Construction Quality Assurance Report

INTERNATIONAL PAPER – RIEGELWOOD MILL

Cell 1 Extension

Prepared for:

International Paper – Riegelwood Mill
865 John L. Riegel Road
Riegelwood, North Carolina 28456

INTERNATIONAL PAPER

May 2009

RICHARDSON SMITH GARDNER & ASSOCIATES
ENGINEERING & GEOLOGICAL SERVICES

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865 John L. Riegel Road
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To the Attention of:
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May 2009

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Construction Quality Assurance Report

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Permit Number 24-02

1.0 INTRODUCTION

1.1 Project Overview

This report provides record documentation and certification associated with construction at the International Paper (IP) Industrial Landfill in Columbus County, North Carolina. The facility is owned and operated by IP, and will receive waste from the IP paper mill in Riegelwood, N.C. This report addresses the construction of the Cell 1 Extension, which is a lined cell constructed as an expansion of the existing lined landfill facility. The landfill is located at the paper mill, at 865 John L. Riegel Road, off Highway 87.

A Permit to Construct an Industrial Solid Waste Landfill facility (Permit # 24-02) at the site was issued on September 3, 2008. The permit and attendant conditions are included here in **Appendix A**.

1.2 Project Description

The Cell 1 Extension adds approximately 2.25 acres to the adjacent industrial waste disposal area. The extension required constructing the liner system over a portion of the 3H:1V perimeter berm of the adjacent, unlined landfill. The extension would increase the lined disposal elevation to the height of the unlined disposal area. To construct the Cell 1 Extension, the vegetation was stripped from the slope over the limits of construction and the surfaced was graded to eliminate dips and ridges. Next, the existing protective cover sand was removed from the Cell 1 liner system to expose the existing anchor trench. The geosynthetic liner system for the lateral expansion was then installed. From the top down, the layers in the geosynthetic liner system are:

- a drainage geocomposite
- a 60-mil HDPE geomembrane
- a Geosynthetic Clay Liner (GCL)

The existing Cell 1 drainage geocomposite was cut and pulled back to expose the primary geomembrane. Cell 1 has a double-liner system, with the bottom secondary liner system consisting of a 40-mil HDPE geomembrane and an overlying drainage geocomposite, and an upper, primary liner system consisting of a GCL, a 40-mil HDPE geomembrane and an overlying drainage geocomposite. The GCL of the Cell 1 Extension was placed over the existing primary geomembrane. Then, the new geomembrane was installed and extrusion welded to existing

primary liner. After the weld was vacuum tested, the drainage geocomposite was deployed and secured to the existing primary drainage geocomposite.

A 2-foot thick sand protective cover layer was placed above the new geosynthetic liner system. Leachate will be collected in an 8-inch diameter perforated HDPE pipe located at the toe of the lateral expansion. The HDPE pipe is embedded in a stone column. The stone column consists of NCDOT 467M stone adjacent to the pipe, with an NCDOT No. 78 stone used as filter. The protective cover layer itself was in turn protected by either a layer of primary sludge.

At the west end of the cell extension, the perforated pipe connects to a solid 24-inch diameter HDPE pipe. All leachate collected in the Cell 1 Extension will gravity drain to the wastewater treatment system for the mill (rather than drain to the existing collection sump).

1.3 Construction and CQA/QC Firms

The major parties were involved in the Cell 1 Extension construction include:

Owner	**International Paper** 865 John L. Riegel Road Riegelwood, N.C. 28546 Contact: Edward J. Kreul Phone: 910-655-6229
Design and CQA Engineer	**Richardson Smith Gardner & Associates** 14 N. Boylan Ave. Raleigh, N.C. 27603 Contact: Gregory N. Richardson, Ph.D., P.E Gregory G. Mills, P.E. Phone: 919-828-0577
Soils Testing Laboratory	**GeoTechnics** 2200 Westinghouse Blvd., Suite 105 Raleigh, N.C. 27604 Contact: Mike Smith, P.E. Phone: 919-876-0405
Geosynthetics Testing Laboratory	**Geotechnics** 544 Braddock Avenue East Pittsburgh, PA 15112 Contact: J.P. Kline, P.E. Phone: 412-823-7600
Surveying	**Cape Fear Engineering, Inc.** 151 Poole Road Suite 100 Belville NC 28451 Phone: 910-383-1044

