade with compacted fill.

D. Care shall be taken during the placing, spreading and compacting operations so as to preserve the integrity of the base liner, river rock or crushed granitic rock, filter fabric, and sand, to prevent mixing of the materials.

E. Exact methods for installation of the leachate collection system shall be presented to the ENGINEER prior to initiating work for approval.

3.04 CLEANING

A. The interior of the pipes shall be thoroughly cleaned of all foreign matter before being gently lowered in the trench and shall be kept clean during laying operations

by means of plugs or other approved methods. During suspension of work for any reason at any time, a suitable stopper shall be placed in the end of the pipe last laid to prevent mud or other foreign material from entering the pipe.

PART 4 - QUALITY ASSURANCE TESTING

4.01 PRESSURE TESTING OUTSIDE THE TRENCH

A. Pressure testing may be conducted prior to pipe installation. After the pipe has been joined, it shall be filled with water, taking care to bleed off any trapped air. It shall then be subjected to a hydrostatic test pressure of a maximum of 1.5 times the system design pressure, for a maximum period of three (3) hours. During this time, the pipe is maintained at the test pressure by the periodic addition of make-up water to compensate for the initial stretching of the pipe. The line pressure-tightness is determined by the ENGINEER by visual examination.

WARNING: Do not proceed with hydrostatic pressure tests above ground unless the construction supervisor has taken appropriate safety precaution.

4.02 PRESSURE TESTING IN THE TRENCH

A. After the pipeline has been laid, it shall be filled with water, taking care to bleed off any trapped air. It shall then be subjected to a hydrostatic pressure test, with a test pressure at the lowest elevation to the system, that is a maximum of 1½ times the system design pressure. When, in the opinion of the ENGINEER, local conditions require that the trenches be backfilled immediately after the pipe has been laid, the pressure test may be made after backfilling has been completed but not sooner than that time which will allow sufficient curing of any concrete that may have been used (typical minimum concrete cure times are 36 hours for early strengths and 7 days for normal-strength materials).

B. The test procedure consist of two steps: the initial expansion and the test phases. To compensate for initial expansion of the pipe under test, sufficient make-up water should be added to the system at hourly intervals for 3 hours to return to the test pressure. After the completion of this first phase (around 4 hours after initially pressurizing the pipe under test), the actual test should begin. The test phase shall not exceed 3 hours. After this testing period, a measured amount of make-up water should be added to return to the test pressure. The amount of make-up water shall not exceed the allowance given in Table 1. Alternatively, testing for leakage can be done by maintaining the test pressure over a period of 4 hours, and then dropping the pressure by 10 psi. If the pressure remains steady (within 5% of the target value) for an hour, no leakage in the system is indicated.

WARNING: Under no circumstances shall the total time under test exceed eight (8) hours at 1½ times the pressure rating. If the test is not completed due to leakage, equipment failure, etc., the test section shall be permitted to "relax" for eight (8) hours prior to the next testing sequence.

4.03 DEFLECTION TESTS

A. The HDPE pipe system has been designed so that the maximum installed deflection does not exceed 5% of the base inside diameter of the pipe. If the CONTRACTOR performs the deflection testing rather than employing an approved test lab, the CONTRACTOR shall furnish the mandrel, labor, materials, and equipment necessary to perform the tests as approved by the ENGINEER. The mandrel shall be pulled through by hand or a hand operated reel in the presence of the ENGINEER. Prior to performing the deflection tests, the CONTRACTOR shall submit to the ENGINEER certification that the 9-arm mandrels are preset as stated above. Each mandrel shall be engraved with the following:

1. Serial Number.

2. Nominal pipe diameter.

3. "ASTM D 3034" and either "SDR-35" or "SDR-26".

4. Percent deflection as stated above.

B. If the mandrel fails to pass any section of pipe, the CONTRACTOR shall excavate to the point of excess deflection and carefully compact around the point where excess deflection was found. After the permanent pavement base has been recompacted and resealed, the line shall be retested. If the mandrel fails to pass a second time, the section shall be replaced. Re-rounding is not permitted.

4.04 REPAIRS

A. If any section of the leachate main fails to pass the test, the CONTRACTOR shall perform an inspection of the faulty section and replace or repair it at no cost the OWNER. He shall make repairs to the various systems with new materials. Repeat tests after disclosed defects have been corrected, until piping system passes test to the satisfaction of the ENGINEER.

SECTION 03300

CONCRETE

PART 1 - GENERAL

1.01 SCOPE

A. This Section includes: furnishing all labor, materials, equipment and incidentals required for complete installation of cast-in-place concrete as shown in the Drawings and as specified in these specifications.

1.02 TESTS

A. Testing and analysis of concrete will be performed by a testing laboratory retained by the OWNER.

B. One random cylinder test set will be taken per day for each type of concrete placed. The set shall consist of three cylinders and one shall be broken at seven days, one at 28 and one held in reserve. The ENGINEER shall be furnished a copy of the test results.

1.03 SUBMITTALS

A. At least 14 days prior to the start of any concrete placement submit the following:

1. Manufacturer's certification that concrete and reinforcing materials meet specification requirements.

B. Submit one copy of delivery tickets for each load of concrete delivered to site to the ENGINEER.

PART 2 - PRODUCTS

2.01 FORM MATERIALS

A. Conform to ACI 301.

2.02 CONCRETE MATERIALS

A. Cement: ASTM C150, Type II, Portland, grey color.

B. Fine Aggregates: Clean natural sand, conforming to ASTM C33.

C. Water: Potable.

D. Water Reducing Admixture: Conform to ASTM C494, Type A.

E. Joint Sealant: Tremco THC-900 or approved equal.

F. Air-Entraining Admixtures: Conform to ASTM C260.

G. Other Admixtures: Conform to manufacturer's recommendations.

2.03 CONCRETE MIX

A. Mix concrete in accordance with ASTM C94.

B. Concrete as delivered to the work shall be homogeneous, readily placeable and uniformly workable; proportion to conform to ACI 211.1.

