CDM

Buncombe County, North Carolina

Solid Waste Management Facility
Cell 6
Construction Quality Assurance Report

Volume 1

January 2006

Report

CDM

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January 20, 2006

Mr. Tim Jewett
North Carolina Department of Environment and Natural Resources
Solid Waste Section
401 Oberlin Road, Ste. 150
Raleigh, North Carolina 27605

Subject: Buncombe County, North Carolina
Buncombe County Solid Waste Management Facility
Cell 6 Construction Quality Assurance Report
Permit No. 11-07

Dear Mr. Jewett:

On behalf of Buncombe County (County), Camp Dresser & McKee (CDM) is submitting the attached two (2) copies of the Construction Quality Assurance (CQA) report documentation for Cell 6 of the Buncombe County Solid Waste Management Facility for your review. Cell 6 was permitted to be constructed in two consecutive phases. Phase 1 (6.4 acres) was constructed to provide the County with immediate disposal capacity. Phase 2 (16.3 acres) was constructed immediately following completion of Phase 1.

The attached CQA report provides complete documentation for Cell 6 including: a narrative encompassing the CQA activities relative to both Phase 1 and 2 construction; Phase 1 CQA documentation as previously submitted for review and approval on June 24, 2005 and amended on July 25, 2005; and Phase 2 CQA documentation compiled during Phase 2 construction.

Please accept this letter as the certification statement required by Rule .1624(b)(16)(C). The testing results and other documentation presented in the attached CQA document have been either reviewed by me or under my direct supervision, and they accurately reflect the installation and testing that was observed by CDM. To the best of my knowledge, information, and belief, the construction of Cell 6 was completed in general accordance with:

- The approved CQA Plan;
- The conditions of the Permit to Construct;
- The requirements of Rule .1624; and
- Acceptable engineering practices.

CDM

On October 12, 2005, the Solid Waste Section approved the Permit to Operate for the Phase 1 of Cell 6 disposal area. The intent of this submittal is to receive a Permit to Operate for Phase 2 of Cell 6. If you have any comments or need additional information for your review, please do not hesitate to contact me at (919) 325-3574.

Very truly yours,

Kenton J. Yang, P.E.
Camp Dresser & McKee

NORTH CAROLINA PROFESSIONAL SEAL 029928 ENGINEER KENTON J. YANG
01/20/06

cc: E. Mussler, NCDENR (SWS)
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File: G-101.1
G-101.5

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Section 1 Introduction

1.1 Facility Location

The Buncombe County Solid Waste Management Facility is a 557-acre site located off NC 251 (Dixie Highway) between Flat Creek Road and Panther Branch Road in northern Buncombe County. The entrance road off Panther Branch Road provides primary access to the facility.

1.2 Organization of the Report

This report summarizes quality assurance services performed during Phase III construction of the Buncombe County Solid Waste Management Facility. Phase III construction is comprised of one cell – Cell 6 (approximately 22.7 acres). Cell 6 is divided into two construction phases to allow the County to begin waste disposal prior to completion of Phase III, with both construction phases occurring consecutively under the same construction contract. Phase 1 construction includes a 6.4-acre alternative Subtitle D liner system, the complete groundwater monitoring system, leachate pumping system and the lower reach of the leachate collection system. Phase 2 construction includes the remaining 16.3-acre alternative Subtitle D liner system, the complete leachate collection system, and the bioreactor system, which includes a 24-inch gas collection line, 6-inch-diameter leachate injection force main, condensate recovery system and appurtenances.

This report details Phase 1 and 2 construction. Included are inspection reports, test data, and discussions on results and procedures used during construction. Specifically, this report addresses the following critical elements:

- landfill foundation,
- compacted soil liner,
- geosynthetic clay liner,
- high density polyethylene (HDPE) liner,
- fabric cushion,
- stone protective cover layer,
- leachate piping system, and
- groundwater monitoring system.

Documentation compiled throughout the construction of the landfill including record drawings are provided in Appendices A through F of this report.

This report is divided into the following sections:

Section 2 - Earthwork
Section 3 - Compacted Soil Liner
Section 4 - Geosynthetic Clay Liner
Section 5 - HDPE Liner
Section 6 - Fabric Cushion

Section 7 - Protective Cover
Section 8 - Leachate Piping System
Section 9 - Groundwater Monitoring System

The landfill was constructed with an approved alternative Subtitle D liner in accordance with North Carolina Solid Waste Rules, 15A NCAC 13B .1600. The alternative composite liner system consists, from bottom to top, of a compacted subgrade, 18 inches of compacted soil liner with a maximum hydraulic conductivity of 1×10^{-5} cm per sec, a geosynthetic clay liner, a 60-mil textured high density polyethylene (HDPE) liner, a 28-ounce fabric cushion, and a 2-foot rock protective cover layer. A groundwater monitoring system consisting of a 60-mil textured HDPE liner and composite drainage net was installed 3 feet below the bottom of the compacted soil liner in the designated sump area.

Leachate is collected in Cell 6 using a submersible side slope riser pump. The pump is installed in a 24-inch, HDPE, perforated sump. An 18-inch riser pipe provides access to the sump without penetrating the liner system. The leachate discharges into a 3-inch HDPE pipe and flows through a series of 90 degrees bends and a flowmeter inside a HDPE vault. Following the flowmeter, the 3-inch HDPE pipe connects to a 6-inch HDPE force main adjacent to the valve vault. The 6-inch HDPE force main discharges into the leachate pond. Currently two submersible side slope riser pumps, previously installed, are used to pump leachate from the leachate pond into tanker trucks that haul the leachate to the Buncombe County Metropolitan Sewerage District Sewer System. Following completion of the Phase 1 Bioreactor XL Project, leachate will be applied to the waste in Cells 1 through 5.

The following table lists the parties involved in the construction, testing, and construction observation services.

Party	Role
Camp Dresser & McKee (CDM)	Engineering Consultants—provided a full-time resident project representative (RPR), quality assurance (QA) inspection and testing, and general services during construction such as coordination of project meetings, clarification of design issues, troubleshooting of field problems, issuance of change orders, project closeout, and other administrative tasks. Construction Quality Assurance (CQA) testing laboratory conducted soil index and permeability testing.
J&L Testing Company, Inc. (JLT)	CQA testing laboratory retained by CDM to conduct permeability testing and composite liner testing.

Party	Role
Alpha Environmental Services, Inc. (Alpha)	CQA independent testing laboratory retained by CDM to conduct CQA testing of soils materials.
Thalle Construction Co., Inc. (Thalle)	General Contractor
Draper-Aden Associates (DAA)	Construction Quality Control (CQC) independent testing laboratory retained by Thalle to conduct conformance tests for soils.
TRI/Environmental, Inc. (TRI)	CQC independent testing laboratory retained by Thalle to conduct conformance tests for geosynthetics.
Hallaton, Inc. (Hallaton)	GCL, HDPE liner, fabric cushion and drainage net installer. Subcontractor to Thalle
Colloid Environmental Technologies Company (CETCO)	Geosynthetic clay liner supplier
AGRU America	HDPE liner supplier
SKAPS Industries (SKAPS)	Fabric cushion and drainage net supplier

Section 2 Earthwork

2.1 Site Preparation

Prior to the start of any earthwork activities, erosion and sediment control structures were installed for areas within the construction limits. Barriers, guards, and enclosures were erected for the protection of trees, wetlands, and other vegetation. The Contractor maintained these structures until all work in the vicinity was completed. Site preparation, as covered in the Cell 6 composite liner system construction plan consisted of clearing, grubbing, vegetation, and topsoil removal over approximately 23 acres not withstanding borrow areas. Within the limits of clearing and grubbing, on-site timber, trees, stumps, brush, shrubs, roots, grass, weeds, rubbish, and other objectionable material resting on or protruding through the ground surface were removed. Material and debris from clearing and grubbing operations were stockpiled and then burned on-site. Topsoil was stockpiled on-site for future use as daily cover.

2.2 Excavation

2.2.1 General Excavation

Within the limits of construction, excavation was performed to attain grades specified on the drawings for the disposal cell, ditches, drop inlet, pipes, and road. The excavation surface was prepared firm and dry. Care was taken to preserve the undisturbed state of subgrade soils. Portions of the excavated material were stockpiled for common fill, compacted soil liner, or use as daily cover. Under no circumstances was the earth ploughed, scraped, or dug with machinery so as to disturb material below the finished subgrade. Prior to placing fill, firmness of the exposed subgrade was checked by proof rolling (under CDM observation) with a loaded off-road truck. All exposed subgrade surfaces were deemed acceptable by the Engineer.

2.2.2 Rock Excavation

2.2.2.1 Rippable Rock Excavation

Rippable rock, defined as any material that cannot be removed by a CAT 235D/CAT 350 excavator or equivalent but can be removed by a CAT D9N or equivalent, was encountered in select locations in Phase 1 but was not encountered in Phase 2. Rock was excavated 4 feet below subgrade and backfilled with compacted common fill. Approximately 6,100 cubic yards of rippable rock was removed from Cell 6.

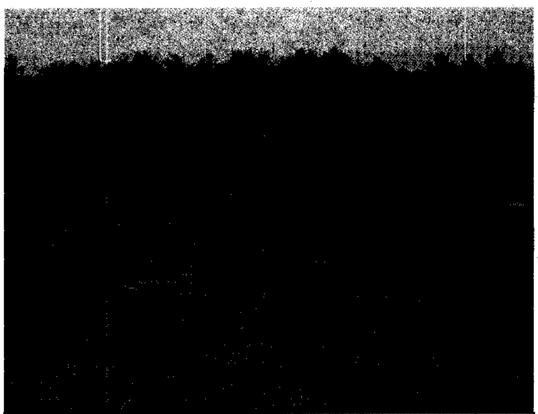


Photo of non-rippable rock excavation.

2.2.2.2 Non-rippable Rock Excavation

Non-rippable rock was encountered only in Phase 2. Rock was excavated 4 feet below subgrade and backfilled with compacted common fill. Approximately 3,800 cubic yards of non-rippable rock was removed from Cell 6.

2.3 Common Fill

2.3.1 Common Fill Characterization

The Construction Quality Control (CQC) subcontractor DAA excavated seven test pits for evaluation as potential common fill borrow material. These test pits were located in Cell 6 (as shown at the end of Appendix A-1a). Bag samples were collected for particle size analyses (ASTM D422), Atterberg limits testing (D4318), and moisture-density relationship determinations (ASTM D698). The laboratory test results for the test pits are contained in Appendix A-1a. CDM performed Construction Quality Assurance (CQA) testing on one 50-pound representative sample. The CQA test results are included in Appendix A-1b.

