CQA PLAN
HALIFAX COUNTY ASH MONOFILL

HALIFAX COUNTY SOLID WASTE DEPARTMENT

HAZEN AND SAWYER
Environmental Engineers & Scientists
RALEIGH, NORTH CAROLINA

MARCH 1992

CONSTRUCTION QUALITY ASSURANCE (CQA) PROGRAM FOR CONSTRUCTION OF HALIFAX COUNTY ASH MONOFILL-CELL 1

Construction Quality Assurance (CQA) for the construction of Halifax County Ash Monofill Cell 1 (the Cell) will be provided by a consulting engineering firm specializing in the inspection and testing of soils and geosynthetics, (the Engineer). Resumes and qualifications of the project team members will be provided to the County for their review.

The project team providing the CQA services shall consist of the following:

A. Project Engineer - Responsible for defining quality assurance requirements compatible with the project objectives, verifying basic data as reasonable and complete, outlining procedures to process data, developing statistical procedures for the analysis of test data and preparing quality assurance memorandums and quality control assessment reports. Construction certification documents will be prepared, signed and sealed by the Project Engineer. The Project Engineer will be a registered Professional Engineer in the state of North Carolina and will report to the County.

B. Construction Quality Assurance Officer - Responsible for the field implementation of the approved quality assurance plan as follows:

- Monitor the quality assurance activities of the field laboratory, assuring conformance with authorized policies, procedures, and sound practices, and recommended improvements as necessary.
- Inform the Project Engineer of non-conformance to the approved CQA program plan.
- Assure that sampling is conducted in a manner consistent with approved guidelines.
- Approve field laboratory data before the data are reported or entered into the data base for analysis.
- Maintain an awareness of the entire field laboratory operation to detect conditions which might directly or indirectly jeopardize the quality of laboratory testing.

- Assure that sample handling procedures are in accordance with the appropriate guidelines for the testing to be conducted.

- Oversee the quality of purchased laboratory materials to insure that purchases do not jeopardize the quality of the testing results.

The Construction Quality Assurance Officer will be experienced in quality assurance testing and inspection. The Construction Quality Assurance Officer will report to the Project Engineer.

C. Engineering Technicians - Responsible for field observations, testing and inspection. Technicians will be assigned to the project as deemed necessary by the Construction Quality Assurance Officer and will be responsible to the Construction Quality Assurance Officer.

REFERENCE LIST OF STANDARDS

(See Individual CQA Program Sections for Referenced Test Methods)

ASTM C136 - Standard Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM D413 - Test Method for Rubber Property - Adhesion to Flexible Substrate

ASTM D422 - Standard Method for Particle-Size Analysis of Soils

ASTM D638 - Standard Test Method for Tensile Properties of Plastics

ASTM D698 - Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 4.4 lb. (2.49 kg) Rammer and 12-inch (305 mm) Drop

ASTM D751 - Standard Methods of Testing Coated Fabrics

ASTM D792 - Standard Test Methods for Specific Gravity and Density of Plastics by Displacement

ASTM D1004 - Test Method for Initial Tear Resistance of Plastic Film and Sheeting

ASTM D1238 - Test Method for Flow Rates of Thermoplastic by Extrusion Plastometer

ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method

ASTM D1557 - Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. (4.54 kg) Rammer and 18-in. (457 mm) Drop

ASTM D1593 - Specification for Nonrigid Vinyl Chloride Plastic Sheetings

ASTM D1603 - Test Method for Carbon Black in Olefin Plastics

ASTM D2172 - Standard Test Methods for Extraction of Bitumen from Bituminous Paving Materials

ASTM D2216 - Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures

ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

ASTM D2937 - Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method

ASTM D3015 - Recommended Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds

ASTM D3083 - Specification for Flexible Poly (Vinyl Chloride) Plastic Sheeting for Pond, Canal, and Reservoir Lining

ASTM D3776 - Test Method for Weight (mass) per Unit Area of Woven Fabric

ASTM D3786 - Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Tester Method

ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4595 - Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method

ASTM D4632 - Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Method)

ASTM D4716 - Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products

ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile

ASTM D4833 - Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

ASTM D5084 - Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

National Sanitation Foundation (NSF) Standard Number 54-Flexible Membrane Liners
Geosynthetics Research Institute (GRI) GM5-1
Ductile/Brittle Transition Time for Notched Polyethylene
Specimens Under Constant Stress

I. LINES AND GRADES

1. The lines and grades shall be established by the General Contractor using control points established in the Contract Drawings as well as other required control points established using survey techniques and approved by the Engineer.

