BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS

GROUNDWATER MONITORING WELL & METHANE PROBE INSTALLATION REPORT (CELL NO. 13)

EAST CAROLINA REGIONAL MSW LANDFILL
BERTIE COUNTY, NORTH CAROLINA
PERMIT NUMBER 08-03

Prepared for:

REPUBLIC SERVICES OF NORTH CAROLINA, LLC
1220 Commerce Street SW, Suite A
Conover, North Carolina 28613

Prepared by:

BUNNELL-LAMMONS ENGINEERING, INC.
6004 Ponders Court
Greenville, South Carolina 29615

NORTH CAROLINA LICENSED SEAL 1043 GEOLOGIST MARK S. PREDDY 12/17/09

NORTH CAROLINA PROFESSIONAL SEAL 13814 ENGINEER DANIEL B. BUNNELL 12/17/09

December 17, 2009

BLE Project Number J09-1001-62

BLE INC.
BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS

December 17, 2009

Republic Services of North Carolina, LLC
1220 Commerce Street SW, Suite A
Conover, North Carolina 28613

Attention: Mr. Raymond Hoffman, P.E.
Area Engineer

Subject: **Groundwater Monitoring Well &**
Methane Probe Installation Report (Cell No. 13)
East Carolina Regional MSW Landfill
Bertie County, North Carolina
Permit Number 08-03
BLE Project Number J09-1001-62

Gentlemen:

As authorized, Bunnell-Lammons Engineering, Inc. (BLE) has recently performed groundwater monitoring well and methane monitoring probe installation in relation to the upcoming construction of Cell No. 13 in Phase 5 at the East Carolina Regional MSW Landfill. The enclosed report describes the work performed and provides the installation records, boring logs, well construction diagrams, well development results, and slug test results.

We appreciate the opportunity to serve as your geological consultant on this project and look forward to working with you on future projects. If you have any questions, please contact us at (864) 288-1265.

Sincerely,

BUNNELL-LAMMONS ENGINEERING, INC.

NORTH CAROLINA LICENSED SEAL 1043 GEOLOGIST MARK S. PREDDY

Mark S. Preddy, P.G.
Senior Geologist
Registered, North Carolina #1043 12/17/09

NORTH CAROLINA PROFESSIONAL SEAL 13814 ENGINEER DANIEL B. BUNNELL

Daniel B. Bunnell, P.E.
Principal Geotechnical Engineer
Registered, North Carolina #13814 12/17/09

cc: Mr. William F. Hodges, P.E. – Hodges, Harbin, Newberry, & Tribble, Inc.

c:\msp files\east carolina lf nc\100162\1001-62 well install.doc

6004 PONDERS COURT
GREENVILLE, SOUTH CAROLINA 29615

PHONE (864) 288-1265
FAX (864) 288-4430

1.0 PROJECT INFORMATION

1.1 Site Information

The East Carolina Regional Municipal Solid Waste (MSW) Landfill is located at 1922 Republican Road in Bertie County, approximately 7.5 miles northwest of Windsor, North Carolina near the community of Aulander (Figure 1). The existing site consists of about 641 acres, which was formerly rural farmland and pine forest. The landfill was permitted for operation in October 1993. The site is owned and operated by Republic Services of North Carolina, LLC (Republic).

Monitoring well installations at the site are being completed in stages as new landfill cells are constructed. Seventeen groundwater monitoring wells (GW-1 through GW-17) have been installed between 1993 and 2007 and in conjunction with the construction of landfill Cells No. 3 through 12. As part of the development of Cell No. 13 in Phase 5, two additional downgradient monitoring wells (GW-18 and GW-21) and one methane monitoring probe (MM-12) are to be installed at the site. The proposed monitoring well and methane probe locations are shown on a sheet titled *Environmental Monitoring Plan, Phase 5 Engineering Plan, East Carolina Regional MSW Landfill*, Sheet 9 of 19, prepared by Hodges, Harbin, Newberry, & Tribble, Inc. (HHNT), and dated April 2008.

Existing monitoring well GW-14 and methane monitoring probe MM-7R were formerly located in the footprint of Cell No. 13 and required abandonment prior to cell construction activities. Documentation of the abandonment of GW-14 and MM-7R are included in BLE's *Report of Piezometer Abandonment: Phase 5 (Cells No. 13 & 14), East Carolina Regional MSW Landfill,* BLE Project Number J09-1001-62, dated November 16, 2009.