2.3.2 Common Fill Compaction Testing

Alpha (CQA) and DAA (CQC) performed field density tests to evaluate fill soil compaction. Shallow nuclear methods (ASTM D2922) were used to perform the field density tests for every lift of fill at a frequency of one test per 10,000 square feet of placed fill. One-point Proctor tests were performed in the field to assist field personnel in establishing maximum dry density of the fill being placed. Appendix A-2a contains results of the field nuclear density/moisture tests for Cell 6. A total of 1,217 density/moisture tests were taken by Alpha and DAA.

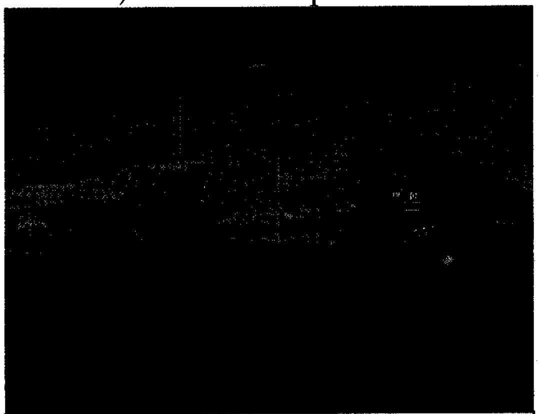


Photo of common fill activities.

Conformance tests were performed by the CQC laboratory. Approximately 220,000 cy of common fill were used within the Cell 6 construction area. Project specifications required testing frequencies of 5,000 cubic yards for Atterberg limits (ASTM D4318), grain size analysis (ASTM D422), and natural moisture (ASTM D2216) and 10,000 cubic yards or change in material for moisture/density (ASTM D698). Results are included in Appendix A-2b. The following table highlights required and actual testing frequency.

CQC Laboratory Testing	Test	Testing Frequency	Common Fill (yd^3)	Required No. of Tests	Actual No. of Tests Performed
Total	Atterberg, grain size, and natural moisture	1 per 5,000 yd^3	220,000	44	44
	Moisture/density	1 per 10,000 yd^3	220,000	22	23

2.4 Record Drawings

Appendix E-1 includes a record drawing of Cell 6, certified by a professional land surveyor currently licensed in the State of North Carolina, showing elevations for the landfill foundation (subgrade) and the associated compacted soil liner and protective cover layer thicknesses.

Section 3
Compacted Soil Liner

3.1 Overview

The compacted soil liner comprises the bottommost layer of the Cell 6 (Phase 1 and Phase 2) alternative liner system. As such, the compacted soil liner serves as an additional barrier to the Geosynthetic Clay Liner (GCL) and 60-mil HDPE Liner to prevent fluid migration into the underlying soils.

Materials for the compacted soil liner must possess the following characteristics:

1) Sufficient shear strength to resist construction and operational stresses;

2) Long-term internal friction (within the soil) and interface friction (between the soil and geosynthetic clay liner) for an acceptable factor of safety against sliding (the minimum required internal and interface friction angle is 20.5 degrees); and

3) Low permeability to facilitate its function as a barrier. The minimum required thickness of the compacted soil liner is 18 inches placed in 6-inch lifts, with a maximum allowable permeability of 1×10^{-5} cm/sec.

The Cell 6 expansion was constructed in phases to address the immediate need for airspace. Phase 1 is 6.4 acres and Phase 2 is 16.6 acres for a total of 23 acres. Thalle was responsible for identifying onsite borrow sources of compacted soil liner material, as well as constructing the clay soil test pads and compacted soil liner for both Phase 1 and Phase 2.

This section outlines the quality control and quality assurance testing conducted prior to and during compacted soil liner construction. CQC testing was performed by DAA. CDM together with Alpha performed field and laboratory CQA testing.

3.2 Pre-Construction CQC and CQA Laboratory Testing

Prior to the start of test pad construction, CQC testing by DAA and CQA testing by CDM were performed on selected soil samples for use as compacted soil liner material. Separate test pads were constructed for Phase 1 and Phase 2 to address changes in the on-site soils available for compacted soil liner construction and to identify soil index values and the range in permeability values representing soils obtained from multiple on-site sources. In addition to the soils obtained from Cells 6, suitable clay liner material was also obtained from the Cell 7 borrow area and an embankment cut adjacent to the scale house, used exclusively for Phase 2. The soils used to construct the Phase 2 compacted soil liner were in some cases non-plastic. However, laboratory test results presented in this Section indicate that the non-plastic soils also meet the required maximum permeability of 1×10^{-5} cm/sec.

3.2.1 Phase 1 CQC Laboratory Testing

DAA obtained samples from a total of nine (9) test pit locations within Cell 6, proposed for use as either common fill or compacted soil liner material. In addition to test pits to locate suitable on-site clay soils, tests were also performed on clay soils stockpiled from previous projects, representing on-site materials.

Testing consisted of Atterberg Limits (ASTM D4318), particle size analyses (ASTM D422), and moisture-density relationship tests (ASTM D698). Based on the results of the above QC tests Thalle selected two locations from which to excavate and stockpile on-site soil liner material. The two sources selected by Thalle to construct Phase 1 were identified as clay soil excavated from the Cell 6 Phase 2 area and the on-site clay soils stockpiled from previous projects. Samples from these two sources were identified by DAA as TP-8 and TP-9, respectively. QC test results are presented in Appendix A-3. Corresponding QA tests are presented in Appendix A-4.

Tests results indicate that the on-site soils suitable for use as compacted soil liner material consist primarily of sandy silts and clays with USCS classifications of MH (elastic sandy SILT) and CH (sandy fat CLAY). These soils were mixed by Thalle Construction to achieve a more homogeneous material for construction of the Phase 1 test pad and Phase 1 compacted soil liner.

3.2.2 CQA Laboratory Testing

Prior to construction of the Phase 1 test pad, two sealed 5-gallon bucket samples of the proposed compacted soil liner material were submitted by Thalle to the CDM CQA Lab for acceptance zone testing, representing samples taken from TP-8 and TP-9. Test results presented in Appendix A-4 indicate a moderate to high plasticity elastic sandy Silt, with corresponding USCS classifications of MH and ML, respectively. The initial QC conformance test results submitted by DAA for the Phase 1 compacted clay soil liner, presented in Appendix A-5a, were consistent with these findings. Additional conformance testing for Phase 2 is presented in Appendix A-5b.

Acceptance zone testing set the initial limits with regard to moisture content and percent compaction (relative to the maximum dry density and optimum moisture content of the samples provided) for construction of the test pad and provided an indication of the soil's compacted, in-place permeability. Acceptance zone criteria included placement and compaction of the clay soil liner at 93 to 95 percent of ASTM D698 maximum dry density (MDD) and 2 to 5 percent wet of the optimum moisture content (OMC). The proctor curves for TP-8 and TP-9, from which the initial acceptance zone criteria was established, are presented in Appendix A-4.

3.3 Test Pad Construction

Test pad construction served to demonstrate the ability of the on-site clay soils to meet the permeability requirement of 1×10^{-5} cm/sec for the compacted soil liner.

3.3.1 Phase 1 Test Pad Construction

Thalle constructed the Phase 1 test pad in the completed Phase 1 subgrade area subsequent to proof rolling, fine grading and acceptance of the prepared surface.

QA tests performed on the TP-8 and TP-9 samples were initially used to monitor compacted soil liner placement with regard to percent compaction and moisture content. Initially the soil liner material was found to be below the optimum moisture content and water added to achieve the desired acceptance zone moisture of 2% to 5% wet of optimum. Required compaction of 93% to 95% of maximum dry density, in accordance with ASTM D-698, was established to achieve the 1×10^{-5} cm/sec permeability requirement. The test pad was constructed in three 6-inch lifts. Test results (i.e. field densities, moisture checks, etc.) reported by Alpha are presented in Appendix A-2a.

In addition to the density/moisture checks CDM also obtained bulk samples at a minimum of three locations for each of the three lifts. Densities based on the TP-8 and TP-9 proctors were initially found to meet or exceed the desired 93% to 95% compaction. Subsequent laboratory tests performed on the bulk samples obtained from the test pad identified that the clay soils used to construct the test pad were higher in maximum dry density and lower in optimum moisture content than the TP-8 and TP-9 soils. As a result, new acceptance zone criteria for Phase 1 was established using the test pad bulk samples. QA tests based on the new acceptance zone criteria confirmed that a minimum of 95% compaction was achieved at each sample location. The test pad was later removed and the soils incorporated into the Phase 1 clay soil liner construction using the new acceptance zone criteria. Results of tests performed on the test pad bulk samples are presented in Appendix A-6a.

Undisturbed tube samples were also taken from each of the three lifts of the Phase 1 test pad for hydraulic conductivity testing. Bulk samples were obtained at the same sample locations to perform remolded permeability tests in the lab. Undisturbed permeability test results for the Phase 1 test pad are presented in Appendix A-6a. Results are summarized below in Table 3-1. Remolded permeability test results corresponding the Phase 1 test pad bulk samples are presented in Appendix A-7a.

Table 3-1 Phase 1 Test Pad - Permeability Test Results

Test No.	Location	Result (cm/sec)
TP1 (Undisturbed)	Lift 1	7.2×10^{-8}
TP2 (Undisturbed)	Lift 2	4.6×10^{-8}
TP3 (Undisturbed)	Lift 3	1.7×10^{-7}
TP1[1] (Remold)	Lift 1	1.6×10^{-6}
TP2[2] (Remold)	Lift 1	2.8×10^{-7}

Test No.	Location	Result (cm/sec)
TP3[1] (Remold)	Lift 1	6.8×10^{-7}
TP4[2] (Remold)	Lift 1	6.5×10^{-7}

[1]Remolded at 93% MDD and 2% wet of OMC
[2]Remolded at 95% MDD and 5% wet of OMC

3.3.2 Phase 2 Test Pad Construction

Thalle constructed the Phase 2 test pad in the completed Phase 2 subgrade area subsequent to proof rolling, fine grading and acceptance of the prepared surface.

Photo of Phase 2 test pad.

Whereas, the on-site soils used for Phase 1 were either clay soils stockpiled from previous projects or soils removed from the Cell 6 construction area, on-site soils used for Phase 2 construction were obtained from the Cell 7 borrow area and the embankment cut adjacent to the scale house. Phase 2 soils were typically classified as MH, ML and SM soils according to their USC Soil Classification, compared to the MH and CH soils used for Phase 1. The Phase 2 soils, although able to meet the 1×10^{-5} cm/sec permeability requirement, were typically lower in plasticity and in some cases non-plastic due to their higher percentage of fine sands and silts.