2. Before staking the various construction points, the Contractor shall furnish calculations to the Engineer or his representative for review. The General Contractor shall give the Engineer sufficient notice to observe the location activities.

3. The Engineer or his representative will perform spot checks using appropriate surveying methods to check for significant errors in the staking of control points.

II. Excavation

A. Soils

1. During site preparation, the exposed subgrade will be visually inspected to assure that all topsoil, vegetation, organic materials and other unsuitable materials are identified, removed and stockpiled in the appropriate location.
2. No stumps, logs or debris should be placed in the topsoil stockpile.
3. No topsoil or other organic natural should be placed in stockpiles to be used in compacted fill for Compacted Soil Liner or Compacted Embankment.

4. If large areas of unsuitable materials not previously identified in the Contract Drawings are encountered, the Engineer and the County are to be notified prior to removal of such areas.

B. Rock

1. The definition of rock shall be as stated in the Contract Specifications.

2. If rock is encountered, the Engineer and the County are to be notified immediately. The methods and equipment used by the General Contractor will be recorded.

3. The General Contractor will be requested to demonstrate that the rock cannot be removed using the excavation equipment specified in the Contract Specifications. Removal is to be attempted at least in the directions parallel and perpendicular to the strike of the rock formation.

4. Once the presence of rock has been verified by the Engineer, the excavation will be monitored to measure the quantity of rock removal. Such measurements will include surveying, direct measurement using a tape, or counting the number of full loads of material removed.

4.1 The method of determining rock quantity is to be agreed to between the General Contractor, Engineer and the County before excavation begins.

C. As-Built Conditions

1. The As-Built drawings will record the preconstruction existing conditions, the elevations representing the base of the excavated areas, and the limits of rock excavation, where applicable.

III. COMPACTED EMBANKMENT

A. Placement of Compacted Embankment Fill

1. All required field density and moisture content tests will be completed before the overlying lift of soil is placed. The surface preparation (e.g. wetting, drying, scarification, etc.) will be completed before the Engineer will allow placement of subsequent lifts.

2. Each load of soil will be visually examined either at the borrow source or at the Cell itself. Any material that does not conform to the Contract Specifications will be removed.

3. Moisture content will be monitored by the Engineer or his representative prior to compaction. If the soil is dry of optimum moisture content, the General Contractor will be required to wet the lift and disc or otherwise evenly distribute the moisture over the lift.

4. The thickness of the loose lift will be measured several times daily at random locations after spreading and leveling is completed by the General Contractor. Loose lift thickness should not exceed 10 inches

for a final 6-inch compacted lift thickness. For a bridging layer, the loose lift thickness may exceed 10 inches and may be adjusted in the field by the Engineer. Lift thickness may be measured using surveying, excavation or by driving a steel pin.

B. Field Density Testing Equipment

1. All testing equipment shipped to the job site will be inspected to insure that it is in proper working order and meets the appropriate ASTM specifications or the manufacturer's specifications. All testing equipment will be assigned an inventory control number and these numbers will be recorded in the field job book. The inventory control numbers will be used in the documentation of the calibration of the equipment.

2. Field density tests will be conducted using a nuclear density gauge as outlined in ASTM D2922. At selected locations, field density tests will be conducted using the sand cone method (ASTM D1556) for comparison with the results of the nuclear density gauge.

3. At the beginning of each day, the manufacturer's recommendations for calibration of the nuclear density gauges will be followed.

4. Whenever a nuclear density gauge is "powered-up", moisture and density standard counts will be taken and entered into each gauge's log. This log will be reviewed weekly to detect sudden changes that would indicate a gauge defect.

5. Once a week, each gauge will be checked for stability and drift. A statistical data analysis will be used to detect a gauge's instability. If an unstable gauge is detected, it will be tagged as out-of-service and will not be used until repaired by the manufacturer's representative.