C. Anchors

1. Minimum Compressive Strength at 7 days: 1,500 psi.

2. Minimum Compressive Strength at 28 days: 3,000 psi.

3. Slump: 1 - 3 inches.

PART 3 - EXECUTION

3.01 FORMWORK ERECTION

A. Conform to ACI 318 and ACI 347.

B. Verify lines, levels, and measurement before proceeding with formwork.

C. Align form joints.

D. Do not apply form release agent where concrete surfaces receive applied coatings which may be affected by agent.

3.02 PLACING CONCRETE

A. Notify ENGINEER minimum 24 hours prior to commencement of concreting operations.

B. Conform to ACI 304.

C. Ready-mixed concrete shall be produced and delivered conforming to ASTM C94 as applicable.

D. Conform to ACI-305 requirements when a 90° F or above temperature occurs during concrete placement or is expected to occur within 24 hours after placement.

E. Dampen forms and subgrade with cool water immediately before concrete placement.

F. Concrete shall have a maximum temperature of 85 degrees F during placement.

G. Protect the concrete with temporary wet covering during any applicable delay between placement and finishing.

H. Begin curing formed concrete immediately after placing. Curing shall consist of continuously wetting the forms for 24 hours. After the first 24-hour curing period, continue to cure formed concrete using one of the following methods:

1. Loosen forms and position soaker hose such that water flows down concrete surfaces.

2. Strip forms and apply curing compound conforming to ASTM C309, Type 2. Do not allow concrete surfaces to dry before curing compound application.

I. Begin curing unformed surfaces immediately after finishing and continue for 24 hours. Curing shall consist of applying and maintaining water saturated material to all exposed surfaces. After the first 24 hour curing period, continue to cure unformed surfaces by the application of one coat of curing compound conforming to ASTM C309, Type 2.

3.03 SCHEDULE FINISHES

A. Broom finish all surfaces.

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 DESCRIPTION

Work to be provided under this division of the specifications includes furnishing, delivering, unloading, handling, storing, protecting, erecting, installing, connecting, adjusting, testing and maintaining, until final acceptance by the OWNER, all materials and equipment which are necessary to complete and make safe and operable all mechanical systems indicated and/or called for on the contract drawings and in these specifications.

1.02 CODES AND STANDARDS

A. Work shall conform to all applicable federal, state and local laws, ordinances and regulation and codes and standards:

1. State Plumbing Code
2. Local codes and ordinances
3. ASME Boiler and Pressure Vessel Code
4. OSHA
5. Owners Insurance Underwriters Criteria
6. Underwriters Laboratories (UL) Criteria
7. American National Standards Institute
8. National Fire Protection Association
9. National Energy Code

B. Where minimum requirements of Codes are exceeded by the drawings and specifications, the requirements of the drawings and specifications shall govern. Where in conflict, Local Code requirements shall take precedence. Where the CONTRACTOR believes any requirements of the drawings and specifications are not in conformance with Code requirements, he shall so notify the ENGINEER before the Work is installed. The decision of the ENGINEER in interpreting the drawings and specifications and Code requirements related thereto shall be considered final.

C. The CONTRACTOR shall give all necessary notices, obtain all permits, pay all inspection and other fees required by governmental authorities having jurisdiction over the Work under this Contract. Receipt of all required approvals, clearances,

and certificates by the OWNER shall be prerequisite to acceptance and final payment for the Work.

D. Submit three copies of OWNER's Underwriter's approval and acceptability prior to beginning work on covered portion of the Work.

1.03 DEFINITIONS

A. The use of terms "pound", "psi", "pounds per square inch" and similar terms referring to pressure shall be interpreted as pounds per square inch above atmosphere.

B. Wherever the terms "ASTM," "ANSI," "ASME", "AWWA," "IEEE," "AISC," or "NEMA" are used, they shall refer to the standards or requirements of the "American Society of Testing Material," the "American National Standards Institute," "The American Society of Mechanical Engineers," "The American Water Works Association," "The Institute of Electrical and Electronic Engineers," "The American Institute of Steel Construction," or "The National Electrical Manufacturers Association," respectively, for the particular item referred to.

C. The use of the word "piping" shall be interpreted to include all pipe, valves, fittings, flanges, or accessories for any particular portion of the Work to which the word "piping" is applied.

D. In all cases where a device or part of equipment is herein referred to in the singular number (such as the "pump"), such reference shall be intended to apply to as many such devices as are required to complete the installation as specified and shown on the Drawings.

1.04 SHOP DRAWINGS

A. In general, shop drawings and related manufacturer's product certification shall be made in accordance with Section 01000 and the General Conditions of the Contract for approval prior to construction or fabrication of the material by the manufacturer. The following items which require shop drawings are brought to the CONTRACTOR's attention. The list may not include all items for which shop drawing submittals are required.

1. All items with equipment numbers

2. All specialty numbers

3. All items on which the manufacturer has been indicated

4. Plumbing components

5. Plumbing systems

6. Controls diagrams

7. Equipment layouts based on approved equipment

B. Prints submitted for approval shall show the following information for each item

1. Manufacturer's name and identification of the item including size and model

2. OWNER's name, ENGINEER's project number, ENGINEER's item identification number or item name

3. General arrangement drawing with dimensions

4. Equipment weight, operating weight and load distribution at mounting points

5. Connection dimensions and specifications

6. Necessary clearance dimensions

7. Materials of construction

8. Utility services required, amps, voltage, kilowatts

9. Wiring and connection diagrams

10. Installation instructions

C. A list of proposed materials with each item identified by manufacturer and catalog number and accompanied by catalog cuts, drawings, or other descriptive material, shall be submitted by the CONTRACTOR with the required number of copies for review within 30 calendar days after award of the Contract and before beginning fabrication or installation of any materials. As soon as possible thereafter, required shop drawings of specially fabricated materials such as switchboards and panelboards, and required shop drawings of electrical systems prepared by approved manufacturers, shall be checked by the CONTRACTOR and then be submitted with the required number of copies for review by the OWNER and ENGINEER.