Existing piezometer PZ-110 was originally installed to monitoring well specifications and is located at the proposed GW-21 location; therefore, this piezometer was relabeled as GW-21. Installation documentation of PZ-110 is included in the *Application for Permit to Construct, Volume I of II, Design Hydrogeologic Report, Phase 5*, Golder Associates Project Number 063-66507.203, dated July 2007. Copies of relevant portions of that report regarding PZ-110 (i.e., field log, boring log, slug test data, and well development data) are attached in the appropriate appendices of this report.

BLE was contracted by Republic to install GW-18 and MM-12, and re-label PZ-110 as GW-21. This report documents the installation and re-labeling activities.

1.2 Geologic Setting

The site is located within the Coastal Plain region in northeastern North Carolina. The Coastal Plain consists of sediments that range in age from Recent to Cretaceous or older and which lie on top of "basement" or crystalline rocks that are similar or equivalent in age to the igneous and metamorphic rocks of the Piedmont region. The Coastal Plain sediments range in thickness from a featheredge along the western edge to several thousand feet along the coast. In the typical Coastal Plain stratigraphic sequence, Cretaceous sediments consisting of the Black Creek and Cape Fear geologic formations directly overlie the basement rocks. Tertiary sediments, which overlie the Cretaceous formations, consist of the Yorktown and Duplin geologic formations. Near-surface

geologic units at the site include the Yorktown formation that lies unconformably on top of the Black Creek formation.

The subsurface geology at the facility generally consists of four discrete sedimentary layers, referred to as Layers I through IV. These layers comprise two fining upward sequences, which are relatively consistent in thickness and lithology. Layers I and II are part of the Tertiary-age Yorktown Formation and Layers III and IV are part of the Cretaceous-age Black Creek Formation. Layer I includes the upper soil layer (silty clay to clayey silt) at the ground surface and is the upper confining unit for the Layer II Aquifer. Layer II is the upper groundwater aquifer and consists of silty fine sand. Layer III is a very silty clay to very clayey silt which defines the base of the Layer II aquifer, and is the upper confining unit for the Layer IV Aquifer. Layer IV is a confined aquifer, consisting of silty and/or clayey fine sand to fine-to-medium sand.

2.0 FIELD EXPLORATION

2.1 General

Field activities were performed between March 22, 2009 and July, 21, 2009. A North Carolina licensed driller (Joe Smith, North Carolina well driller certification number 3362-A) from Landprobe, Inc., a subsidiary of BLE, performed the drilling and well installation activities under the supervision of a North Carolina registered geologist from BLE. Representatives of BLE also performed well development, slug testing, and soil laboratory testing. Mr. Thomas J. Fields, PLS-2906, of Troy, North Carolina surveyed the completed well locations for horizontal and vertical control. The elevation data for the new monitoring wells are included in Appendix A and summarized on Table 1. The locations of the new wells are shown on Figure 2.

2.2 Monitoring Well Installation

One new groundwater monitoring well (GW-18) and one new methane monitoring probe (MM-12) were installed at the facility. Installation procedures were performed in accordance with the *North Carolina Well Construction Standards* Rule 15A NCAC 2C, .0108 (*Standards for Construction: Wells other than Water Supply*). Provided below are procedures and results for drilling, well installation, slug testing, and development. North Carolina Non-Residential Well Completions Records (Form GW-1b) are included in Appendix B.

2.2.1 Drilling Procedures and Subsurface Conditions Encountered

The soil test borings for the monitoring well and probe were conducted in general accordance with ASTM D-1586 using an ATV-mounted drilling rig employing hollow stem augers in soil (CME-750 drill rig). Drilling procedures are described in Appendix C. The soil descriptions on the field boring log (Appendix D) and the final soil test boring log (Appendix E) were based on visual examination by a North Carolina registered geologist. An information sheet, which describes the Unified Soil Classification System (USCS) terms and symbols used on the soil test boring logs, is also included in Appendix E.

The subsurface conditions encountered at GW-18 consisted of about 9.5 feet of Layer I silty clay underlain by approximately 15 feet of Layer II silty sand. The subsurface conditions encountered at MM-12 consisted of about 8 feet of Layer I silty clay, underlain by Layer II silty sand.