6. Nuclear density gauges marked out-of-service will be removed from the job site at the end of that shift.

C. Frequency of Field Density Testing

1. The area of the Compacted Embankment will be divided into equal segments and shown on the Engineer's grid layout drawing prepared prior to construction. Each segment will be assigned a number. No less than five field density tests will be performed for each full compacted lift at grid locations selected at random by the Engineer or his representatives.

2. Two bulk samples of the Compacted Embankment for each full lift will be collected at random locations by the CQA officer during placement or compaction. The following tests will be performed:

   2.1 Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures, ASTM D2216.

   2.2 Method for Particle-Size Analysis of Soils, ASTM D422.

   2.3 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils, ASTM D4318.

3. The testing described above may be waived if appropriate prequalification testing has been completed at the borrow or stockpile location.

IV. COMPACTED SOIL LINER — NOT APPLICABLE

V. GEOMEMBRANE

A. Geomembrane Manufacturer

1. The General Contractor will submit the following, as obtained from the Geomembrane Manufacturer, to the Engineer:

- Production Certification including project references
- Testing Program for Compound Ingredients
- Material Certification
- Test Data for Material and Resin (including Stress Cracking)
- Other information required by the Contract Specifications

1.1 All of the above submittals will be reviewed and retained by the Engineer.

1.2 If any of the above submittals do not conform to the Contract Specifications, the Engineer will notify the General Contractor and the County.

B. Geomembrane Installation

1. The General Contractor will submit the following to the Engineer prior to installation:

   1.1 Qualifications of Geomembrane Contractor Superintendent and Foreman
   1.2 Resumes of Geomembrane Contractor field crew
   1.3 Six sets of field geomembrane erection drawings
   1.4 Quality Control Certificates

2. The above submittals will be reviewed and retained by the Engineer to verify conformance with the Contract Specifications. Materials not conforming will be rejected.

3. An initial CQA meeting will be held prior to installation. The General Contractor, Geomembrane Contractor, Engineer or his representative, and a representative of the County will be in attendance. The following issues will be discussed and agreed upon by all parties.

   3.1 Testing of welders,
   3.2 Characteristics of "good" weld,
   3.3 Repair procedures, and
   3.4 Destructive and nondestructive testing procedures.

4. The CQA Officer or his representative will sample rolls from each shipment of geomembrane delivered to the site. The <u>minimum</u> number of rolls to be sampled for each shipment will be determined by computing the cube root of the total number of rolls delivered in the

shipment and rounding this value upward to the nearest integer. For instance, if 40 rolls of geomembrane are delivered in a shipment, at least four rolls will be sampled.

4.1 The minimum conformance sampling criteria shall be as outlined in the Contract Specifications.

4.2 The random samples must be representative of the material supplied and exclude the outer wrap of geomembrane if signs of scuffing or other damage is observed. Samples should be full roll width and at least 3 ft. long.

4.3 The CQA Officer or his representative will measure the thickness of each of the random geomembrane samples at the project site prior to geomembrane installation. Material that does not fall within acceptable thickness criteria outlined in the Contract Specifications will be rejected.

4.4 As directed by the CQA Officer, samples will be selected at random and sent to the laboratory for conformance testing. The laboratory testing program will be directed by the CQA Officer and include but not be limited to the following properties:

4.4.1 Thickness (ASTM D1593)
4.4.2 Density (ASTM D792)
4.4.3 Melt Flow Index (ASTM D1238)
4.4.4 Carbon Black Content (ASTM D1603)
4.4.5 Carbon Black Disperson (ASTM D3015)

4.4.6 Tensile Properties (ASTM D638)

4.4.7 Tear Resistance (ASTM D1004)

5. The Engineer or CQA Officer may take additional samples for conformance testing from any rolls that are of questionable quality.

6. The Geomembrane Contractor will submit a daily field record to the Engineer. The daily field record will be reviewed and retained by the Engineer. Any discrepancies will be brought to the Geomembrane Contractor's attention immediately.

7. The Engineer or his representative will mark all areas where grinding is considered to be excessive. The location and repair method for the excessive grinding will be recorded in the daily field reports. The method of repair will be determined in the field by the Engineer.