Contractor	**Saiia Construction, Inc.** 324 Commons Dr. Birmingham, AL 35209 Contact: Gary Wilford Phone: (205) 943-2241
Geosynthetics Contractor	**Environmental Specialties, Inc.** 7943 Pecue Lane, Suite A Baton Rouge, LA 70809 Contact: Kevin Simms Phone: 225-291-2700

1.4 Project Documents

The following documents were referenced during the Cell 1 construction and CQA/QC activities:

1. Construction Permit:
   - "International Paper, Riegelwood Pulp and Paper Mill, Facility Permit No. 24-02, Permit to Construct Industrial Solid Waste Landfill," dated December 20, 2003, as modified by Permit Modification for Cell 1 Extension submitted by Richardson Smith Gardner & Associates dated July 13, 2007, and revised August 12, 2008.

2. Construction Documents prepared by Richardson Smith Gardner & Associates:
   - "Technical Specifications – International Paper, Riegelwood, N.C., April 2008.
   - Construction Drawings: " International Paper, Columbus County, North Carolina, Industrial Landfill, Cell 1 South Expansion Construction Drawings," dated July 2008, revised September 2008.
   - CQA Manual "Construction Quality Assurance (CQA) Manual, International Paper, Riegelwood, North Carolina," February 2002.

1.5 CQA/QC Responsibilities

Richardson Smith Gardner and Associates (RSG) were retained by International Paper (IP) to provide Construction Quality Assurance (CQA) for the Cell 1 Extension construction. RSG provided day-to-day on-site construction oversight, with Geotechnics providing laboratory soils testing (in Raleigh) and geosynthetics testing (in both Raleigh and East Pittsburgh, Pennsylvania).

The Project CQA Manual defines Construction Quality Assurance (CQA) as "the planned and systematic program employed by the Owner to assure conformity . . . with the project drawings and project specifications." The purpose of the CQA program is to "provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service."

1.6 Cells 1 Expansion Modifications

During construction, modifications were made to the design and construction documents to accommodate field conditions and/or improve constructability based on practical considerations.

It is RSG's judgment that none of the modifications are considered significant in scope or would impact the operations of the facility, and all of the design modifications meet the intent of the permitted design. It is further our opinion that in some cases, the modifications are an enhancement/improvement to the original design. The modifications are summarized below.

1. Perimeter side-slope berms. At the edge of the Cell 1 Extension on the side slopes, fill was placed approximately 2 feet high with a top width of about 5 feet. The fill was placed so that the anchor trench on the side slope will be higher than the top of the protective cover soil. The 2-foot high "berms" are designed to contain any potential lateral leachate seep. The berms aree not shown on the Permit Modification drawings,but were added to the construction issue drawings. No Design Modification was issued for the minor change, but the mini-berms are shown on the as-built drawings included with this report.

2.0 CONSTRUCTION SUMMARY

The Cell 1 Extension began on or about November 1, 2008. Saiia Construction, Inc. (Saiia) began by establishing perimeter erosion and sediment controls as needed, then clearing away the existing vegetation on the perimeter slope in the expansion area and blading the surface smooth with a bulldozer. The geosynthetic liner system (geomembrane plus drainage composite) was installed between December 2-6, 2008. After all liner work was complete, Saiia began installing the sand protective cover. The existing waste in Cell 1 is at approximately the same elevation as the toe of the Cell 1 Extension. Saiia used the existing waste to create a roadway adjacent to the toe of the expansion area. Dump trucks stockpiled sand protective cover by the roadway. Saiia then used a D-3 bulldozer to spread the sand protective cover.

Saiia placed all of the protective cover sand before installing the leachate collection pipe and gravel column. The sandbags that had previously been used to weigh down the geosynthetics were placed end to end along the toe of the slope where the 8-inch HDPE collector pipe would be located before the protective cover sand was spread. After the protective cover sand was in-place, the contactor used a mini-excavator to remove the protective cover sand above the sandbags. The remaining sand was then removed with shovels. The 8-inch perforated HDPE pipe was welded and placed along the toe in contact with the drainage composite, then the 467M and 78 stone columns were placed around the pipe. Photographs documenting construction are presented in **Appendix B.**

2.1 Borrow Site Preparation

Soil from the on-site borrow area (referred to as the "South Ponds") was used for all construction activities. Borrow material was fine sand, properly classified by the Unified Soil Classification System as an SP-SM. The color of the material from the borrow sources varied from gray to brown to orange.No sample had more than 26% fine particles or particles larger than 3/8 inch. Typical samples had around 10 to 12% fines, and were easily compacted. The borrow soil generally was found below the water table. The contractor excavated the material from below the water table , and stockpiled it in mounds to drain. Sinceborrow soil is sandy, it could be loaded into a truck after about 15 minutes. However, it was generally allowed to drain for a day.