Acceptance zone criteria for Phase 2 compacted clay liner construction was established using Phase 2 test pad results. QA tests confirmed that a minimum of 95% compaction was achieved at each sample location. The test pad was later incorporated into the Phase 2 clay soil liner construction.

Undisturbed tube samples were taken from each of the three lifts of the Phase 2 test pad for hydraulic conductivity testing. Bulk samples were also obtained at the same sample locations to perform remolded permeability tests in the lab. Undisturbed permeability test results are presented in Appendix A-6b. Results are summarized below in Table 3-2. Remolded permeability test results corresponding to the Phase 2 test pad bulk samples are presented in Appendix A-7b.

Table 3-2 Phase 2 Test Pad - Permeability Test Results

Test No.	Location	Result (cm/sec)
TP1 (Undisturbed)	Lift 1	6.2×10^{-8}

Test No.	Location	Result (cm/sec)
TP2 (Undisturbed)	Lift 2	5.7×10^{-8}
TP3 (Undisturbed)	Lift 3	6.1×10^{-8}
TP1[3] (Remold)	Lift 1	5.5×10^{-7}
TP2[3] (Remold)	Lift 2	5.7×10^{-7}
TP3[3] (Remold)	Lift 1	6.5×10^{-7}

[3]Remolded at 95% MDD and 3% wet of OMC

3.4 Interface Friction Angle Tests

As part of the conformance test requirements, Thalle contracted with TRI to perform interface friction angle testing (ASTM D5321) for the compacted soil liner/GCL and the GCL/textured HDPE . Results met the specification requirements and are summarized below in Table 3-3. Actual data sheets are included in Appendix A-11.

Table 3-3 Compacted Soil Liner Strength Tests

Test	Results	Specifications
Interface Friction Angle (Compacted soil liner/GCL)	29.1 degrees	20.5 degrees
Interface Friction Angle (GCL/HDPE)	24.8 degrees	20.5 degrees

In addition, JLT performed QA testing of the same liner components to verify the interface friction angle test results provided by TRI. Results of the supplemental QA testing are presented in Appendix A-12.

3.5 Compacted Soil Liner Construction

The compacted soil liner was constructed by Thalle starting with the Phase 1 area in the northernmost area of Cell 6, representing an area of approximately 6.4 acres. Following completion of the Phase 1 area in July 2005, Thalle began construction of the Phase 2 area, including placement of the compacted soil liner, representing an additional 16.6 acres for a total 23-acre cell.

Photo of compacted soil liner operations.

3.5.1 CQC Conformance Testing

DAA performed CQC testing during construction of the compacted soil liner including density checks, moisture contents and one-point proctors for compaction control. Results are presented in Appendix A-2a. These results were used by Thalle to monitor clay soil placement (e.g. moisture content, compaction, etc.). Each lift of the clay soil liner was reworked as needed to maintain the desired moisture content by either drying or adding water and recompacting each lift as needed to meet the acceptance zone criteria. CQC testing was also used to determine when the compacted clay soil liner was ready for CQA testing by CDM. Only the CQA testing performed by CDM was used to determine regulatory compliance.

3.5.2 CQA Conformance Testing

CDM field personnel with the assistance of Alpha monitored placement of the Phase 1 and Phase 2 compacted soil liner and performed CQA testing in accordance with the project specifications. CQA testing included: verifying lift thickness, performing field density and moisture content checks and collecting samples for geotechnical laboratory testing. Density and moisture content checks performed by Alpha are presented in Appendix A-2b.

3.5.2.1 Phase 1 CQA Conformance Testing

Geotechnical laboratory testing performed by CDM as part of the Phase 1 quality assurance program included (12) undisturbed permeability tests at a minimum frequency of 1 test/2 acres/lift, based on a Phase 1 area of approximately 6.4 acres and placement of the compacted soil liner in three 6-inch lifts. Hydraulic conductivity test results for the Phase 1 area are summarized below in Table 3-3 and presented in Appendix A-8a. All undisturbed permeability samples taken during construction of the Phase 1 compacted soil liner met the required 1×10^{-5} cm/sec hydraulic conductivity. In addition, (42) particle-size analyses with hydrometers and (42) Atterberg Limits were also performed for the same Phase 1 area. CQA test results for the compacted soil liner are presented in Appendix A-9a. Index tests performed on undisturbed permeability tube samples are presented in Appendix A-10a.

Locations of the undisturbed permeability samples are shown on an attached acre plan also presented in Appendix A-8a. The same acre plan was used to identify index test locations and presented in Appendix A-9a.

Table 3-4 Phase 1 Compacted Soil Liner Permeability Test Results

Test No.	Location	Result (cm/sec)
CSL-1-PT-1-5	Lift 1	1.3×10^{-7}
CSL-1-PT-2-2	Lift 1	3.4×10^{-8}
CSL-1-PT-3-6	Lift 1	2.0×10^{-7}
CSL-1-PT-4-5	Lift 1	5.6×10^{-8}
CSL-2-PT-1-5	Lift 2	5.4×10^{-8}

Test No.	Location	Result (cm/sec)
CSL-2-PT-2-1	Lift 2	1.4×10^{-7}
CSL-2-PT-3-3	Lift 2	3.1×10^{-6}
CSL-2-PT-4-6	Lift 2	2.9×10^{-8}
CSL-3-PT-1-3	Lift 3	7.5×10^{-8}
CSL-3-PT-2-2	Lift 3	4.6×10^{-7}
CSL-3-PT-3-1	Lift 3	6.9×10^{-8}
CSL-3-PT-4-5	Lift 3	5.9×10^{-8}

3.5.2.2 Phase 2 CQA Conformance Testing

Geotechnical laboratory testing performed by CDM as part of the Phase 2 quality assurance program included (24) undisturbed permeability tests at a minimum frequency of 1 test/2 acres/lift, based on a Phase 2 area of approximately 16.6 acres and placement of the compacted soil liner in three 6-inch lifts. Hydraulic conductivity test results for the Phase 2 area are summarized below in Table 3-3 and presented in Appendix A-8b. All undisturbed permeability samples taken during construction of the Phase 2 compacted soil liner met the required 1×10^{-5} cm/sec hydraulic conductivity. In addition, (96) particle-size analyses with hydrometers and (96) Atterberg Limits were also performed for the same Phase 2 area. CQA test results for the compacted soil liner are presented in Appendix A-9b. Index tests performed on undisturbed permeability tube samples are presented in Appendix A-10b.

<u>Note:</u> Some clay soil liner samples tested indicate plasticity index values below the targeted index of 10, with some samples identified as being non-plastic. These low plasticity index materials were permitted since soils with similarly low plasticity indices and comparable percentages of fines have exhibited hydraulic conductivities much less than the 1×10^{-5} cm/sec required in the project specifications.

Locations of the undisturbed permeability samples are shown on an attached acre plan also presented in Appendix A-8b. The same acre plan was also used to identify index test locations and presented in Appendix A-9b.

Table 3-5 Phase 2 Compacted Soil Liner Permeability Test Results

Test No.	Location	Result (cm/sec)
CSL-1-PT-1-1	Lift 1	4.6×10^{-8}
CSL-1-PT-2-3	Lift 1	3.5×10^{-8}
CSL-1-PT-2-10	Lift 1	1.5×10^{-7}
CSL-1-PT-2-12	Lift 1	7.1×10^{-8}

Test No.	Location	Result (cm/sec)
CSL-1-PT-3-14	Lift 1	2.3×10^{-6}
CSL-1-PT-4-16	Lift 1	3.2×10^{-8}
CSL-1-PT-1-7	Lift 1	9.4×10^{-8}
CSL-1-PT-2-6	Lift 1	1.8×10^{-7}
CSL-2-PT-1-2	Lift 2	8.1×10^{-8}
CSL-2-PT-2-3	Lift 2	4.0×10^{-8}
CSL-2-PT-1-10	Lift 2	1.0×10^{-7}
CSL-2-PT-1-12	Lift 2	1.9×10^{-7}
CSL-2-PT-2-14	Lift 2	5.4×10^{-7}
CSL-2-PT-5-16	Lift 2	3.9×10^{-7}
CSL-2-PT-2-8	Lift 2	2.4×10^{-7}
CSL-2-PT-3-6	Lift 2	9.9×10^{-8}
CSL-3-PT-1-2	Lift 3	1.7×10^{-7}
CSL-3-PT-1-4	Lift 3	4.5×10^{-7}
CSL-3-PT-1-10	Lift 3	3.2×10^{-7}
CSL-3-PT-3-12	Lift 3	4.0×10^{-7}
CSL-3-PT-4-14	Lift 3	3.1×10^{-7}
CSL-3-PT-1-16	Lift 3	1.8×10^{-7}
CSL-3-PT-1-8	Lift 3	7.2×10^{-8}
CSL-3-PT-4-6	Lift 3	1.7×10^{-7}

Note: CSL-1-PT-1-5 = Clay Soil Liner, lift 1, perm tube location, sample number in sequence sampled and acre number

3.6 Certified Survey

Thalle was responsible for providing a survey (on a 50-foot grid) certified by a professional land surveyor currently licensed in the State of North Carolina showing the elevation of the bottom and the top of the compacted soil liner for both Phase 1 and Phase 2 to demonstrate that the liner layer is at least 18 inches thick. The certified survey is included in Appendix E-1a (Phase 1) and E-1b (Phase 2).

CDM, in addition to the certified survey, conducted thickness checks of the compacted soil liner using a hand probe at a frequency of four thickness checks per acre. The required 18-inch compacted soil liner thickness was verified at each of the selected probe locations. Probe holes were filled with powdered bentonite immediately following each thickness check.

Section 4
Geosynthetic Clay Liner

4.1 Overview

The Geosynthetic Clay Liner (GCL) material used for the construction of Cell 6 consists of a layer of sodium bentonite clay encapsulated between two geotextiles. CETCO of Arlington Heights, Illinois was the manufacturer and supplier of Bentomat ST GCL used for the construction of Cell 6. Hallaton of Towson, Maryland was responsible for the installation of the GCL material in accordance with the project contract documents.