8. Overheating of the geomembrane will be monitored by the Engineer or his representative. Coupons will be cut from the end of the extrusion seams and the bottom side of the seam will be observed for visible warping or deformation. The locations and repair method of overheated areas will be recorded in the daily field reports. The method of repair will be determined in the field by the Engineer.

9. During seaming, the Engineer or his representative will observe the seams for the following:

   9.1 Proper preparation,

   9.2 Grinding technique (where applicable),

9.3 Overheating, and

9.4 Proper distribution of slack.

10. The Engineer or his representative will observe the geomembrane during the coolest part of the day to check for slack. Any areas where "Trampolining" occurs will be marked by the Engineer for repair by the Geomembrane Contractor.

11. All pipe boots will be observed by the Engineer or his representative for proper welding technique and existance of slack in the geomembrane.

C. Trial Seams

1. The Geomembrane Contractor will perform a trial seam under the conditions outlined in the Contract Specifications. The trial seam should be approximately 5- ft. long. The Engineer will sample the trial seam from the center 3-ft. of the test sample.

1.1 The date, time and equipment, as well as liner temperature, welding temperature, and seaming parameters will be recorded for each trial seam.

1.2 A minimum of three specimens from each sample will be tested in peel (ASTM D413 as modified in NSF 54). Film Tear Bond (FTB) type failures will be the criterion for qualification of the trial seam. Testing will be performed in the field by the Geomembrane Contractor under full-time observation by the Engineer or his representative.

1.3 Untested portions of the trial seam will be retained by the Engineer for the project record and future testing as required.

1.4 All trial seams must pass the field testing before production seaming is performed by the Geomembrane Contractor.

2. The Geomembrane Contractor will obtain samples of field seams, suitable for testing, from the beginning and end of each field run and as directed in the Contract Specifications. These samples may be from areas either to be buried in the anchor trench or covered with another sheet.

2.1 The date, time, equipment,seam number, and seaming parameters will be marked on each sample and recorded on a daily geomembrane field summary.

3. Samples retained will be tested in the field by the Geomembrane Contractor. A minimum of two specimens from each sample will be tested in peel (ASTM D413 as modified in NSF 54). FTB type failures will be the criterion for qualification of the production seam. Testing should be performed at least 15 minutes after completion of the seam by the Geomembrane Contractor.

4. Should the results of any of the above described tests not meet the physical properties in accordance with the Contract Specifications, the Engineer may require additional samples to be taken from seams performed on that particular half day. Said samples are to be tested for the same properties as described in Paragraph No. C-A.3, above.

Depending on the results of these tests, the Engineer will decide on appropriate repair procedures.

5. The Engineer or the County may require additional random samples to be taken for testing in areas which visually appear defective and not in accordance with the Contract Specifications.

D. Non-Destructive Testing

1. The Geomembrane Contractor is responsible for the completion of non-destructive testing of the entire length of all field seams; verifying that the seam is watertight. Testing can be a vacuum test, pressure test, or approved equal, and will be described in writing by the Geomembrane Contractor and approved by the Engineer in advance.

2. Non-destructive testing will be observed by the Engineer or his representative on a full-time basis.

E. Destructive Testing of Production Seams

1. During geomembrane installation, the Engineer will perform additional conformance testing, as required, using the procedures outlined in above.

2. Destructive laboratory testing of seams is the responsibility of the Engineer. A report of all testing is to be provided by the Engineer. The Film Tear Bond (FTB) criteria will be used to qualify a seam. Load and strain at break and the type of failure will be recorded for each specimen.

3. Destructive seam samples will be laboratory tested by the Engineer. Testing frequency is outlined in the Contract Specifications.

3.1 Test samples will be at least 12 inches by 24 inches in size. A minimum of five die cut peel specimens will be tested for each sample in accordance with ASTM D413 as modified in NSF 54. At least five specimens from each sample will be tested for bonded shear strength in accordance with ASTM D3083 as modified in NSF 54.

3.2 All laboratory specimens will be conditioned for a minimum of one hour prior to testing at the Standard Atmosphere for Testing Geosynthetics, that is, air maintained at a relative humidity of $65 \pm 5\%$ and a temperature of $21 \pm 2°C$ ($70 \pm 4°F$).