2.2 Subgrade Construction

Subgrade construction consisted of clearing the vegetation from the existing slope, then using the dozer to blade the surface smooth. As described in Section 1.6, two mini-berms, each 2-foot high, were constructed along the lateral perimeter slopes of the expansion area.

Prior to installing the geosynthetic liner system, geotextile wrapped perforated pipes were installed to extend the existing Cell 1 pipes to the top of the berm. The perforatedpipes were installed to collect any gas or seeps that might come from the existing unlined landfill. The upper ends of the perforated pipes daylight beyond the anchor trench of the Cell 1 Extension; the pipes' lower sections ended at the underdrain (installed for Cell 1).

2.3 GCL

Geosynthetics installation began on December 1, 2008 and was completed on December 7, 2008. From the top down, the layers in the geosynthetic liner system are:

- a primary geocomposite drainage media
- a primary 60-mil HDPE geomembrane
- a Geosynthetic Clay Liner (GCL)

The geosynthetic clay liner (GCL) was placed on the approved subgrade. Powdered bentonite was added to the butt seams of the GCL per the manufacturer's installation requirements. All horizontal seams were shingle lapped to prevent liquid from ponding against the seams. The GCL was installed only over approved subgrade and during suitable weather conditions. Care was taken during deployment to ensure that the methods used did not result in rutting or other damage to the subgrade.

2.4 Geomembrane

The geomembrane was installed over the GCL during suitable weather conditions. Care was taken during deployment to ensure that the methods used did not result in rutting or other damage to the subgrade or GCL.

Sandbags were used to anchor geomembrane panel ends until adjacent panels were seamed. Panels extending to the crest of the slopes were placed in the anchor trench and sandbagged as required until the trenches were backfilled. At the end of each day's deployment, the installer placed sandbags continuously along exposed panel ends for protection.

In general, the installer used fusion seams to join panels and whenever possible. Extrusion seams were used on patches and other repairs, and on the tie in to the existing Cell 1 primary liner. All seams were tested by destructive and non-destructive means, as described in Section 5. In general, horizontal seams were shingle lapped to prevent liquid from ponding against seams. The exception was along the side seams for Panels P-33 to P-56 where, due to gusty winds, the installer was allowed to reverse the lap on the side seams. The lapped edge was trimmed to allow water to flow over the seam to prevent ponding. Photographs of the geomembrane installation and testing are included in **Appendix B.**

2.5 Geocomposite

A geonet drainage media bonded on each side with a nonwoven geotextile, or drainage geocomposite, was placed over the primary liner system. The drainage geocomposite speeds leachate removal from the cell, and also protects the primary liner. The Transnet 270-2-6 drainage geocomposite manufactured by Skaps Industries was used.

Adjacent panels of drainage geocomposite were joined in two ways. The core geonet of the drainage geocomposite was secured with nylon ties. The ties were placed at least every 5-feet on all seams. The top geotextile layer of the drainage geocomposite was then sewn on all seams. The drainage geocomposite was placed perpendicular to the slopes and extended to the existing Cell 1 drainge geocomposite. The core geonets were tied together with nylon ties. The textile ends of the Cell 1 Extension drainage geocomposite were heatbonded to prevent future clogging.

2.6 Leachate Collection System

The drainage composite flow is removed from the Cell 1 Extension by an 8-inch perforated HDPE (SDR 17) pipe set in gravel column. The gravel column is located on the bench at the toe of the Cell 1 Extension slope. The pipe for the collection system was welded together on the protective cover sand adjacent to the final pipe location then lowered into place. The perforated pipe terminates at the western end of the Cell 1 Extension inside a 24-inch diameter HDPE pipe. The 24-inch pipe allows storm water run-off or leachate to be removed from the Cell 1 Extension area by gravity, rather than be pumped from Cell 1. All leachate and storm water from the landfill are directed to the plant's wastewater treatment system, specifically to the ASB Channel of the treatment system.