CDM conducted the CQA inspection during the installation of the GCL. TRI was the independent laboratory that tested GCL samples. Construction inspection services provided by CDM were performed to confirm that the project was constructed in accordance with:

- The construction permit issued by the North Carolina Solid Waste Section (Permit No. 11-07);
- Contract documents prepared by CDM dated December 2004;
- Good engineering practices; and
- Industry standards.

4.2 Pre-construction Submittals

CDM conducted reviews of the material submitted by the GCL manufacturer and Hallaton. The GCL material met the physical property requirements of the specifications. The seaming and testing methods submitted as part of Hallaton's pre-construction CQA document were consistent with the project requirements. All submittals were approved for installation of GCL material.

The GCL project QC log is included in Appendix B-1. Hallaton's crew personnel qualifications are located in Appendix B-2a (Phase 1) and B-2b (Phase 2). Thalle submitted GCL certification reports and material specifications for each roll delivered to the site. Copies of these certification reports are included in Appendix B-3a (Phase 1) and B-3b (Phase 2), and the GCL receiving logs are included in Appendix B-4a (Phase 1) and B-4b (Phase 2). CDM confirmed that the submittals are in conformance with the project requirements.

4.3 GCL Certification and Conformance Testing

The following amount of GCL was installed as primary liner system:

Phase 1: 317,730 square feet
Phase 2: 781,207 square feet
Total: 1,098,973 square feet

An identification sticker was attached to the end of each roll identifying the manufacturer and the roll number. A conformance testing certificate for each roll was also submitted. As part of the CQA procedure, CDM reviewed the submitted roll certificates to verify that test values met the minimum criteria specified in the project documents. CDM also verified that the rolls delivered to the site had the same identification number as shown on the certificates. Hallaton obtained conformance test samples from the liner rolls delivered on site at a minimum frequency of one per 40,000 square feet or one per lot, whichever was more frequent. For the 1,138,500 square feet of GCL delivered, 29 tests were required. A total of 33 samples were tested by TRI. The following conformance tests were conducted by the laboratory:

- Mass Per Unit Area
- Peel Strength
- Index Flux (every lot)

The conformance test results are located in Appendix B-5. The results met project specifications and were approved by CDM prior to placement of the liner.

4.4 Subgrade Inspection and Liner Deployment

A CDM representative was on site to monitor the final grading of the compacted low permeability soil liner surface. CDM evaluated the compacted low permeability soil liner surface for moisture content, desiccation cracks, and thickness. The final surface of the compacted low permeability soil liner was sealed by a smooth drum roller. Thalle employed laborers to remove rocks and roots from the smooth-drummed surface. Ruts and holes were filled in with approved material to facilitate a uniform surface for GCL deployment. In areas where desiccation cracks had formed in the compacted soil liner, the damaged area was re-wetted and rolled to CDM's satisfaction. Prior to deployment of each panel, CDM representatives conducted visual inspections of the s compacted low permeability soil liner surface for the presence of foreign objects (debris, stones, roots, rocks). Once an area was deemed acceptable by CDM, Hallaton preceded with GCL panel deployment and seaming. Representatives of CDM and Hallaton signed a subgrade acceptance form for the area receiving GCL that day. Copies of the signed subgrade acceptance certificates are included in Appendix B-6a (Phase 1) and B-6b (Phase 2).

Photo of GCL deployment.

A rubber wheeled forklift equipped with a spreader bar and cloth slings was used for GCL deployment. The forklift remained parallel with the landfill slope and avoided sharp turns when possible to minimize rutting of the low permeability soil liner surface. Significant rutting was repaired immediately by the Contractor to the satisfaction of the Engineer.

Hallaton marked the beginning and end of each panel deployed with the panel ID number, date, and roll number. GCL tracking logs are provided in Appendix B-7a (Phase 1) and Appendix B-7b (Phase 2). Hallaton personnel aligned panels with the adjacent panel to ensure proper overlap for seaming purposes. After each panel deployment, CDM conducted a visual observation of the panel for physical defects. Along with a visual inspection, a metal detector was used to sweep the GCL panels following installation to locate broken needles resulting from the GCL manufacturing process. All positive responses were investigated by cutting the GCL and probing into the low permeability liner. The metal wire fragments found were within the low permeability liner material and did not appear to be the result of broken metal needles imbedded within the GCL.

Photo of metal detector inspection.

The small sections of GCL that were removed were patched with a larger underlying piece of GCL and granular bentonite was placed along the edges. GCL damages and failures were recorded on the damage/failure log in Appendix B-8a (Phase 1) and Appendix B-8b (Phase 2). During the installation of the GCL, there were no damages.

4.5 GCL Seaming

Seaming of the liner panels was conducted using a minimum 12-inch overlap. CDM inspected all seams for proper overlap.

4.6 GCL Panel Layout Record Drawings

GCL panels were placed in the same general directions as identified by the HPDE panel placement.

Section 5
HDPE Liner

5.1 Overview

The synthetic liner material used for the construction of Cell 6 is a 60-mil, textured, HDPE liner. Argu America of Georgetown, South Carolina manufactured the liner, and Hallaton installed the material in accordance with the project specifications.

CDM conducted the CQA inspection during the HPDE liner installation. Samples were sent to TRI for laboratory testing. Hallaton was responsible for liner placement, welding, and on-site destructive and non-destructive testing under CDM observation. Hallaton was also responsible for obtaining and shipping samples taken for conformance testing and laboratory destructive testing.

Construction inspection services provided by CDM were performed to confirm that the project was constructed in accordance with:

- The construction permit issued by the North Carolina Department of the Environment and Natural Resources Solid Waste Section (Permit No. 11-07);
- Contract documents prepared by CDM dated December 2004;
- Good engineering practices; and
- Industry standards.

5.2 Pre-Construction Submittals

CDM reviewed the material submitted by Argu America and the equipment specifications and personnel qualifications submitted by Hallaton. The liner project QC log is included in Appendix C-1, and Hallaton's welding crew personnel qualifications are included in Appendix C-2a (Phase 1) and C-2b (Phase 2). Appendix C-3a (Phase 1) and C-3b (Phase 2) contain the tensiometer certificates. All seaming and testing methods submitted as part of Hallaton's pre-construction CQC documentation were consistent with the project requirements. All submittals were approved for synthetic liner installation.

Hallaton submitted liner certification reports and material specifications for each roll delivered to the site. Copies of all liner certification reports are included in Appendix C-4a (Phase 1) and C-4b (Phase 2). CDM reviewed the submittals for conformance with the project requirements. The liner receiving logs are included in Appendix C-5a (Phase 1) and C-5b (Phase 2).

5.3 HDPE Liner Certification and Conformance Testing

The approximate amount of HDPE liner installed is as follows:

Phase 1: 319,217 square feet
Phase 2: 781,815 square feet
Total: 1,101,032 square feet

An identification sticker was attached to the end of each roll identifying the manufacturer and the roll number. A conformance testing certificate for each roll was also submitted. As part of the CQA procedure, CDM reviewed the submitted roll certificates to verify that test values met the minimum criteria specified in the project documents. CDM also verified that the rolls delivered to the site had the same identification number as shown on the certificates. Conformance tests were performed at a minimum frequency of one per 100,000 square feet or per lot, whichever was more frequent. Delivered HDPE liner totaled 1,131,600 square feet. Based on the minimum testing frequency, 12 conformance tests were required. A total of 13 samples were tested by TRI. The following conformance tests were conducted by the laboratory:

- Thickness
- Density
- Tensile Properties
- Tear Resistance
- Carbon Black Content
- Carbon Black Dispersion

All conformance test results are located in Appendix C-6. The conformance test results were reviewed and approved by CDM.

5.4 HDPE Liner Deployment

Panels were deployed into their positions using a forklift with a spreader bar and cloth slings positioned at the anchor trench. Hallaton personnel then manually pulled the material down the slopes. The panels were aligned with the adjacent panel to ensure the proper overlap for seaming purposes. After each panel deployment, CDM visually inspected the panel for physical defects. Any defect noticed was clearly marked and subsequently repaired by Hallaton to CDM's satisfaction. Hallaton marked the beginning and end of each panel deployed with the panel identification (ID) number, date, and roll number. The HDPE liner installation tracking log is included in Appendix C-7a (Phase 1) and C-7b (Phase 2).

5.5 HDPE Liner Seaming

The seaming of the liner panels was conducted using a dual track hot wedge welder and an extrusion welder. The dual track hot wedge weld was the primary seaming method used to join the liner panels, while the extrusion weld was used for patching, detail work, and areas inaccessible to the hot wedge machine.

5.5.1 Pre-Weld Seams

At the start of each shift, a pre-weld sample was obtained from each welding machine. The pre-weld sample was tested to verify that the welding parameters for each machine (temperature, voltage, and speed) were correctly set to yield an acceptable seam. A total of six, 1-inch wide specimens were cut from each sample and tested in the field for peel and shear (three each) strength using a tensiometer supplied by Hallaton. Each specimen was required to achieve minimum peel and shear values of 78 and 120 lb/in, respectively, incursion less than 10 percent. Pre-weld seam data were recorded on the forms included in Appendix C-8a (Phase 1) and C-8b (Phase 2). Tensiometer calibration reports are included in Appendix C-3a (Phase 1) and C-3b (Phase 2).

Photo of liner coupon sampling.

5.5.2 Production Seams

After achieving passing results of the pre-weld specimens, Hallaton proceeded with liner panel welding. CDM inspected all liner surfaces to be welded for mud, sand, dirt, and water. Liner surfaces found to be unacceptable were cleaned using cloth or paper towels. At the conclusion of panel seaming, the CDM representative conducted a visual observation of each seam for uniformity and workmanship. Defects observed were clearly marked on the liner and subsequently repaired and tested by Hallaton.

At the conclusion of each day of seaming operations, sand bags were installed along the edges of unseamed liner panels to protect against wind uplift.

5.5.3 Seam Testing

All seams were subjected to non-destructive testing. Samples for destructive testing were obtained only after a seam had passed the non-destructive testing.

5.5.3.1 Non-Destructive Seam Testing

The non-destructive testing method entailed air pressure testing or vacuum testing. Air pressure testing was used to test the air channel formed by the dual track hot wedge welder. The gap was pressurized by plugging one end of the channel and injecting air through the other end with a needle-fitted pump equipped with a pressure gauge and valve. The gap was pressurized between 25 to 30 psi, and the valve was shut to maintain the pressure. The pressure was monitored for 5 minutes. The starting and ending times and pressures were recorded on the liner panels. The maximum allowable drop in pressure over the 5-minute period was 3 psi. After a seam passed the air pressure test, pressure was released from the plugged end to ensure that the entire length of the seam was pressurized. CDM observed the pressure testing and recorded the information on the appropriate seaming test forms included in Appendix C-9a (Phase 1) and C-9b (Phase 2).