D. Shop drawings submitted by the CONTRACTOR shall be checked for accuracy, coordinated with other work and corrected if necessary before submission to the ENGINEER.

E. Review of shop drawings or equipment schedules by the ENGINEER shall not relieve the CONTRACTOR from responsibility for errors of any kind on his part or responsibility for meeting the requirements of the Contract Document.

F. Each print and shop drawing submitted shall bear on its face the approval stamp of the CONTRACTOR indicating that the submission has been thoroughly checked

by the CONTRACTOR. Shop drawings submitted unchecked and/or unstamped to the ENGINEER will be returned to the CONTRACTOR without review by the ENGINEER.

G. All shop drawings requiring approval by any code enforcement authority and/or the OWNER's underwriter, shall bear the required approval stamp on the submittal.

H. Where a particular product is specified or listed as a minimum requirement or standard of quality, alternate products may be submitted. However, submittal data shall include one complete submittal covering the specified product to compare with the alternate product being offered as a substitute. Failure to comply with this provision or failure to include sufficient data on both products for accurate comparison will result in automatic rejection of the substitute product.

1.05 SAMPLES OF MATERIALS

Samples of all materials shall be submitted in conformity with the applicable instructions covered in the "General Conditions" of the specifications when requested by the ENGINEER or the OWNER.

1.06 OPERATING AND MAINTENANCE MANUALS

Furnish to the ENGINEER no later than 10 days before start-up a minimum of four (4) separate sets of bound instruction books for each item or equipment including the following:

A. Installation and Start-Up Instructions

B. Operating Instructions

C. Parts List

D. Recommended Preventative Maintenance Procedures

E. Recommended Spare Parts List

F. Performance Test Report

1.07 INSTRUCTIONS TO OPERATING PERSONNEL

The CONTRACTOR shall, with the assistance of his subcontractors and/or equipment suppliers, instruct OWNER's operating personnel in the safe and correct procedure for normal and emergency starting and stopping, cleaning, checking, logging, lubricating, periodic testing, trouble shooting and normal operating of equipment and/or systems provided by the CONTRACTOR. The instructions shall be in the form of qualified personnel of the CONTRACTOR and his subcontractors reviewing the installation with the OWNER's operating personnel as well as covering all operating, maintenance, and similar literature provided as specified herein.

1.08 SPECIALIZED SERVICES

As herein specified, and/or required, the CONTRACTOR shall provide any necessary specialized services, such as accredited direct factory representatives of manufacturers as may be required for supervision or erection and/or adjusting and placing equipment provided by the CONTRACTOR in operation.

1.09 EQUIPMENT TAGGING

All equipment shall be identified with a minimum of one inch high stainless steel tag embossed with the equipment number and permanently affixed to the equipment. Hanging tags attached to the equipment by wire or other means will not be accepted as permanent tagging.

PART 2 - PRODUCTS

2.01 KIND AND QUALITY OF MATERIALS

A. All equipment, materials, and accessories shall be new, the latest model and of the best quality and grade specified and shall be in strict accordance with the Specifications and Drawings. All mechanical equipment shall be the product of reputable manufacturers and equipment shall have the manufacturer's name, address and model number on a nameplate securely affixed in a conspicuous place.

B. Certain manufacturer's product names, figure numbers, etc., are used in these contract documents to establish qualities of the materials, workmanship, and performance required. In such cases, the item mentioned is a product known to the ENGINEER which offers the design, materials, workmanship, and performance required. Proposals and contract shall be based on the use of name products and no other.

C. CONTRACTOR may submit with his proposal alternate products, which may be considered by the OWNER and ENGINEER as being the full equal of and similar in all respects to those mentioned. These will be reviewed for use if upon submission, descriptive and technical data sufficient to demonstrate quality beyond question is provided. The burden of proof in questions of equality lies with the CONTRACTOR. The sole judge of equality shall be the OWNER and ENGINEER. Proposal for alternate materials shall include complete data demonstrating cost reduction to be passed on to the OWNER.

1. Any and all changes to the Work, the design, the Work of other trades or contractors, brought about by the allowance of a substitution shall be the responsibility of the CONTRACTOR for requesting that substitution.

2. Where indicated in the Contract Documents as "Manufacturer's Name ...No Alternates Accepted.," the CONTRACTOR shall submit no alternates.

2.02 MATERIALS FURNISHED BY THE OWNER

A. Equipment or materials furnished by the OWNER or existing will be designated in the drawings or specifications.

B. All such materials shall be carefully inspected by the CONTRACTOR upon delivery to determine all possible damage sustained during shipment or otherwise and shall report all damage found to the OWNER. When accepted by the CONTRACTOR, such materials shall become his complete responsibility and shall be repaired or replaced by the CONTRACTOR without additional cost to the OWNER if damaged in any way by the CONTRACTOR's failure to properly unload, handle, store, protect, install and maintain the materials until final acceptance by the OWNER of the completed installation.

2.03 TOOLS AND SPECIAL WRENCHES

CONTRACTOR shall provide one complete new and unused set of any special tools and wrenches required for normal operation, adjustment and maintenance of each dissimilar piece of equipment. Each set of such tools and wrenches shall be contained in a suitable metal tool box and shall be delivered to the OWNER's authorized representative at the completion of the work.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Refer to all Mechanical, Structural, Electrical and other Contract drawings and other divisions of the specifications for all construction details, materials, and requirements which have a bearing on Work to be provided under this division of the specifications.