The gravel columns are made of NCDOT No. 467M stone, covered by NCDOT No. 78 filter stone. All stone was granite from Universal Transloaders in Leland, N.C. A minimum 6-inch layer of the protective cover sand was placed over the No. 78 stone to prevent the stone from clogging due to sand washed by erosional, storm water flows, rather than from seepage.

2.7 Protective Cover

A 2-foot thick sand protective cover layer was placed above the geosynthetic liner system. The protective cover sand was from the on-site borrow area.

2.8 Reclaimed Sludge Raincover

To minimize the potential for erosion, a reclaimed sludge from the landfill was placed over the protective cover sand. In landfill operations, reclaimed sludge has proven to be an erosion resistant cover on slopes. The sludge provides a growth media for volunteer vegetation, which is preferable to geosynthetic raincover because the velocity of runoff at the toe of the slope is reduced, so potential erosion of the protective cover is minimized.

3.0 CQA PROGRAM

In satisfying the requirements of the Project CQA Manual for Cell 1, the following activities were performed:

- Observation and documentation of the construction of the subgrade, the GCL, the primary 60-mil HDPE geomembrane, the leachate collection system and the protective cover.
- Field and/or laboratory testing of the geosynthetics, drainage aggregate and protective cover.
- Review of submittals from the Contractor for conformance with project specifications and CQA requirements.
- Review and preparation of the record drawings.
- Preparation of the final CQA report.

Field daily CQA reports are included in **AppendixC**.

4.0 EARTHWORK CQA

4.1 Earthwork Materials

Soil used in the Cell 1 Extension was from the on-site borrow area, referred to as the "South Ponds" borrow area, and used in the Cell 1 construction in 2002 and 2003. The South Ponds material (USCS SP-SM) was used for both structural fill and protective cover. Structural fill for the Cell 1 Extension was limited to two berms, each approximately 2-feet tall, placed on the existing 3H:1V side slopes at the lateral limits of the expansion area, using less than 200 cubic yards of material. The berms were added to elevate the anchor trench slightly above the protective cover to contain any potential leachate seeps within the limits of the lined area.

Soil used the protective cover was required to be classified according to the Unified Soil Classification System (USCS) as SW, SP, SM, or SC based on ASTM D 2488 (visual classification). The protective cover soil was from the on-site, South Ponds borrow area used in constructing Cell 1. No additional laboratory tests were made on the borrow soil, but laboratory results from Cell 1 are presented in **Appendix D** for reference. Site specific soil was used in the interface friction tests with the geosynthetics, presented in **Appendix E**.

The Project Specifications require the Protective Cover sand to be compacted to 90% maximum dry density (MDD), based on a Standard Proctor for areas in the landfill base. The Cell 1 Extension was entirely on the side slopes of the landfill, so compaction tests were not required. However, the sand is at or above 90% MDD after being placed (and tracked) by a bull dozer.

4.2 Earthwork Survey Verification

The surveyor was on site to stake and verify the location of the 2-foot high berms.
As construction in the cell was completed, the surveyors verified that the prepared subgrade surface conformed to the design. Control points on the subgrade obtained by the surveyor to verify that the design grades and elevations were met. The project specifications require a control point grid on 100 by 100 foot spacing. Since the construction was on a slope generally

100-feet long or less, a modified grid that included control points at the top, toe, and mid-point of each slope was used in confirmation surveying. The modified control points allowed a more accurate survey of the subgrade, and provided 50% more points than a 100-foot grid would have. The CQA survey data showed that the side slopes are at approximately 3H:1V, and the valley slope (at the toe of the Cell 1 Extension, where the leachate collection pipe would be) has at a minimum slope of 0.5%. All record drawings are included in **Appendix K**.

5.0 GEOMEMBRANE CQA

5.1 Material Approval

The CQA engineer reviewed and approved of the geomembrane proposed by the contractor for the project. The selected material was a 60-mil textured HDPE geomembrane, manufactured by GSE of Houston, Texas. Selected copies of the manufacturer's submittals are presented in **Appendix F.1**.

5.2 Geomembrane Manufacturer Submittals

The manufacturer submitted conformance test results verifying that the required number of CQA tests were preformed on the geomembrane. A summary of the required and actual test frequencies are shown on **Table 7.1**.