Vacuum testing was used to test areas sealed with the extrusion welder (patches, detail work). Vacuum tests were performed by first applying a soapy solution on top of the seam to be tested. Then a rectangular plexiglass-faced vacuum box was placed on the seam and a 5-psi vacuum was pulled in the box for a period of not less than 10 seconds. The seam was observed through the viewing window for the presence of soap bubbles. The presence of no bubbles indicated a good seam. CDM observed the vacuum testing and recorded the information on the appropriate forms included in Appendix C-13a (Phase 1) and C-13b (Phase 2). All vacuum tests yielded passing results.

Photo of vacuum testing.

5.5.3.2 Destructive Seam Testing

Project specifications required that destructive seam testing be performed on the field seams at a rate of one sample per machine for every 500 feet of seam length.

To obtain a destructive sample, CDM identified the location of the destructive sample and instructed Hallaton to cut the sample. Each sample was 3 feet long. The sample was divided into three 1-foot long samples. One 1-foot sample was tested by Hallaton on-site. The sample was divided into six, 1-inch wide coupons. The tensiometer was used to test three coupons for peel and three for shear. Destructive test logs are included in Appendix C-10a (Phase 1) and C-10b (Phase 2). For both Phase 1 and 2, a total of four samples were below the minimum shear value of 120 lb/in, but passed laboratory testing.

Destructive samples were sent by overnight delivery to the independent laboratory for testing. The samples were tested by the laboratory for peel and shear strengths, in accordance with ASTM D4437, as modified in NSF Standard 54. All specimens were required to achieve minimum peel and shear values of 78 and 120 lb/in, respectively, incursion less than 10 percent, and a film tear bond (FTB). The laboratory destruct testing results are included in Appendix C-11a (Phase 1) and C-11b (Phase 2).

Phase 1

For the Phase 1 area, a total length of 14,790 feet was seamed. Since 28 destructive samples were obtained and tested, the testing frequency was roughly one sample per 528 feet. Destructive samples were taken along seam lengths that exhibited the most difficulty in completing, or indicated the possibility of machine troubles. Examples of difficult areas included panels requiring extra cleaning, re-alignment during the seaming process, or low welding voltages.

Phase 2

For the Phase 2 area, a total length of 35,938 feet was seamed. Since 65 destructive samples were obtained and tested, the testing frequency was roughly one sample per

553 feet. Destructive samples were taken along seam lengths that exhibited the most difficulty in completing, or indicated the possibility of machine troubles. Examples of difficult areas included panels requiring extra cleaning, re-alignment during the seaming process, or low welding voltages.

5.5.3.3 Procedure for Failed Test

The HDPE liner damage and/or failure report forms are included in Appendix C-12a (Phase 1) and C-12b (Phase 2), and the HDPE liner patch placement log is included in Appendix C-13a (Phase 1) and C-13b (Phase 2).

5.5.4 Repair of Failed Seams

Phase 1
No destructs failed.

Phase 2
No destructs failed.

5.6 HDPE Liner Electrical Resistivity Testing

Once stone was in place above the fabric cushion, electrical resistivity testing was performed to locate any possible liner leaks. Page 7 of this section shows a few pictures of leaks that were detected and repaired.

Phase 1
One leak was detected. The leak was an approximate 4-foot long gash, which appeared to result from contact with the blade of the dozer used to deploy the protective cover. Hallaton exposed the area, performed vacuum testing and patched the area using an extrusion weld. Leak Location Services, Inc. provided a follow-up test on the patched area which resulted in a no leak response. The Phase 1 report prepared by Leak Location Services, Inc. is provided in Appendix C-14a.

Phase 1 Retest
On June 23, 2005, an approximate 1.5-inch rain event occurred in the course of one hour that breeched the Phase 1 interim berm and flooded the completed composite liner system at the low sump area of Phase 1. As a result, the 24-inch protective cover rock layer was inundated with silt and sand. At CDM's direction, the Contractor proceeded with the remediation of the protective cover rock layer by removing the soil laden rock (see Page 7 of this Section). In the process of removing sediment contaminated protective cover rock, five damages to the HPDE liner were visually identified. These damages were repaired and tested in accordance with the Contract Documents and the Contractor proceeded with placement of clean protective cover rock.

Following placement of protective cover rock, CDM directed the Contractor to perform leak location detection in areas that received traffic during the remediation. Using electro leak location detection, one additional damage to the HDPE liner was located and subsequently repaired in accordance with the Contract Documents. Appendix C-14b includes the documentation for the six HDPE liner damages and includes damage locations, repair logs, and the certified leak detection report.

Phase 2

Three leaks were detected. The location and description of each leak is included in Appendix C-14c. Hallaton exposed each area, performed vacuum testing and patched the areas using an extrusion weld. Leak Location Services, Inc. provided a follow-up test on each patched area which resulted in a no leak response.

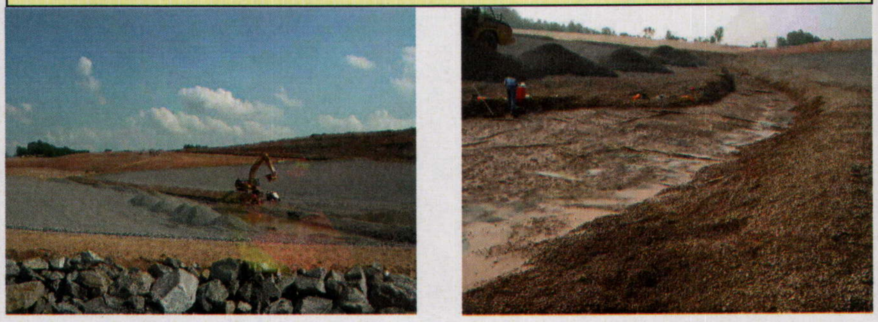
5.7 HDPE Liner Panel Layout Record Drawings

A copy of the liner panel layout record drawing as provided by Thalle is included in Appendix E-2b (Phase 1) and E-2c (Phase 2).

Typical liner damages found by electro leak detection.

Typical electro leak detection operations.

June 23, 2005 breech of rainwater into Phase 1 and remediation activities.



Section 6
Fabric Cushion

Following the HDPE liner installation for the composite liner, CDM inspected for stones, liner scrap, and other materials on the liner area before placement of the fabric cushion. The 28-oz. geotextile was selected to cushion the protective stone cover overlying the HDPE liner.

6.1 Conformance Testing

The fabric cushion manufacturer (SKAPS) was responsible for providing quality control certificates and test results at a frequency of one per 50,000 square feet. Certification reports for the fabric cushion material are provided in Appendix D-1. The amount of fabric cushion received on-site for use in construction of Cell 6 is as follows:

Phase 1:	551,250 square feet
Phase 2:	454,500 square feet
Total:	1,005,750 square feet

The material manufacturer's shipping order lists are included in Appendix D-2a (Phase 1) and D-2b (Phase 2). Samples of fabric cushion were obtained for conformance testing at the frequency of one sample per 100,000 square feet or one per lot, whichever was more frequent. For this project, 11 conformance samples were obtained and subsequently tested by TRI. Based on CDM's review of the conformance testing results, the fabric cushion is acceptable for use on this project. Conformance test results are contained in Appendix D-3.

6.2 Installation Method

Prior to installation, the HDPE liner was inspected to be clear of stones, liner scrap, and other materials. During installation, Hallaton exercised care with keeping rocks, soil, and other debris from being entrapped between the HDPE liner and the fabric cushion. Adjoining fabric cushion panels were overlapped a minimum of 4 inches and heat seamed using a hot-wedge welder with continuous temperature control and monitoring.

Any damage to the fabric was repaired using patches 24 inches or larger. Fabric cushion was inspected prior to installation of the protective cover layer.

Section 7
Protective Cover

7.1 Material Description

Hedrick Industries of Swannanoa, North Carolina provided crushed, washed, NCDOT No. 57M stone for the 24-inch-thick protective cover. Appendix A-13 includes the manufacturer's certification letter and 17 sieve analysis test reports.

7.2 Protective Cover Placement

The protective cover layer was placed on top of the 28-oz. fabric cushion using one (1) CAT 938 size loader, two (2) off-road articulated dump trucks, and one (1) CAT D5/D6 LGP bulldozer. Thalle constructed, at minimum, 4-foot thick temporary stone haul roads within Cell 6 to protect the HDPE liner from vehicle loads (25-ton dump trucks). Truck traffic was confined to these haul roads, constructed with 4-foot depths of stone. Once hauling was completed for an area, the stone used for the temporary haul roads was spread into adjacent areas using the CAT D5/D6 LGP bulldozer.

Photo of protective cover placement.

On June 23, 2005, an approximate 1.5-inch rain event occurred in the course of one hour that breeched the Phase 1 interim berm and flooded the completed composite liner system at the low sump area of Phase 1. As a result, the 24-inch protective cover rock layer was inundated with silt and sand. At CDM's direction, the Contractor proceeded with the remediation of the protective cover rock layer by removing the soil laden rock (see Section 5, Page 5-7). In the process of removing sediment contaminated protective cover rock, five damages to the HPDE liner were visually identified. These damages were repaired and tested in accordance with the Contract Documents and the Contractor proceeded with placement of clean protective cover rock.

Following placement of protective cover rock, CDM directed the Contractor to perform leak location detection in areas that received traffic during the remediation. Using electro leak location detection, one additional damage to the HDPE liner was located and subsequently repaired in accordance with the Contract Documents. Appendix C-14b includes the documentation for the six HDPE liner damages and includes damage locations, repair logs, and the certified leak detection report.

7.3 Record Drawings

CDM field personnel observed stone layer placement and grading Thalle. Appendix E-1 includes a record drawing of Cell 6, certified by a professional land surveyor currently licensed in the State of North Carolina, showing elevations between the top of the clay liner and the top of the protective cover.

Section 8
Leachate Piping System

8.1 Introduction

The leachate piping system requirements for Cell 6 are minimal due to the bowl-shaped configuration and the use of rock for the drainage layer. The relatively steep slopes of the cells combined with the highly permeable NCDOT No. 57M stone efficiently route leachate to the sump area in most areas without the need for piping. Cell 6 construction included the following:

- 991 linear feet of 10-inch perforated HDPE pipe,
- 272 linear feet of 10-inch solid HDPE pipe (cleanout),
- 105 linear feet of 18-inch solid HDPE pipe (slope riser), and
- 43 linear feet of 24-inch diameter sump (SDR 17 perforated HDPE).