B. All apparatus, equipment and piping shall fit into the space provided in the building or within the property and shall be installed at such time and in such manner as to avoid damage to the building structure or property and as required by the job progress. Equipment, apparatus, and accessories requiring normal servicing or maintenance shall be made readily accessible. Installation of Division 15 systems shall be made at such time and in such manner as meets with the approval of the OWNER.

C. Piping equipment shall be routed as shown on the Drawings. All piping not specifically located on the Drawings shall be routed as close as possible to walls, columns, or so as to take a minimum amount of space. All items such as offsets and fittings, required to accomplish the complete operational system shall be furnished and installed at no additional cost. Equipment shall be located as shown on the Drawings except where interferences exist. Decisions as to which item is to be relocated shall be made by the ENGINEER.

3.02 COOPERATION WITH OTHER TRADES

A. The CONTRACTOR shall cooperate and coordinate with the OWNER and other trades in the scheduling of work, delivery of and moving of material, and location of anchor bolts, sleeves, equipment and materials.

B. The OWNER and other contractors will perform certain other work within the building. The CONTRACTOR shall adjust his schedule to meet the requirements of the OWNER, and to allow the OWNER to perform his work while new construction is occurring. Alteration to existing utilities shall be coordinated with the OWNER and shall be made at times suitable to OWNER.

C. No additional funds will be allowed if in the opinion of the OWNER, the interference or relocation could have been avoided by advance planning on the part of the CONTRACTOR.

3.03 TRANSPORTATION, DELIVERY AND STORAGE

A. The CONTRACTOR shall provide and pay for all freight, express, trucking, transportation, cartage, storage and handling of equipment and materials supplied by CONTRACTOR. Materials shall be delivered to the job site in ample quantities to ensure uninterrupted progress of the work. Extra handling, shipping, and storage expenses incurred in expediting materials to prevent interruption of the overall job progress shall be paid for by the CONTRACTOR.

B. Protection of materials from loss or damage from all causes at all times during construction shall be the CONTRACTOR's responsibility. Temporary pallets and other suitable supports shall be provided to prevent all materials from being stored directly on the ground. Material that could be damaged by weather or high humidity shall be suitably protected.

3.04 WORKMANSHIP

A. All equipment, materials and specialties shall be installed and connected in accordance with the best practice and standards for respective work.

B. Workmanship shall be of the highest quality and no substandard work will be accepted. All work shall be done by properly supervised workmen skilled in the trades involved. What might be considered usual, customary or acceptable materials and workmanship in work under contracts shall have no bearing on Work under this Contract.

3.05 CLEANING, TESTING AND INSPECTION OF MATERIALS AND EQUIPMENT

A. The CONTRACTOR shall clean and test all material, equipment and systems installed and demonstrate proper operation to the ENGINEER.

B. The CONTRACTOR shall furnish all labor, instruments and equipment required to test and clean the systems and shall pay all expenses involved. Hydrostatic tests shall meet applicable codes.

C. If tests show that work or equipment is defective or does not comply with the Specifications, the CONTRACTOR shall immediately make all corrections and perform all work required to place the equipment or system into proper operation, at no additional cost.

D. All valves, traps, specialties, and/or other equipment shall be properly tested and adjusted in a manner applicable to the particular item of equipment.

3.06 CLEANING

After the fixtures, material and equipment have been set, are ready for use and before final inspection is made, the CONTRACTOR shall thoroughly clean all fixtures, material and equipment. All paint, stickers, rust, stains, and other foreign matter or discoloration shall be removed and the system left in clean and acceptable condition and ready for use.

3.07 EXECUTION OF WORK

During execution of the Work under this Contract, the CONTRACTOR shall take all precautions to avoid damage to the buildings and service.

3.08 EXISTING SERVICES AND FACILITIES

A. Existing services may be interrupted, when necessary for connection to or modification of existing system or facilities, only at prearranged times approved by the OWNER. Services may be interrupted only after the provision of all temporary work and availability of adequate labor and materials has assured that the duration of the interruption will not exceed the time agreed upon. Existing services shall be guarded against unscheduled interruptions or damage resulting form the work of the CONTRACTOR. All existing services and facilities damaged by the CONTRACTOR through negligence or through the use of faulty materials or workmanship shall be promptly repaired or replaced by the CONTRACTOR without additional cost to the OWNER.

B. Materials and equipment that are removed and to remain the property of the OWNER or reinstalled are identified on the drawings. Store at the location and in the manner directed by the OWNER's authorized representative. All other material and equipment demolished or removed as a part of this Contract shall become the property of the CONTRACTOR and shall be promptly removed from site. Storage or sale of removed material will not be permitted on project site.

SECTION 15420

LEACHATE/STORMWATER PUMPS AND ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION

The work included in this section includes furnishing all labor, equipment, tools, and materials required for installation of leachate pumps at the primary and secondary leachate pump stations, stormwater pump stations complete and ready for operation.

A. Work under this division shall be coordinated with the requirements of all contract documents, and constructed at locations indicated on the Contract Drawings in order to provide a complete functional installation. Any labor, materials, equipment, and apparatus not specifically mentioned herein or shown on the drawings, which may be found necessary to complete any portion of the work in a substantial manner and in compliance with the requirements stated or implied by the contract documents, shall be furnished by the CONTRACTOR without additional compensation.

1.02 GUARANTEE

CONTRACTOR shall guarantee all work and rectify any defects due to faulty materials or workmanship for a period of 18 months after acceptance by the OWNER or 12 months after start-up, whichever comes first. CONTRACTOR shall pay for damage to other work resulting from faulty materials or workmanship which occurs within said period.