The manufacturer's conformance tests showed that all rolls tested met or exceeded the Project Specifications. The Manufacturer's Quality Control Certificates were obtained for all rolls of geomembrane delivered to the site. Lists were also obtained including resin batch/lot numbers for each roll. Each certificate was reviewed for conformance with the geomembrane and resin properties outlined in the project specification. Manufacturer's quality control certificates for each roll are presented in **Appendix F.2**.

5.3 Interface Friction Tests (All)

The contractor was also required to perform interface friction tests on the geosynthetics and the site soil. Interface friction tests for all materials are summarized in **Table7.2**.

Table 7.2: Interface Friction (ASTM D 5321) Test Summary		
Interface	200 psf Load (125 psf min req. Result)	2,500 psf Load (1,000 min. req. Result)
South Ponds Soil vs. GCL	229	1698
GCL vs. 60-mil Geomembrane	156	1183
Geonet Drainage Media vs. 60-mil Geomembrane	135	1030
South Ponds Soil vs. Geonet Drainage Media	244	1636

The results given in the table above represent peak shear values. All samples met or exceeded the project specifications. The complete test results are presented in **Appendix E**.

5.4 Geomembrane Conformance Testing

In addition to the tests performed by the manufacturer, CQA tests were required for the same properties at a frequency of one test every 200,000 square feet, or one test per lot. CQA conformance samples were taken at the factory and shipped to the geosynthetics testing laboratory in East Pittsburgh, Pennsylvania. All required conformance tests were preformed on the 60-mil HDPE. All CQA conformance test results are presented in **Appendix F.3,** and summarized in **Table 7.3.**

All samples passed the CQA conformance testing, and the representative rolls were approved for shipping.

5.5 Geomembrane Inventory

After the conformance testing was completed, a total of 11 rolls (approximately 125,000 square feet) of 60-mil textured HDPE geomembrane were approved and delivered for Cell 1 construction. The 60-mil HDPE came from one resin lot.

As the geomembrane was delivered to the site, a CQA representative inventoried each roll and checked the roll number against the roll numbers on the manufacturer's QC Certificates. The geomembrane inventory forms are provided in **Appendix F.3**

5.6 Geomembrane Subgrade Approval

Prior to installing the secondary geomembrane, the subgrade surface was prepared by the Contractor. The surface was cleared of vegetation and fine graded. The subgrade was surveyed, as described in Section 5. The CQA engineer reviewed the survey data before the installer was allowed to deploy the geomembrane. The survey results are included in the as-built drawings in **Appendix F.3**.

In addition to relying on survey results, the on-site CQA representative and the ESI superintendent verified that the subgrade surface was smooth and free from objects that could

potentially damage the geomembrane. The on-site CQA representative also inspected the subgrade for soft, uneven or otherwise unsuitable areas. Any deficient area was repaired before the secondary geomembrane was deployed. The ESI superintendent and the on-site CQA representative signed subgrade approval forms verifying that they accepted the condition of the subgrade before deploying the secondary geomembrane. The subgrade approval forms are presented in **Appendix F.4.**

5.7 Trial Welds

ESI seaming personnel made trial welds before each shift began and after lunch and whenever cold starts of welding equipment were required. The CQA representative recorded the seaming temperature and rates of travel. Seaming personnel completed all trial seams before production seaming began. ESI tested the trial welds for peel and shear using a field tensiometer. The CQA representative observed testing. If the trial weld did not meet the Project Specifications, the installer adjusted the equipment and/or seaming procedures and prepared a new test seam, or the equipment was marked as "out of service" and repaired. Trial seam data is on “Trial Seam Report" forms. Completed forms are presented in **Appendix F.5**.

5.8 Geomembrane Installation

As each geomembrane panel was placed, a CQA representative recorded the panel identification number, source roll number and panel dimensions. The panel number and date placed were also written on the geomembrane itself. The CQA representative visually examined each panel soon after deployment for evidence of any material damage or defects. Any such defects were marked on the panel for repair by placement of a patch. Overlaps with adjacent panels were checked, and all exceeded the 3-inch minimum.