The collection pipe was extended from the south end of the sump to capture concentrated leachate flows from the south slope. The sump and collection pipe are surrounded with NCDOT No. 4 stone and wrapped with a woven monofilament filter fabric. Three sieve analysis reports along with the stone manufacturer's certification are included in Appendix A-14.

8.2 Placement

Photo of leachate pipe installation.

Thalle completed the installation of the 2-foot stone protection layer prior to installing the leachate piping system. Thalle dug a 3-foot wide trench along the proposed alignment for the collection lines and a 6-foot wide trench for the sump. The fabric cushion was inspected during this process to ensure that no damage occurred. Monofilament fabric was laid prior to placing pipe. The perforated leachate collection pipe was then assembled and placed on top of the monofilament fabric. The majority of pipe connections were joined using a fusion welder; however, several of the connections were electro-fusion coupled due to limited access for the welder. The trenches were backfilled with No. 4 stone. The filter fabric was wrapped around the stone with a 1-foot overlap.

8.3 Leachate Pipe Testing

8.3.1 Leachate Collection Pipe Testing

Florida JetClean, Inc. was retained by Thalle to jetclean and videotape the leachate collection lines for Cell 6. The Engineer reviewed the videos for obstructions, sags, and pipe damage. The Cell 6 video indicated the following pipe to be in good condition:

- 10-inch perforated HDPE pipe,
- 10-inch solid HDPE pipe,
- 18-inch solid HDPE pipe, and
- 24-inch perforated HDPE pipe.

8.3.2 Solid Pipe Testing

Solid pipe was pressure tested by Thalle and observed by CDM's RPR. The testing was conducted by first filling the solid pipe with clean water. Next, the air entrapped in the pipe was vented through the highest end of the pipe. The pipe was pressurized to approximately 30 psi and remained in this condition for a 3-hour settlement period. After three hours, the entrapped air was then released from the high end and more water was added. The pipe was then pressurized until the pressure gauge registered a reading of 30 psi. The pressure was monitored for a period of 3 hours, during which no pressure drop was observed. At the end of the test period, pressure was released at the low end of the pipe. The remaining water was then emptied into the manholes.

8.3.3 Bootless Pipe Penetration Testing

The bootless pipe penetration for the GMS of Cell 6 was tested by pressurizing to 5 psi. The pressure was monitored for a period of 10 minutes. No loss of pressure was observed during the testing period. At the end of the testing, the pressure was released. An extrusion weld was placed over the threaded hole of the bootless unit.

Section 9
Groundwater Monitoring System

The groundwater monitoring system (GMS) is designed to function as a leak detection system. The GMS (approximately 1.5 acres) is located at the lowest area underneath the sump of Cell 6, three feet below the compacted low permeability soil liner. The GMS was installed in Cell 6 and consists of a 60-mil textured HDPE liner overlain by a double-sided, heat-bonded geocomposite drainage net. A 10-inch HDPE pipe with perforated inlet section was installed to convey liquid into a collection sump. Three feet of compacted common fill were placed over the GMS.

9.1 GMS Excavation and Backfill

Cell 6 GMS was excavated approximately 4-feet below the 18-inch compacted low permeability soil liner subgrade, corresponding to 1-foot below the HDPE liner subgrade in the GMS. The undercut area was backfilled to HDPE liner subgrade with common fill. Rocks larger than 1-inch in diameter were removed from the HDPE liner subgrade. Fill soils were visually inspected to be free of topsoil, roots, and other deleterious materials. The common fill subgrade was compacted to at least 95 percent of the soil's maximum dry density as determined by ASTM D698. CDM technicians monitored common fill placement on a full-time basis and also performed CQA testing and general site observations.

9.2 HDPE Liner

CDM conducted the CQA inspection and testing during the installation of the synthetic liner into the GMS. Hallaton was responsible for liner placement, welding, and on-site destructive and non-destructive testing under CDM observation. Hallaton was also responsible for obtaining and shipping samples taken for conformance testing and laboratory destructive testing.

Construction inspection services provided by CDM were performed to confirm that the GMS was constructed in accordance with:

- The construction permit issued by the North Carolina Department of the Environment and Natural Resources Solid Waste Section (Permit No. 11-07);
- Contract documents prepared by CDM dated December 2004;
- Good engineering practices; and
- Industry standards.

9.2.1 Pre-Construction Submittals

All seaming and testing methods submitted as part of Hallaton's pre-construction CQC documentation were consistent with the project requirements (see Section 5). All submittals were approved for synthetic liner installation.

The liner receiving logs are included in Appendix F-1. Hallaton submitted liner certification reports and material specifications for each roll delivered to the site. Copies of all liner certification reports are included in Appendix F-2. As part of the

CQA procedure, CDM reviewed the submitted roll certificates to verify that test values met the minimum criteria specified in the project documents. CDM also verified that the rolls delivered to the site had the same identification number as shown on the certificates.

9.2.2 HDPE Liner Conformance Testing

Approximately 75,175 square feet of HDPE liner was used for the GMS installation. Conformance tests were performed at a minimum frequency of one per 100,000 square feet or per lot, whichever was more frequent. A total of four samples were collected and shipped by the Contractor to TRI. The following conformance tests were conducted by the laboratory:

- Thickness
- Density
- Tensile Properties
- Tear Resistance
- Carbon Black Content
- Carbon Black Dispersion

All conformance test results are located in Appendix F-3. The conformance test results were reviewed and approved by CDM.

9.2.3 Subgrade Surface Preparation

Prior to HDPE liner placement on the subgrade in the GMS, a CAT CS563 smooth-drum vibratory compactor proof rolled the areas until firm. CDM inspected the subgrade surface for the presence of any deleterious materials. Once the subgrade was deemed acceptable, CDM allowed Hallaton to proceed with liner panel deployment and seaming. A copy of the subgrade surface acceptance form is included in Appendix F-4.

9.2.4 HDPE Liner Installation

HDPE liner panels were deployed in the same matter as described in Section 5.4 of this report. The HDPE liner installation tracking log is included in Appendix F-5.

Pre-weld samples were obtained and the data is included in Appendix F-6. HDPE liner seaming followed the same methods as outlined in Section 5.5 of this report.

All seams were subjected to non-destructive testing. Results are included in Appendix F-7 and the method for sampling is detailed in Section 5.6.3.1 of this report.

Samples for destructive testing were obtained only after a seam had passed the non-destructive testing. Destructive test logs are included in Appendix F-8. Sampling methods were detailed in Section 5.5.3.2 of this report.

For the GMS, a total length of 3,359 feet was seamed. Since seven destructive samples were obtained and tested (see Appendix F-9), the testing frequency was roughly one sample per 480 feet. Destructive samples were taken along seam lengths that exhibited the most difficulty in completing, or indicated the possibility of machine troubles. Examples of difficult areas included panels requiring extra cleaning, re-alignment during the seaming process, or low welding voltages. None of the destruct samples failed.

The HDPE liner damage and/or failure report forms are included in Appendix F-10, and the HDPE liner patch placement log is included in Appendix F-11.

9.3 Drainage Net

Following installation of the GMS HDPE liner, both CDM and Hallaton inspected and approved the lined areas for drainage net placement. The purpose of the drainage net is to provide lateral flow to the collection pipe within the GMS. The drainage net consists of the following heat-bonded layers (top to bottom):

1. 6 oz. geotextile fabric,

2. drainage net, and

3. 6 oz. geotextile fabric.

The lower fabric provides a high frictional interface between the textured liner and the drainage net, while the upper layer minimizes soil intrusion into the annular space of the drainage layer.

9.3.1 Conformance Testing

The drainage net manufacturer (SKAPS) was responsible for providing quality control certificates and test results at a frequency of one per 50,000 square feet of manufactured drainage net. Approximately 74,200 square feet of drainage net was delivered on site. The drainage net manufacturer's shipping order list is included in Appendix F-12. Manufacturer's certification reports for the drainage net material are provided in Appendix F-13. Samples of drainage net were obtained for conformance testing at the frequency of one sample per 100,000 square feet or one per change in lot number. For this project, one composite drainage net conformance sample was obtained and subsequently tested by TRI. The conformance testing results demonstrated that the drainage net was acceptable for use on this project. The conformance testing result is included in Appendix F-14.

9.3.2 Installation Method

The composite drainage net was placed directly in contact with the HDPE liner in the groundwater monitoring area of Phase 1 of Cell 6. In general, the panels were deployed following the same panel layout as the underlying HDPE liner. The seams were positioned parallel to the slopes, with the exception of areas with compound slopes, in which perpendicular seams could not be avoided.

The panels were positioned in direct contact with adjacent panels, and were joined by fastening the drainage net with plastic ties. The ties were placed every 5 feet in areas where the seam laid parallel with the slopes. In areas where the seam laid in a somewhat diagonal direction to the slopes or in areas of possible stress, the tying frequency increased to one tie every 6 inches. The 6-inch spacing pattern was also used in the anchor trenches and for joining to the ends of panels. End panels were overlapped a minimum of 1 foot in the primary direction of flow.

CDM inspected the drainage panels for damage incurred during staging or placement. Damages were repaired by placing a patch over the torn area and attaching it to the underlying panel with plastic ties.

After connecting the drainage net with plastic ties, the geotextile fabric ends were neatly overlapped and sewn together using a portable sewing machine and thread. This was performed to ensure that the overlaying backfill layer would not intrude into the drainage net openings. Sandbags were also used temporarily along the exposed edges of the composite panels to prevent wind uplift after placement. Finally, the backfill layer was placed on top of the drainage net.

9.4 Common Fill Placement in GMS

After the GMS was completed, a 3-foot-thick layer of common fill was placed in three 12-inch compacted lifts.

The common fill was placed over the drainage net using a CAT D5LGPH low-ground-pressure bulldozer and compacted with a CAT CS563 smooth-drum vibratory compactor. The first lift of common fill placed over the drainage net was about 18 inches thick to minimize pressure on the drainage net and HDPE liner from equipment loading.

9.5 Record Drawings

A copy of the HDPE liner panel layout record drawing as provided by Thalle is included in Appendix E-2a.

APPENDIX C-14b

Leak Location Services, Inc. Reports
Phase 1 Retest

LEAK LOCATION SERVICES, INC.