3.3 Peel tests will be performed on both seams of a double-hot wedge fusion seam.

4. The load and elongation at failure will be measured for each specimen. FTB is the qualifying criterion.

4.1 The Engineer will describe the type of failure for each specimen and record the presence of any disbonding, delamination, foreign material in the bond area, etc.

4.2 As a general guideline, the bonded shear strength should equal or exceed 90% of the tensile strength (in pounds per unit width) of the parent material. If a shear specimen exhibits a failure within the grinding preparation area adjacent to the seam

that falls below 80% of the parent material strength, the Engineer may require additional seam repair. The elongation of the specimen at failure should be a minimum of 30% for shear testing.

4.3 As a general guideline, the peel adhesion should exceed 60% of the sheet yield stress of the parent material. If a peel specimen fails in the grinding preparation area, this should be clearly noted on the test report.

5. For double hot wedge fusion seams, both seams will be tested and are subject to qualification criteria.

VI. Leachate Collection and Removal System

A. Synthetic Drainage Media (SDM)

1. The SDM will be confirmation tested by the Engineer to determine its ability to transmit water in-place (ASTM D4716) under the conditions outlined in the project specifications. Transmissivity test data generated by suppliers will be submitted with bid documents. The results of this test will be submitted to the Engineer for review.

2. Upon delivery to the site, the SDM will be inspected by a representative of the Engineer and compared to bid samples submitted by the General Contractor. All applicable product information will be recorded. The following is a Summary of

the documentation that will be submitted by the General Contractor prior to installation:

2.1 Hydraulic Transmissivity Test Data (with bid)

2.2 Three Synthetic Drainage Media Samples (with bid)

2.3 Mill Certificate

2.4 Six sets of Field Erection Drawings

2.5 Delivery Tickets

3. The Filter Geotextile to be used in the SDM will be confirmation tested to assure conformance with the Contract Specifications. Upon delivery to the site, a minimum of five rolls of geotextile will be sampled by the Engineer. Samples will be full roll width and at least five feet long. The inner and outer wraps of the rolls will be excluded from the samples.

3.1 Conformance testing will be performed to assure that the properties of each type of geotextile meet or exceed the requirements outlined in the Contract Specifications. Testing includes but is not limited to the following properties:

3.1.1 Mass Per Unit Area (ASTM D3776)

3.1.2 Grab Tensile (ASTM D4632)

3.1.3 Burst Strength (ASTM D3786)

3.1.4 Puncture Resistance (ASTM D4833)

3.1.5 AOS (ASTM D4751)

3.2 The minimum sampling frequency and tests to be performed will be established in the Contract Specifications.

4. Test data will be submitted to the CQA Officer for review and approval. Any material not conforming to the requirements in the Contract Specifications will be resampled and retested as directed by the CQA Officer. If the retested material fails the conformance testing, the Engineer will recommend rejection of the geotextile lot in question.

5. Rolls of geonet delivered to the site will be inspected by the Engineer or his representative. A minimum of three randomly selected rolls will be sampled for conformance testing. Samples will be at least three feet long by the full roll width.

5.1 Samples submitted for conformance testing will be inspected by the CQA Officer on site. The geonet thickness and aperture will be measured. Samples will be forwarded to the laboratory for additional verification of physical or performance properties, including but not limited to the following:

5.1.1 Density (ASTM D792)
5.1.2 Carbon Black Content (ASTM D1603)
5.1.3 Melt Index (optional) (ASTM D1238)
5.1.4 Compression (optional) ASTM D35 Proposed Method, (latest revision)
5.1.5 Tensile Properties (optional) (ASTM D4595)

6. Test data will be submitted to the CQA Officer for review and approval. Any material not conforming to the requirements in the Contract Specifications will be resampled and retested as directed by the CQA Officer. If the retested material fails the conformance testing, the Engineer will recommend rejection of the entire lot of geonet in question.

7. Disqualified or otherwise unsuitable material will be removed from the project site by the General Contractor at no expense to the County.

8. Roll tags or packing lists will be retained for all rolls of geonet and geotextile delivered to the site.

9. Storage and handling conditions for the geonet and geotextile will be observed by the Engineer or his representative. The material should be kept as dry and as free of dirt and debris as possible.