A total of 56 geomembrane panels were placed, covering 108,907 square feet in 3-D surface area. Panel dimensions and roll numbers are recorded in the Panel Placement Records in **Appendix F.6.** The in-place panels of geomembrane were surveyed by Cape Fear Engineering. The as-built drawing for the primary and the secondary geomembrane are included in **Appendix K.**

5.9 Production Seaming

Each field seam was given a unique identification number. The seam number represents the panels incorporated in the seam. For instance, Field Seam Pl/P2 identifies the field seam formed by Panels 1 and 2. In general, panels were seamed on the day they were place, except for the tie-in seam to Cell 1 which was not welded to the existing primary liner until at least one day after deployment. The CQA representatives observed each seam as it was being completed ensure both the integrity of the seam and the consistency of the seaming technique. The seam number, machine number, welder and seaming parameters, and any defects were recorded on the Geomembrane Seam Reports presented in **Appendix F.7**.

Prior to fusion seaming, ESI technicians measured and visually inspected the overlap area and cleaned the seam area using dry cloths. Extrusion seam areas were prepared by beveling the

edges of the 40-mil HDPE patch and grinding the seam area to remove surface oxidation. Patches were first bonded using hot air "Leister" equipment, and then the extrusion seam was completed.

CQA representatives observed preparation and seaming procedures to ensure that no areas were overheated or showed signs of excessive grinding outside of the extrusion seam area.

5.10 Nondestructive Seam Testing

ESI conducted nondestructive testing of all field seams. Fusion seams were tested using air pressure tests of the channel between the inner and outer seams. All extrusion welds were tested using a vacuum box. All extrusion seams were vacuum box tested by ESI.

For each double-hot wedge fusion seam, the beginning air pressure, test duration and final air pressure were recorded. The length of the segment tested was also recorded. The air channel pressure was monitored for at least five minutes. A beginning air pressure of at least 30-psi was used for testing. The maximum allowable pressure drop during the five-minute monitoring period was 3 psi. All seams passed the air testing, or the area causing pressure loss was found, repaired, and retested. Nondestructive testing information was recorded on the forms presented in **Appendix F.8.**

5.11 Destructive Seam Testing

Destructive seam testing was performed on production seams as required in the Project Specifications. The Installer cut and removed samples at locations selected by the CQA engineer. The Project Specifications require one destructive sample per 500 linear feet of seam length. A total of 5,335 linear feet of seaming was completed. A total of 17 destructive seam samples were taken, for an average of about one sample per 314 linear feet of seam, exceeding the Project Specifications. All seam samples were tested both in the field and laboratory. All samples met or exceeded the Project Specifications. Destructive sample results are presented in **Appendix F.9**. The locations of the destructive samples are shown on the As-built drawings in **Appendix F.11**.

The "extra samples" are the result of two factors. First, the CQA Manual specification of one sample for every 500 feet of seam was interpreted to mean one sample for each 500 feet of seam for each welder. A second factor was the CQA decision to sample each welder each day, even though the CQA Manual does not require such a frequency. Over the course of the geomembrane installation, the daily testing beyond the requirements of the CQA Manual added extra tests, but ensured a quality installation.

Geotechnics conducted destructive seam testing (at their laboratories in both Raleigh and in East Pittsburgh, Pennsylvania). ESI had a calibrated tensiometer at the site, which they used for their test welds and for testing destructive samples in the field.

Destructive samples from the double-hot wedge fusion seams were tested in peel and shear in accordance with ASTM D6392. Five coupons were tested in peel on both the inside and outside tracks, and 5 coupons were tested in shear. A gauge length of 2.5 inches was used for all testing.

Destructive samples passed if 4 out of 5 specimens met the following criteria:

1. Film Tear Bond (FTB) type failures on 4 of the 5 specimens, defined as tearing in the membrane itself before ply separation of the seam.
2. A minimum load at yield of 91 lb/in width for peel
3. A minimum load at yield of 120 lb/in width for shear

All destructive test locations are shown on the As-built HDPE drawings provided by Cape Fear Engineering and included in Appendix **F.11**.

5.12 Repairs/Patches

When defects were observed in the surface of the geomembrane (inadvertently caused by workers, imperfections in the sheet, etc.), a repair/patch was required to be placed. Repairs were required at all destructive sample locations. Additionally, repairs/patches ("cap strips") were required at all "Tees" formed by the intersection of three panels, and over seams with failed destructive samples. Repair Records are in **Appendix F.10**. Repairs/patches were first leistered in place and subsequently extrusion welded and non-destructively tested by vacuum box methods.

All testing indicates that the Geomembrane meets the material and seam requirements defined in the Project Specifications.

The following appendices complete this section.