1.03 SHOP DRAWINGS AND SUBMITTALS

A. In general, shop drawings and related manufacturer's product certification shall be made in accordance with Section 01000 and the General Conditions of the Contract for approval prior to construction or fabrication of the material by the manufacturer. The following items which require shop drawings are brought to the CONTRACTOR's attention. The list may not include all items for which shop drawing submittals are required.

1. Pump materials, performance curves, and other related details.

2. Valve manufacturer, model numbers, materials, and fabrication details.

3. Certifications from pipe and fittings suppliers certifying the materials specifications.

B. Operation maintenance manuals and spare parts lists shall be provided for each item of equipment and format for these shall be as described in Section 01000; General Requirements.

1.04 TOOLS AND SPARE PARTS

A. Tools and spare parts shall be furnished as specified herein.

B. Spare parts shall be marked with parts numbers and the equipment the spare parts are for. Spare parts shall be packed in suitable containers also marked with the parts numbers and equipment for which intended.

C. Prior to final acceptance of the work the CONTRACTOR shall turn over to the OWNER all specified spare parts. The CONTRACTOR shall prepare a listing of all such spare parts and include a copy of the list in the operation and maintenance manuals.

PART 2 - PRODUCT

2.01 PRIMARY LEACHATE AND STORMWATER WITHDRAWAL PUMP

The CONTRACTOR shall provide a Model TSP27-1 manufactured by EPG Companies, P.O. Box 224, 9060 Zachary Lane North, Suite 115, Maple Grove, Minnesota 55369 or approved equal.

2.02 SECONDARY LEACHATE PUMP

The CONTRACTOR shall provide a Model TSP5-2 manufactured by EPG Companies, P.O. Box 224, 9060 Zachary Lane North, Suite 115, Maple Grove, Minnesota 55369 or approved equal.

2.03 FLOW METERS

The CONTRACTOR shall furnish EPG Companies flow metering system for primary, secondary pump stations at Disposal Unit A-1 pump station and at stormwater pump station to register product flow rate and totalized flow. The system shall operate from a 115 or 230 Volt, 60 Hertz power supply.

A. The sensor shall have as standard features:

1. Dual Magnets: Sensor shall utilize a dual magnet drum design to assure unimpeded operation of the paddlewheel.

2. Wide Range/High Accuracy: Sensor shall measure a flow range from 0.6 to 25,000 gpm with a linearity and repeatability factor of +/-0.5 percent.

3. Special Mount: The sensor shall be installed in a special mount on the discharge line of the pump to maximize system accuracy.

4. Pipe Sizes: Will operate correctly in 1/2- to 72-inch diameter pipes.

B. The flow meter shall include as standard features:

1. Flow Totalizer: Meter shall include a bi-directional, eight-digit flow totalizer.

2. Programmability: Meter shall be front panel programmable for ease of field changes and troubleshooting.

3. Non-Volatile Memory: Meter shall include a non-volatile memory to retain programming choices, presets and count values when power is discontinued.

4. LCD Display: Meter shall show flow rate and totalizer rates using an LCD display.

5. Menu Driven Programming: Meter programming shall be menu driven to simplify setup.

6. Temperature Range: Shall maintain full function in temperatures between 0° and 50°C.

C. Operations:

The flow sensor is a paddlewheel type sensor installed in a special adaptor, located on the discharge line of a pump. The adaptor minimizes flow turbulence, thus providing an accurate flow rate measurement.

The flow meter provides a 12 VDC power supply to the flow sensor. The sensor uses the power to energize an induction coil which senses the rotation of the magnets in the drum of the paddlewheel. The coil transmits this information as a high frequency signal linear to the product flow. The meter interprets this data and displays the signal. The totalizer is resettable.

2.04 PUMP STATION CONTROLS

The CONTRACTOR shall furnish two EPG Companies U.L. listed, L975 PT control panel to operate two or more pump motors and auxiliary equipment in manual or automatic mode or approved equal. One parcel is for primary and secondary leachate pumps, and one is for stormwater unit. The panel will be either NEMA type 4 or 4X.

A. Enclosures shall come equipped with an inner door, stainless-steel drip shield and tamper resistant latch. The NEMA 4 enclosures are finished with polyester urethane paint. The NEMA 4X enclosures can be either stainless steel or non-metallic.

B. The control system will operate from a 230 volt, 60 hertz, one-phase power supply. Pump control components will be sized to operate pump motor of specified horsepower.

C. The control panel shall include the following as standard features:

1. Main 100 Amp Disconnect Switch with Door Interlock: Shall prevent opening of panel while power is on.

2. Control Transformer: Transformer with fused primary to isolate control circuits from power circuit and for easier and safer field wiring of accessories. It shall lower incoming voltage to 120 volts.

3. Corrosion Inhibitor Emitter: Inclusion of an industrial corrosion inhibitor emitter that shall protect internal components of control panel from severe corrosion for up to one year.

4. Lightning Arrestor: Shall be connected, metal to metal, to well water strata.

D. The control panel shall include the following as standard features for each pump motor:

1. LevelMaster™ Level Controls: The LevelMaster shall be mounted on the inner door. Meter shall provide digital read-out and have the capability to monitor and maintain pumping operations and at least two other level signals. Level controls shall be accurate to within 0.1 inch.

2. Motor Protection: To be provided by two each 250 volt, 8 amp dual element fuses and internal thermal overloads.

3. Motor Contactors: The motor contactors will be sized to the motor horsepower.

4. "Hand-Off-Auto" Selector Switches: Allows manual or automatic operation. The selector switch shall be heavy duty, oil tight and NEMA 4 rated, mounted on the inner door.

5. Running Lights: Indicates energization of motor circuit. Light shall be heavy duty, oil tight, NEMA 4 rated with voltage surge suppression built in to prolong lamp life.

6. Motor Start Winding Control with Start Capacitors and Start Winding Relay: Capacitor is used to start motor. Relay is used to remove startwinding from circuit when motor reaches operating speed.