16124 UNIVERSITY OAK • SAN ANTONIO, TEXAS 78249 • (210) 408-1241 / FAX (210) 408-1242

July 22, 2005

Thalle Construction Co., Inc.
228 South Churton Street
Hillsborough, NC 27278

Attention: Chris Haverstrom

Fax: (919) 245-1516

Subject: Final Report for Supplemental "Electrical Leak Location Survey of the Newly Constructed Buncombe County Landfill Cell 6 Phase 2 1 LETEST Located Near Asheville, North Carolina"; LLSI Project 607

Dear Mr. Halverstrom:

On June 29 and 30, 2005, Martin Morales, and on July 19 and 20, 2005, Harvey Moy, both of Leak Location Services, Inc. (LLSI) conducted leak location surveys of the HDPE geomembrane of a part of the first phase of the subject project. This area had been previously surveyed for leaks by LLSI as detailed in a report dated June 21, 2005. After the survey, a storm damaged part of the installation and parts of the installation had to be repaired. This report is for the surveys of the repaired parts and for the survey of the access roads to the repairs.

The cell is constructed from the top down with a 24-inch stone drainage layer, a 24-oz. geotextile cushion, 60-mil textured HDPE primary geomembrane, geosynthetic clay liner (GCL), 18-inch compacted soil liner, and compacted soil subgrade. The survey area was not isolated from earth ground during the survey. This report documents the results of the survey.

I. RESULTS

On the first survey, one leak was found. The areas surveyed included a 60 by 120-foot area and the areas adjacent to the leachate collection system south of the 60 by 120-foot area. Figure 1 shows the approximate location of the leak. The leak was a 3.5-foot by 1.5 foot tear. Measurements were made to document the leak detection sensitivity. A 0.25-inch artificial leak was buried in the soil and leak location survey lines were run along both sides of the artificial leak. These tests showed that the artificial leak could be easily detected from 10 feet away. Therefore, the effective survey area extended 10 feet on each side of the leak location survey lines. So the effective survey area for the 60 by 120 foot area extended 10 feet on either side, so it was actually 80 feet by 120 feet. Two leak location survey lines were taken along and 5 feet on each side of the center drainage berm. The effective survey area overlapped at the center of the berm and extended 35 feet on both sides of the berm.

On the second survey, the area of the access road extending to the northwest corner and extending to north of the southeast corner were surveyed. No leaks were found. A 0.25-inch artificial leak was buried in the soil and leak location survey lines were run along both sides of the artificial leak. These tests showed that the artificial leak could be easily detected from 5 and 10 feet away.

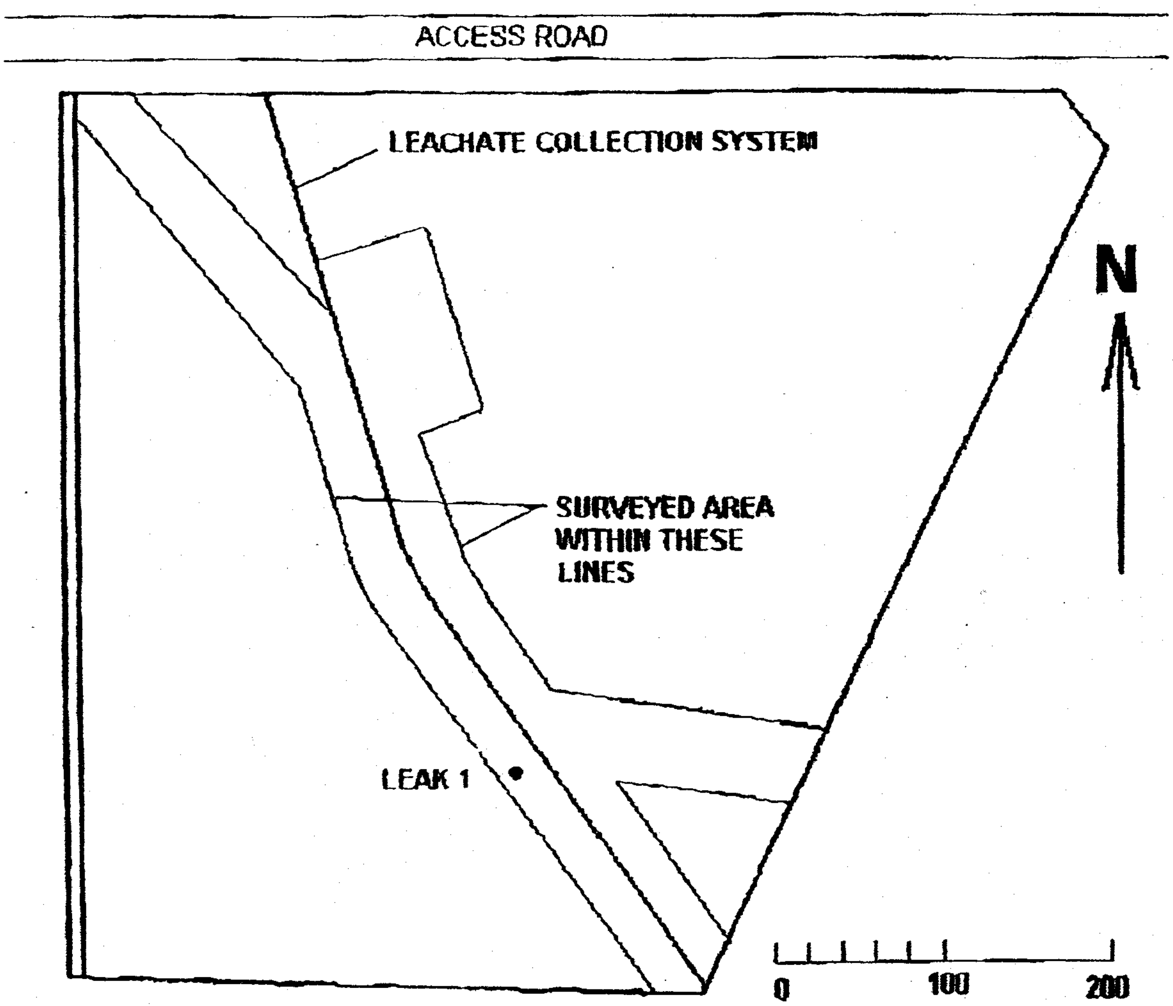


FIGURE 1. APPROXIMATE LOCATION OF THE LEAK

II. TECHNIQUE

The electrical leak location method detects electrical paths through the liner caused by water or moisture in the leaks. A voltage is connected to one electrode placed in the natural material covering the liner and to a second electrode connected to earth ground. Electrical current flowing through the leaks in the liner produces localized anomalous areas of high current density near the leaks. These areas are located by making electrical potential measurement scans on the natural material on the geomembrane liner.

A systematic survey was conducted on survey lines spaced 5 feet apart. Survey lines were marked with survey flags with string lines connecting corresponding survey flags. The survey line between the strings was followed by remaining approximately midway between the strings. Measurements were made approximately every 3 feet along the survey lines. The data was periodically downloaded to a computer for storage, plotting, and analysis for smaller leak signals. The data was plotted to identify areas with anomalous signals for further investigations. Manual measurements were made to isolate the leak location for excavation while the survey crew was at the site. After the leak was repaired, additional manual measurements were made around the excavation to determine if any additional leaks were present. There were none.

We appreciate this opportunity to have been of service to Thalle Construction Company.

Very truly yours,

Glenn T. Darilek

Glenn T. Darilek
Principal Engineer

PRE-WELD TESTING

DATE: Various JOB NAME: Buncombe Co. LF Cell 6-PHASE I JOB NO.: 0509-0505 MATERIAL: 60 mil HDPE

TIME	AMBIENT TEMP.	WEATHER	WIND	TECH.	MACHINE			DESTRUCTIVE TEST						PASS FAIL	EFR INITIALS
					ID NO.	TEMP.	SPEED	PEEL			SHEAR				
6/28/05 8:00	65°	Cloudy	None	SM	X7	470/550		153	148	149	161	163	157	Pass	RS
6/29/05 7:30	65°	Cloudy	None	SM	X7	470/550		149	151	157	163	148	161	Pass	RS
6/30/05 4:00	80°	Sunny	None	SM	X7	470/550		152	147	148	160	163	149	Pass	RS

FORM CQC-[illegible]07

PATCH PLACEMENT LOG

(one sheet per day)

DATE: Various JOB NAME: Buncombe Co. LF Cell 6-PHASE I JOB NO.: 0509-0505 MATERIAL: 60 mil HDPE Textured

AMBIENT TEMP.: AM PM WIND: WEATHER:

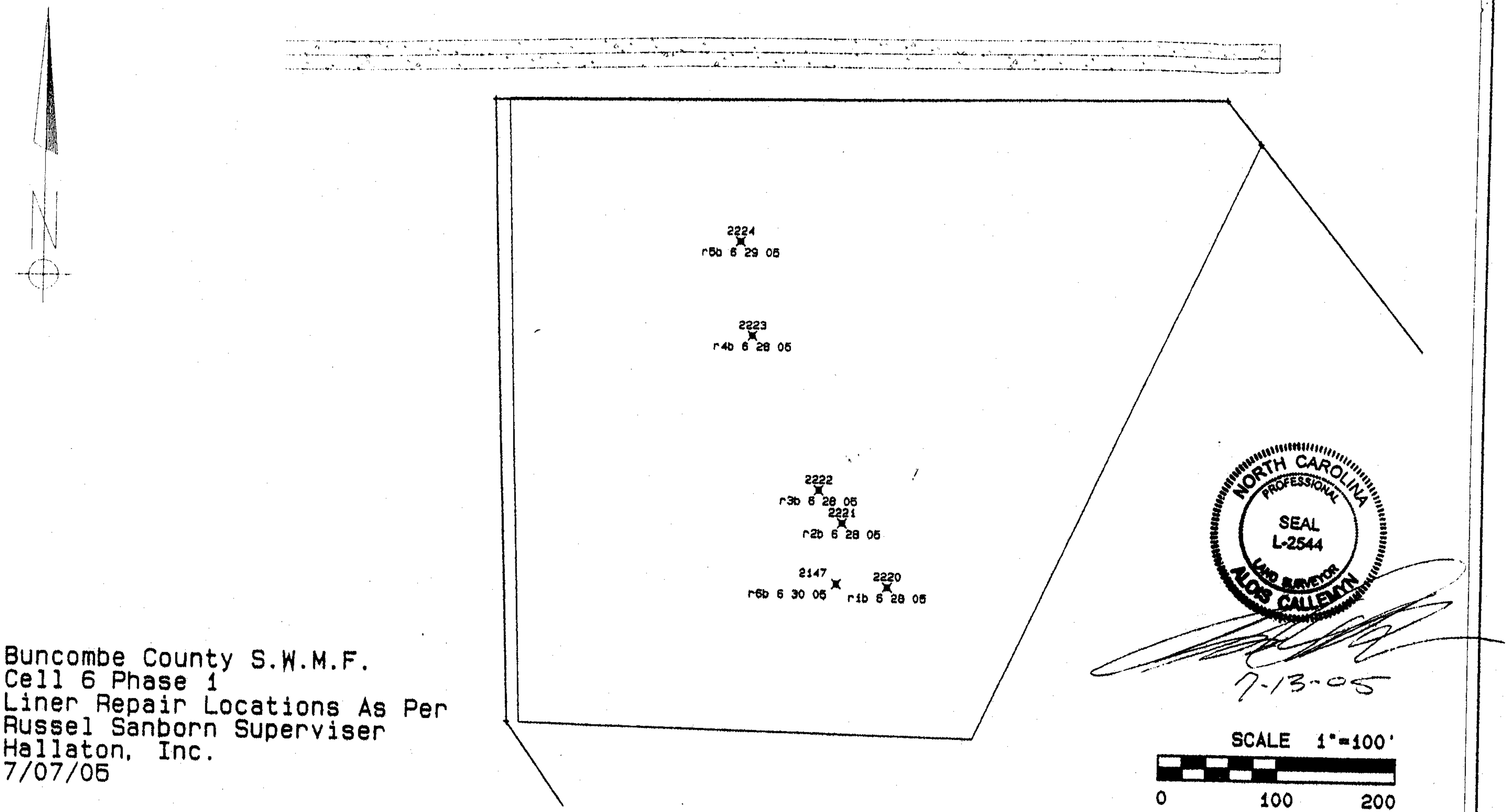
			INSTALLATION			EXTRUSION WELD		
TIME	PATCH NO.	DESCRIPTION LOCATION	TECH.	MACH ID. NO.	MACH. TEMP.	VAC. TEST Y/N	PASS/FAIL	COMMENTS
6/28/05								
8:45	R127	Surveyed by Thalle	SM	X7	470/550	Yes	Pass	Material damage cause by equipment removing mud & contaminated stone.
9:45	R128	Surveyed by Thalle	SM	X7	470/550	Yes	Pass	Material damage cause by equipment removing mud & contaminated stone.
10:30	R129	Surveyed by Thalle	SM	X7	470/550	Yes	Pass	Material damage cause by equipment removing mud & contaminated stone.
11:30	R130	Surveyed by Thalle	SM	X7	470/550	Yes	Pass	Material damage cause by equipment removing mud & contaminated stone.
6/29/05								
9:15	R131	Surveyed by Thalle	SM	X7	470/550	Yes	Pass	Material damage cause by equipment removing mud & contaminated stone.
6/30/05								
4:45	R132	Surveyed by Thalle	SM	X7	470/550	Yes	Pass	Material damage cause by equipment removing mud & contaminated stone.

COMMENTS:

DAILY TOTALS: Liner________sq. ft., Length Seamed_______ ft., No. Destructs marked ____

Coordinate data from project:
THALLE-ASHEVILLE
07/12/05 13:24:25

Point	Northing	Easting	Elevation	Description	Layer Name
2,147	738,867.8485	922,058.8383	2,005.68	r6b 6 30 05	PHASE1 LIN RPAIR
2,220	738,865.6573	922,101.9314	2,005.87	r1b 6 28 05	PHASE1 LIN RPAIR
2,221	738,918.9925	922,063.0512	2,004.06	r2b 6 28 05	PHASE1 LIN RPAIR
2,222	738,946.3696	922,042.8810	2,003.18	r3b 6 28 05	PHASE1 LIN RPAIR
2,223	739,075.4133	921,984.7513	1,999.69	r4b 6 28 05	PHASE1 LIN RPAIR
2,224	739,154.6316	921,973.1946	1,999.13	r5b 6 29 05	PHASE1 LIN RPAIR



Buncombe County S.W.M.F.
Cell 6 Phase 1
Liner Repair Locations As Per
Russel Sanborn Superviser
Hallaton, Inc.
7/07/05

APPENDIX C-14c

Leak Location Services, Inc. Reports
Phase 2 of Cell 6

LEAK LOCATION SERVICES, INC.

16124 UNIVERSITY OAK • SAN ANTONIO, TEXAS 78249 • (210) 408-1241 / FAX (210) 408-1242

October 12, 2005

RECEIVED
OCT 1 7 2005
THALLE

Thalle Construction Co., Inc.
228 South Churton Street
Hillsborough, NC 27278

Attention: Chris Haverstrom

Fax: (919) 245-1516

Subject: Report for "Electrical Leak Location Survey of the Newly Constructed Buncombe County Landfill, Cell 6, Phase 2, Located Near Asheville, North Carolina"; LLSI Project 607

Dear Mr. Halverstrom:

On October 6 through 10, 2005, Harvey Moy and Thane Hefley of Leak Location Services, Inc. (LLSI) conducted a leak location survey of the HDPE geomembrane of Phase 2 of the subject project. The cell is constructed from the top down with a 24-inch stone drainage layer, a 24-oz. geotextile cushion, 60-mil textured HDPE primary geomembrane, geosynthetic clay liner (GCL), 18-inch compacted soil liner, and compacted soil subgrade. The survey area was not isolated from earth ground during the survey. This report documents the results of the survey.

I. RESULTS

Three leaks were found. Table 1 lists the approximate locations and descriptions of the leaks. Figure 1 shows the approximate locations of the leaks found in Cell 6, Phase 2. Measurements were made to document the leak detection sensitivity. A 0.25-inch artificial leak was buried in the soil and leak location survey lines were run along both sides of the artificial leak. These tests showed that the artificial leak could be easily detected from 10 feet away.

Table 1. Approximate Locations and Descriptions of the Leaks

Leak	Location	Description
1	Line 345 at 33 feet	Triangular cut approximately 2 feet by 2 feet by 1.5 feet
2	Line 445 at 87 feet	Tear with rough edges approximately 3.5 inches
3	Line 575 at 6 feet	Semi-circular tear approximately 6 inches in diameter

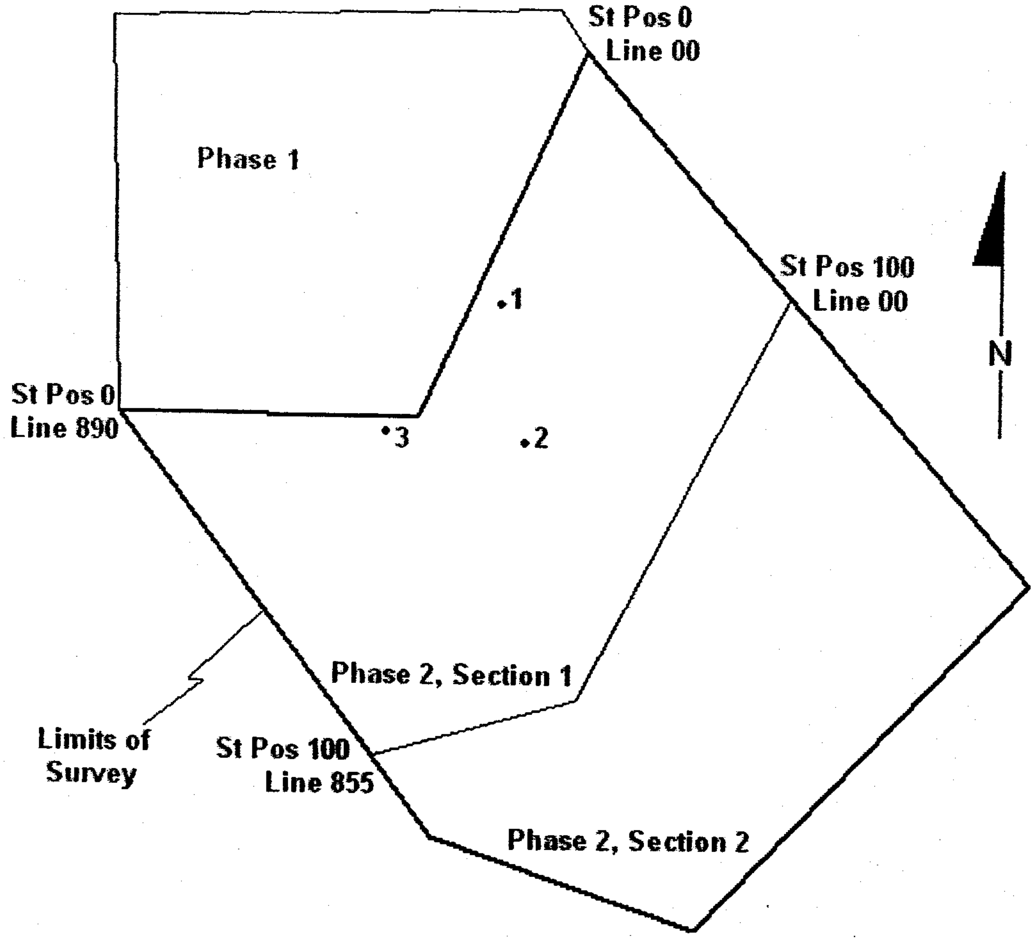


FIGURE 1. APPROXIMATE LOCATIONS OF THE LEAKS

II. TECHNIQUE

The electrical leak location method detects electrical paths through the liner caused by water or moisture in the leaks. A voltage is connected to one electrode placed in the natural material covering the liner and to a second electrode connected to earth ground. Electrical current flowing through the leaks in the liner produces localized anomalous areas of high current density near the leaks. These areas are located by making electrical potential measurement scans on the natural material on the geomembrane liner.

A systematic survey was conducted on survey lines spaced 5 feet apart. Survey lines were marked with survey flags with string lines connecting corresponding survey flags. The survey line between the strings was followed by remaining approximately midway between the strings. Measurements were made approximately every 3 feet along the survey lines. The data was periodically downloaded to a computer for storage, plotting, and analysis for smaller leak signals. The data was plotted to identify areas with anomalous signals for further investigations. Manual measurements were made to isolate the leak location for excavation while the survey crew was at the site. After the leak was repaired, additional manual measurements were made around the excavation to determine if any additional leaks were present. There were none.

We appreciate this opportunity to have been of service to Thalle Construction Company.

Very truly yours,

Robert M. Stephens III
Project Manager

Approved by:

Glenn T. Darilek
Principal Engineer