Appendix F.1.....Selected HDPE Manufacturer's Submittals
Appendix F.2.....HDPE Manufacturer's Conformance Test Results
Appendix F.3.....HDPE CQA Conformance Test Results and Roll Inventory
Appendix F.4.....Subgrade Acceptance Forms
Appendix F.5.....HDPE Trial Weld Logs
Appendix F.6.....HDPE Panel Placement
Appendix F.7.....Panel Seaming Records
Appendix F.8.....HDPE Non-Destructive Tests
Appendix F.9.....HDPE Destructive Seam Tests
Appendix F.10.....HDPE Repair Records
Appendix F.11.....HDPE As-built Drawings

6.0 GCL CQA

6.1 Material Approval

The proposed geosynthetic clay liner (GCL) product was reviewed by the CQA Engineer. The proposed GCL was Bentomat DN, manufactured by Colloid Environmental Technologies Company (CETCO), of Arlington Heights, Illinois. The rolls were manufactured at CETCO's facility in Farimont, Georgia. Copies of selected product submittals for these products are presented in **Appendix G.1**. The GCL was identical to the GCL used in constructing Cell 1.

6.2 Manufacturer's Quality Control Submittals

The manufacturer's quality control submittals for the specific rolls to be delivered to the site were reviewed prior to shipping the GCL. Copies of these certificates are in **Appendix G.2.** Based on the manufacturer's conformance tests, all material meet or exceeded the project specifications.

8.3 Material Control Testing

CQA conformance testing on the GCL was based on 51 rolls of GCL totaling 120,968 square feet. All rolls were from the same lot. The GCL roll inventory is presented in **Appendix G.3.** Based on the CQA testing frequency of one test every 200,000 square feet, one test was required and one was performed. Results of the conformance tests are summarized in **Table 8.1.** The complete conformance test results are presented in **Appendix G.4.** CQA conformance test results met or exceeded the project specifications.

6.3 Installation

The GCL was installed as required by the project specifications and CQA manual. Side seams were overlapped by 6-inches, end seams overlapped by 12-inches. The engineer allowed end seams on the 3H:1V sideslopes (which is permitted by the project specifications). The installer attempted to minimize end seams on the sideslopes.

Powdered bentonite was placed on all roll end-seams, and on all seams between rolls that were not full width. The Cetco GCL is manufactured so that powdered bentonite is not required on side lap seams of full-width panels.

The GCL panels were not surveyed. The GCL was installed to approximately one foot beyond the existing Cell 1 anchor trench and over the Cell 1 Primary Geomembrane. The Cell 1 Extension geomembrane extended beyond the GCL and was welded to the existing primary geomembrane.

7.0 LEACHATE MANAGEMENT SYSTEM CQA

7.1 Material Approval

The CQA engineer reviewed and approved the leachate management system components proposed by the Contractor. The selected materials included the following

Drainage Aggregate (No. 467M and No. 78 stone)	Universal Transloaders (from Vulcan Materials)
HDPE Pipe & Fittings	PolyPipe EHMW PE 3408 (SDR 17) – 3:, 6" & 8" diameter (SDR 26) – 24" diameter
Pre-cast concrete Products	Cape Fear Pre-cast
Geotextiles & Geonet Drainage Media	See **Sections 10.0 and 11.0**

Copies of selected submittals for these products can be found in **Appendix H.1.**

7.2 Manufacturer's Quality Control Submittals

The CQA engineer reviewed and approved the products proposed by the contractor. The aggregate proposed was delivered from an NCDOT inspected quarry; therefore, no gradation test was required. All stone was delivered from Universal Transloaders in Leland, N.C., although it was mined from the Martin Marietta Quarry in Rockingham, N.C.

The CQA tests for calcium carbonate on the stone samples content were omitted. There are two reasons justifying the omission of the tests. First, since the material was almost entirely granite and contained no limestone, by visual inspection its calcium carbonate content could be determined to be less than the 15% specified. Second, the nature of the waste at the landfill is slightly caustic and not acidic, so the calcium carbonate content would be irrelevant in regards to the performance of the aggregate.