7. Terminal Strip: Provides ease in connection of external components.

E. The EPG submersible pressure transmitter level sensor shall have a range of 0 to 2.5 feet with a 4 to 20 MA output signal. Transmitter construction shall be stainless-steel body, stainless-steel diaphragm and Viton seals with chemical resistant signal cable. The transmitter circuit shall be protected by intrinsically safe barriers.

F. Multiple System: This system is designed to operate two or more pumps upon changes in liquid level as sensed by the submersible pressure transmitter. The pump or pumps will continue to run until the selected level is reached. If liquid level changes beyond set points, a high and/or low level will be annunciated.

2.05 JUNCTION BOX

A. Junction box (JB-1) shall be NEMA 4X polycarbonate or other noncorrosive material with a clear lexan cover. Junction box shall be sized to permit at least three-inch spacing between terminal strips, four inches between conduit entering box and terminal strips, and three inches between the terminal strips and sides of the box. All boxes shall be at least 6-3/4 inches deep with liquid-tight bushings and hubs at all outlets.

2.06 ALARM BOX

A. A heavy duty weather tight plastic NEMA 3R box (JB-2) shall be provided to house the alarm light, alarm horn, and silence pushbutton. The box shall be mounted on the outside of the security fence, as shown on Contract Drawings. The alarm light shall be mounted on top of the box, the alarm horn on one of the sides, and the silence pushbutton on the front. A small aluminum or stainless steel sign shall be provided indicating silence button operation and providing the Public Utilities Department number to call for emergencies.

2.07 TELEMETRY SYSTEM

A. Contacts for future telemetry use and space shall be provided for an 18 inch enclosure for the remote telemetry units (RTU) next to the control panel.

2.08 WIRING SYSTEMS

A. All wire shall be type XHHW stranded copper, moisture and heat resistant synthetic polymer insulation.

B. All control wiring shall be XHHW stranded copper and numbered for identification at each end. Control wire size shall be at least AWG #16. All wiring is to be on the surface of the subpanel and laid in plastic raceways. Numbering of wires shall be from the meter box through the field side of the terminal strip in the junction boxes.

2.09 PORTABLE POWER AND CONTROL CABLE

A. The portable power and control cable between JB-2 and the submersible pumps shall be the pump manufacturer's standard cable or Type W moisture and oil resistant, multiconductor flexible power cable with identified grounding conductor suitable for extra hard duty usage in damp locations. Cable runs shall be suitable for disconnect and removal when the pump is removed and reinstalled.

PART 3 - EXECUTION

3.01 TESTING

A. Each pump casing shall be hydrostatically tested by the manufacturer in accordance with Hydraulic Institute Standards at 250 PSIG.

B. Production performance testing will be conducted by the manufacturer on each pump unit. Head shut off and a minimum of 2 operating points will be measured at design speed to verify performance.

3.02 INSTALLATION

Pumps will be installed by a CONTRACTOR authorized for this type of installation by the pump manufacturer and in accordance with Manufacturer's instructions.

3.03 ELECTRICAL EQUIPMENT

A. Electrical equipment shall be protected from the weather, in particular, dripping or splashing water, at all times during shipment, storage and construction. Manufacturer's recommendations with regard to storage and protection shall be followed. Should any apparatus be subjected to possible injury by water, it shall be thoroughly dried and put through a dielectric test, at the expense of the CONTRACTOR. The ENGINEER shall ascertain suitability of the apparatus. No equipment with visible signs of weathering will be accepted. CONTRACTOR shall replace equipment deemed unacceptable by the ENGINEER without additional cost to the OWNER.

B. Damaged or Defective Equipment: Inspect all equipment and materials prior to installation. Damaged equipment and materials shall not be installed or placed in service until the ENGINEER has been notified. CONTRACTOR shall replace or repair to new condition and test the damaged equipment in compliance with industry standards at no additional cost to the OWNER. Equipment required for the test shall be provided by the CONTRACTOR.

3.04 INSTALLATION - ELECTRICAL

A. Make electrical connections to equipment in accordance with equipment manufacturer's instructions, contract drawings, and the following:

1. Verify that wiring and outlet rough-in work is complete and that utilization equipment is ready for electrical connection, wiring, and energization.

2. Make wiring connections in control panels or in the wiring compartment of pre-wired equipment. Provide all interconnecting wiring where indicated.

3. Install and connect disconnect switches, controllers, control stations, and control devices as indicated.

4. Use rigid metallic or Schedule 80 PVC conduit only.

5. Use type XHHW stranded copper wire between the control panel and JB-1, between JB-1 and JB-2, and between other components such as the control panel and flow meter enclosure, etc.

6. Provide suitable strain-relief clamps for cable connections to submersible pumps per the pump manufacturer's requirements.

7. Power cables in side slope riser shall be 600 volt, Type W, copper, round portable power cable, three conductor with equipment ground wires or the pump manufacturer's standard.

8. The pump station electrical service shall be grounded by a #4 AWG (minimum) copper conductor bonded to a 3/4" ten foot (minimum) long driven ground rod located a minimum of 10 feet from the wetwell. CONTRACTOR shall verify that the service ground is adequate for the conditions at the site.

B. Install support systems sized and fastened to accommodate weight of equipment and conduit, including wiring, which they carry.

1. Fasten rods, conduit clamps, control panel and junction boxes to support structure using beam clamps or nut and bolt type hardware appropriate for the installation of 316 stainless steel.

2. Use of expansion anchors or preset inserts to fasten the support bars to the concrete posts is prohibited. Stainless steel through bolts shall be used.