10. Geotextiles should be kept in protective wrapping until installation. Any rolls of geotextile delivered to the site without UV and moisture protection wrapping may be rejected by the Engineer or his representative.

11. Placement and connections for the Synthetic Drainage Media will be observed and recorded by the Engineer or his representative to assure conformation with the Contract Specifications and Manufacturer's recommendation. Any

damaged material (including underlying geomembrane) will be marked for repair or replacement.

B. Natural Drainage Media

1. Prior to placement, a minimum of three samples of Natural Drainage Media will be obtained by the CQA Officer. Gradation Analysis (ASTM D422) will be performed on each sample. Constant head permeability tests will be performed on one representative sample of Natural Drainage Media as directed by the Engineer.

2. One representative sample of Natural Drainage Media will be obtained for each full day's placement. Gradation analysis (ASTM D422) will be performed on each sample. A minimum of one constant head permeability test will be performed on a representative sample selected by the Engineer.

C. Drainage Pipe

1. Manufacturer's technical data shall be provided to the Engineer by the supplier. The literature will be retained by the Engineer.

2. A minimum 1-foot long specimen of each solid and perforated pipe of each pipe size will be retained by the Engineer.

3. Connections for drainage pipe will be observed by the Engineer or his representative for any holes or burrs in the weld that may potentially damage the geomembrane.

4. The length and location of each collector pipe will be recorded prior to placement of overlying material.

D. Sump Areas

1. The leachate standpipe, base and bearing plates will be visually inspected by the Engineer or his representative prior to placement to assure that they are smooth and free of burrs or sharp edges which may potentially damage the geomembrane.

2. The sump areas will be observed to check for sharp or other potentially damaging objects prior to placement of the riser and geomembrane protection. The sump areas will be cleaned by the Geomembrane Contractor prior to observations by the Engineer or his representative.

3. The Engineer or his representative will verify the proper geomembrane protection has been provided by the General Contractor before the riser assembly is placed in the sump area.

4. A hydraulic test of the sump areas may be performed by the Engineer prior to placement of the riser assembly if deemed necessary.

VII. OPERATION COVER

A. Placement of Operational Cover Fill

1. The height of the Operational Cover placed will not exceed the elevations shown on the Contract Drawings. The height of the Operational Cover will be measured by the Engineer or his representative.

2. Each load of fill will be visually examined at the source or at the Cell itself. Any evidence of material that does not conform to the Contract Specifications will be removed.

VIII. DATA BASE MANAGEMENT

1. The results of the grain size, Atterberg Limits, modified Proctor, moisture content, field density, and laboratory permeability tests will be compiled and maintained on-site.

2. Statistical analyses, including mean and standard deviation, will be performed on data for each soil type used for Compacted Soil Liner construction. The analyses will be made for physical properties (limits, grain size, maximum dry density) and field compaction results. These analyses will be updated bi-weekly during the period of active fill placement.

3. Statistical analyses will be performed on all geosynthetics conformance test data.

4. Statistical analyses will be performed for the laboratory destructive testing for geomembrane production seams. The mean, range and standard deviation for stress at yield will be recorded for peel and shear data.

IX. AS-BUILT CONDITIONS

1. The finished lines and grades of the surface of the Existing Conditions, Excavation, Compacted Embankment, Compacted Soil Liner, and Operational Cover will be presented by the Engineer.

2. An as-built drawing showing the location and identifying number of the geomembrane panels, seam and destructive samples will be maintained and updated by the Engineer. This does not replace the required Panel Layout As-Built to be submitted by the Geomembrane Contractor. The Engineer's layout drawing will be used to check the drawing submitted by the Geomembrane Contracts.

3. Details showing Synthetic Drainage Media connections will be submitted.

4. As-built location and details for construction of the Leachate Collection and Removal System will be submitted.

CQA SUBMITTAL

1. The Construction Certification document will contain the results of all tests performed on the following components, where applicable:

   1.1 Compacted Embankment,
   1.2 Compacted Soil Liner,
   1.3 Synthetic and natural drainage media,
   1.4 Geomembrane material and installation,
   1.5 Operational Cover,
   1.6 Leachate Removal and Discharge System, and
   1.7 Other elements of construction incorporated into one Cell.

2. "As-Built" drawings will be included with the CQA document.