7.3 Protective Cover

The project specifications require the protective cover to meet the following requirements:

•	Materials	SW, SP, SM or SC, with no deleterious material
•	Gradation	Maximum particle size = 3-inches
•	Lift Thickness	12-inches
•	Density	Minimum 90%v max. Standard Proctor dry density (landfill base only)
•	Particle Size	No more than 25% passing No. 200 sieve

Material control tests for the protective cover are summarized in **Table 9.1**. Based on surveyed quantities, approximately 8100 cubic yards of protective cover sand were placed in the cell. However, none of the Cell 1 Extension area is on the base. According to the CQA Manual, density tests were not required for material placed on side slopes. By inspection, the protective cover soil was at greater than 90% compaction, since a bulldozer cannot operate in the fine sand below 90% compaction. Second, since the protective cover material was sand, it is at or above 90% compaction once it is placed, based on Proctor curves for the material. The specifications required visual inspection only to assess the USCS classification of the material. One load of material that appeared to have excessive silt/clay content was reject and not placed in the protective cover.

7.4 Protective Cover Thickness

The thickness of the protective cover was verified by survey performed by Cape Fear Engineering, and by depth checks performed by the CQA personnel in the field. The as-built subgrade was compared to the as-built protective cover. Gravel columns containing leachate collection pipes are at the toe of most berms within the landfill. These columns are approximately 3-feet thick. Therefore, the control points surveyed at the toe of slopes for the subgrade could not be compared to those surveyed on the protective cover. As-built drawings for the leachate collection pipes and the top of the protective cover are presented in **Appendix F.4**.

The following information completes this section:

Appendix F.1	Protective Cover Conformance Tests
Appendix F.2	Leachate Collection System Drawings

8.0 GEOTEXTILE CQA

8.1 Material Approval

The CQA engineer reviewed and approved the geotextile components proposed by the Contractor. The selected material was a Contech C-60NW non-woven geotextile for use as the bonded non-woven on the drainage geocomposite. The geotextile was an AASHTO M-288 Class 2 geotextile, as required by the project specifications. The product was manufactured by Synthetic Industries in Chattanooga, Tennessee. The submittal for this product is presented in **Appendix H.1.**

8.2 Materials Control Testing

CQA conformance testing was required on one sample of the type GT-S geotextile (out of 110,000 square feet). The 6-ounce per square yard geotextile was manufactured by TNS Mills of Spartanburg, South Carolina and approved for use on the drainage geocomposite. The geotextile

was taken at the factory and sampled prior to heat bonding with the drainage geocomposite. Results of the conformance testing are included in Section 11.0 of this report.

The following information completes this section:

Appendix H.1	Selected Geotextile Manufacturer's Submittals
Appendix H.2	Geotextile Conformance Tests

9.0 DRAINAGE GEOCOMPOSITE CQA

9.1 Material Approval

The CQA engineer reviewed and approved the geonet drainage media products proposed by the Contractor. The selected materials were a Transnet 270-2-6 geocomposite manufactured by Skaps Industries of Commerce, Georgia. The Transnet is typical bi-planar geonet construction. Copies of selected product submittals for these products are presented in **Appendix J.1.**

9.2 Manufacturer's Quality Control Testing

The CQA engineer reviewed and approved of the manufacturer's quality control certificates prior to shipping each type of geonet drainage media to the site. Copies of the certificates for the Skaps (bi-planar) product are presented in **Appendix J.2**.

9.3 Material Control Testing

The results of CQA and manufacturer's conformance testing are summarized in **Table 11.1**. CQA conformance test results for the Skaps Transnet geocomposite are included in **Appendix J.3**. A total of 45 rolls of Transnet (totaling 126,000 square feet) were available for use on the project. The inventory of rolls of the Transnet geocomposite are presented in **Appendix J.4**.

All rolls of the drainage geocomposite were from the same lot. The CQA Manual requires one transmissivity test per lot, regardless of the square footage in the lot. The geosynthetics testing laboratory accidentally ran transmissivity tests on all 7 conformance samples. All test results are included.

The following information completes this section:

Appendix J.1	Manufacturer's Submittals
Appendix J.2	Manufacturer's Conformance Tests– Skaps Transnet
Appendix J.3	CQA Conformance Tests – Skaps Transnet
Appendix J.4	Roll Inventory – Skaps Transnet

10.0 CQA CERTIFICATION

Based on the observations and results of the CQA program documented herein, it is our professional opinion that the construction of Cell 1 Extension of the International Paper – Riegelwood Mill Industrial Landfill was completed in accordance with the following:

i. The Project CQA Manual;
ii. The conditions of the Permit to Construct;
iii. The requirements of 15A NCAC 13B.0504 and
iv. Acceptable engineering practices.

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