3. Fastening supports to piping, mechanical equipment, or conduit is prohibited.

4. Use of powder-actuated anchors is prohibited.

5. Drilling of structural steel members is prohibited.

6. Fabricate support bars from stainless steel or aluminum. Stainless steel unistrut may be utilized for this purpose.

7. Install control cabinets, disconnects, etc., with a minimum of four stainless steel nut and bolt assemblies passing completely through support posts or bars. Unistrut compatible hardware shall be used where necessary.

C. Identify all electrical distribution and control equipment, and loads served, to meet the regulatory requirements and as indicated below:

1. Secure nameplates to equipment using stainless steel screws or rivets, with edges parallel to equipment lines.

2. Use nameplates with 3/16 inch high indented lettering to identify individual switches, circuit breakers, receptacle circuits, loads served, and control equipment.

3. Label float leads with 316 stainless tags.

D. Install wire markers on each conductor in control panel and junction box. Wire markers shall be on each end of the conductor.

1. Use branch circuit or circuit breaker number to identify power circuits.

2. Use control wire number as indicated on manufacturers' schematics and interconnection diagrams to identify control wiring.

E. Neatly train and secure wiring inside panels, boxes, equipment, and panel boards.

F. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires where necessary.

G. Protect exposed cables in wetwell from mechanical damage during construction and locate to avoid damage during operation or maintenance.

H. Verify that mechanical work which is likely to injure conductors has been completed before installation.

I. Completely and thoroughly swab raceway system before installing conductors.

J. Make taps and terminations to carry the full ampacity of conductors without perceptible temperature rise. Splices are not permitted in either power or control circuits.

K. Tie back spare conductors with electrical tape.

L. Use of aluminum wire is prohibited.

M. Install all wiring devices in accordance with manufacturer's instructions.

1. Install convenience receptacle at location indicated on contract drawings with neutral pole on bottom.

2. Install emergency generator receptacle at location shown on contract drawings.

3. Install mechanical interlock on main and emergency circuit breakers such that when the main breaker is on, the emergency breaker is off and vice versa.

N. No more than two wires shall be connected to a single terminal position on the terminal blocks.

3.05 FIELD QUALITY CONTROL

A. The ENGINEER will perform field inspection and testing of wiring prior to energizing circuits.

1. Inspect wire and cables for physical damage and proper connection.

2. Torque test conductor connections and terminations to the manufacturer's recommended values.

3. Perform continuity test on all power and control circuit conductors. Verify proper phasing connections for motor feeders.

4. Pump motors to verify proper rotation prior to energizing control system for testing.

3.06 FINAL INSPECTION AND TESTING

A. After the installation is complete, deliver to the ENGINEER the following information with the request for final inspection:

1. One set of contract drawings marked to show all significant changes in layout, equipment ratings and locations, alterations in the size of access hatches, or any other data differing from the contract design.

2. Certificate of final inspection from applicable permitting authority.

3. A test report from supplier of all motors, listing horsepower, voltage and full load current.

Results shall be turned over to ENGINEER along with serial numbers of the unit tested at the completion of the final inspection. Results must be certified.

B. The pump station shall be thoroughly tested to demonstrate that the entire system is in proper working order and in accordance with the plans and specifications. Each pump with its control circuit shall be run as nearly as possible under operating conditions for a sufficient length of time to demonstrate correct alignment, wiring capacity, speed and satisfactory operation. All isolation and check valves shall be tested for proper operation. During the final inspection and test, the CONTRACTOR shall furnish the test instruments. Readings shall be made of line voltage and current at the main disconnect during starting and operating conditions, as well as pump discharge pressures and flows. Such results must meet pump manufacturer's specifications.

C. Each pump will be hoisted and removed from wet well, inspected and replaced, then operated to test for leaks at discharge seal.

D. The costs of the test shall be borne by the CONTRACTOR, including expense incident to retest caused by defects and/or failures of the equipment to meet the specifications.

APPENDIX B

QUALITY ASSURANCE CHECKLISTS AND FORMS

CONSTRUCTION DAILY LOG

Project:
Contract Number:
Law Project Number:

Date: _____ By: _____

Describe Weather Conditions:

Temperature am: _____

Temperature pm: _____

Precipitation:

amount: _____

time: _____

CONTRACTOR start work time: _____

CONTRACTOR end work time: _____

Site Visitors:

Name: _____ Purpose: _____

Name: _____ Purpose: _____

Name: _____ Purpose: _____

Meetings: Attach a copy of the minutes

Labor:

CONTRACTOR	Type	Hrs

Equipment:

CONTRACTOR	Type	Hrs

Materials (other than liner):

Supplier	Type	Quantity	Use

Summarize the work performed today from diary:

Attach sheets from the Liner Installation/Construction and Quality Control Plan

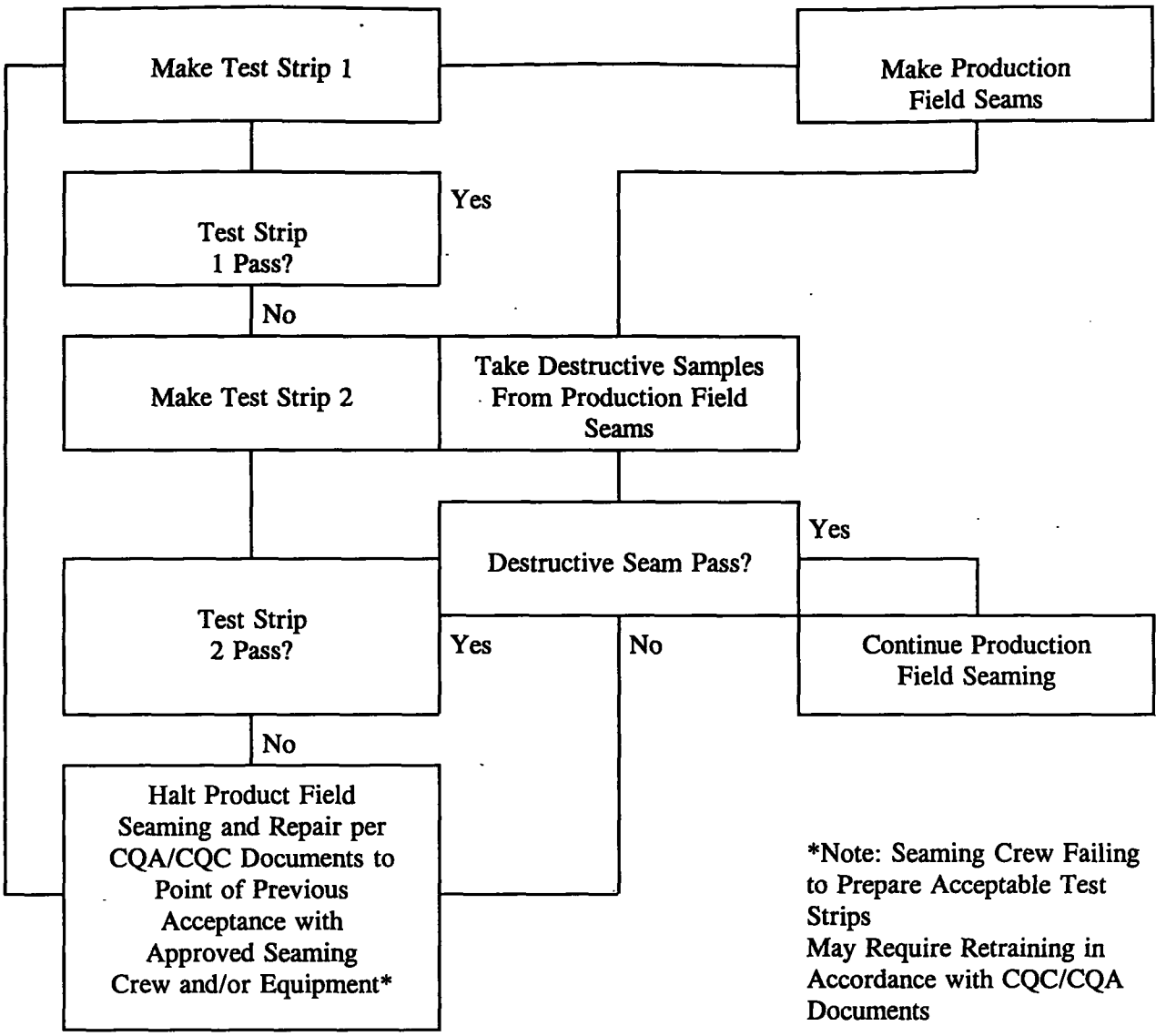

FIGURE 1. TEST STRIP PROCESS FLOW CHART

SUBGRADE SURFACE ACCEPTANCE

PROJECT:_____ JOB NUMBER:_____

LOCATION: _____ DATE:_____

I, the undersigned duly authorized representative of _____, certify that upon visual inspection the subgrade surface described below meets criteria for installation of a _____ mil flexible membrane line. By signing below, however, Gundle acknowledges no responsibility for the subgrade design, degree of moisture or compaction, integrity, elevation, or maintenance thereof, in any way.

Approximate size of area: _____

Description of
area:_____

_____

_____

_____

_____

_____

_____ _____ _____

Manufacturer's Representative OWNER/CONTRACTOR Inspector

FIGURE 5

PROJECT: _____
LOCATION: _____
DATE _____ P.F. # _____

PRE-START SITE INSPECTION

1. INSPECTED BY:

NAME REPRESENTING POSITION

_____

_____

_____

_____

2. DESCRIPTION OF INSPECTED AREA

_____

_____

_____

PHOTOS ENCLOSED ___ TO FOLLOW ___

3. REMEDIAL WORK REQUIRED:

_____

_____

_____

4. DATE & CONDITIONS OF GUNDLE START-UP:

_____

_____

_____

5. FURTHER INSPECTION REQUIRED: YES ___ NO ___ DATE: _____

6. BILLING FOR ADDITIONAL INSPECTION/WORK (Must be accompanied by Change Order)

_____

_____

_____ _____ _____

Manufacturer's Representative OWNER/CONTRACTOR Inspector

FIGURE 5A

QUALITY CONTROL CERTIFICATE

MATERIAL _____ DATE _____

BATCH # _____ PROJECT _____

ROLL # _____ _____

TEST PARAMETER	REQUIRED SPECIFICATIONS	TEST RESULTS	ASTM TEST METHOD
Thickness, mils			D1593
Density, gms/cm^3			D1505
Tensile Strength (psi) Yield			D638 Type IV
Break			2 ipm
% Elongation, Break			D638

CERTIFIED BY:

_____

Darlene Phouangsavanh
Lab Supervisor

SITE WELDING QUALITY CONTROL REPORTS

PROJECT _____ CONTRACT # _____

SITE _____ DATE _____

MATERIAL _____ THICKNESS _____

Weld Reference _____

Weld Inspection _____ Observations _____

Weld Re-Inspection _____ Observations _____

Sample Weld Location _____

Samples By: _____

SAMPLE WELD TEST RESULTS

Sample Weld #	Specimen	Peel Results
	1	
	2	
	1	
	2	
	1	
	2	

CERTIFIED BY:

_____

Lab Technician

LABORATORY REPORT # _____

DATE: _____

SUBJECT:

Resin quality control _____ Batch # _____

TEST METHOD:

Melt Index	ASTM D1238 E & P
Density	ASTM D1505

TEST RESULTS:

Melt Index, E	_____	g/10 min.
P	_____	g/10 min.
Density	_____	g/cm^3

CONCLUSION:

CERTIFIED BY:

_____

Darlene Phouangsavanh
Lab Supervisor

APPENDIX C

SOILS INFORMATION