2.2.2 Groundwater Monitoring Well & Methane Probe Installation

A two-inch inside diameter (ID) polyvinyl chloride (PVC) groundwater monitoring well was installed in the water table aquifer (Layer II silty sand) at the GW-18 location to a total depth of 26.91 feet. Additionally, a two-inch ID methane monitoring probe was installed to intersect the Layer I silty clay and the upper portion of the Layer II silty sand at the MM-12 location to a total depth of 10.33 feet. The as-built well and probe locations are shown on the attached Figure 2. Monitoring well and probe installation procedures are described in Appendix F and installation diagrams are included on the soil test boring logs in Appendix E. Well construction data is summarized on Table 1. The monitoring well was developed and slug tested after installation activities were completed.

2.2.3 Hydraulic Conductivity and Slug Test Results

Hydraulic conductivity is defined as the volume of water that will move through a porous medium in unit time under a unit hydraulic gradient through a unit area at right angles to the direction of flow. A field permeability (slug) test was performed in monitoring well GW-18 to measure the *in situ* hydraulic conductivity of the aquifer materials exposed to the well screen. Slug test field procedures and results are presented in Appendix G and are summarized on Table 2. Since Layer II was not fully saturated at the GW-18 location, the Bouwer and Rice (1976) method for partially-penetrating wells in an unconfined aquifer was used. The slug test result indicated a hydraulic conductivity of 7.65×10^{-3} cm/sec in well GW-18. The slug test results obtained by Golder for well GW-21 indicated a hydraulic conductivity of 5.48×10^{-3} cm/sec.

2.2.4 Effective Porosity and Specific Yield Results

Effective porosity is the volume of void spaces through which water or other fluids can travel in sediment divided by the total volume of the sediment. Effective porosity can be assumed to be approximately equal to specific yield. Specific yield is defined as the ratio of the volume of water that drains from a saturated soil sample owing to the attraction of gravity, to the total volume of the sample.

The grain size analysis performed on a soil sample collected from the Layer II sand at GW-18 was used to estimate specific yield (Fetter, 1994). The results indicate a specific yield of about 36%. The soil laboratory testing results are included in Appendix H.

2.2.5 Monitoring Well Development Results

Monitoring well GW-18 was purged and developed to reduce the groundwater turbidity to the lowest practical level utilizing conventional development techniques. The well development consisted of purging and surging using a submersible pump and surge block. The well had relatively high yield and approximately 385 gallons (155 casing volumes) was purged from the well. Turbidity, pH, temperature, and specific conductivity were measured during the well

development. Turbidity values were high near the inception of the well development, and were reduced to as low as 15.03 NTUs at the completion of well development. A well development log for GW-18 is attached in Appendix I, along with the Golders' development results for GW-21.

3.0 CONCLUSION

As part of the upcoming construction of Cell No. 13 at the landfill, the groundwater and methane monitoring systems has been updated by:

- installing, developing, and slug testing one new groundwater monitoring well (GW-18);
- installing one new methane monitoring probe (MM-12);
- re-labeling an existing unused well/piezometer (PZ-110 [Golder, 2007]) as a groundwater monitoring well (GW-21). Installation documentation for GW-21 (a.k.a., PZ-110) is provided by Golder (2007); copies of pertinent logs and forms for GW-21 are attached in the appendices of this report; and
- abandoning one groundwater monitoring well (GW-14) and one methane monitoring probe (MM-7R) formerly located in the footprint of Cell No. 13 (reported under separate cover by BLE in November 2009).

Installation and abandonment activities were performed in accordance with the facility permit and the applicable North Carolina Department of Environment and Natural Resources rules.

4.0 REFERENCES

Bouwer, H. and Rice, R.C., 1976, "A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells," Water Resources Research, Vol. 12, No. 3, pp. 423-428.
- Slug testing data reduction procedures.

Bunnell-Lammons Engineering, Inc., November 16, 2009, *Report of Piezometer Abandonment: Phase 5 (Cells No. 13 & 14), East Carolina Regional MSW Landfill,* BLE Project Number J09-1001-62.
- Abandonment documentation for GW-14 and MM-7R.

Fetter, C.W., 1994, *Applied Hydrogeology*: Merrill Publishing Company, Columbus, Ohio.
- Basic hydrogeologic principles and estimates of effective porosity in soils.

Golder Associates, July 2007, *Application for Permit to Construct, Volume I of II, Design Hydrogeologic Report, Phase 5*, Golder Associates Project Number 063-66507.203.
- Installation documentation for PZ-110 that was re-labeled as GW-21.

TABLES

TABLE 1

WELL AND PROBE CONSTRUCTION & GROUNDWATER ELEVATION INFORMATION
East Carolina Regional MSW Landfill
Bertie Co., North Carolina
BLE Project Number J09-1001-62

	Survey Information				Groundwater						
					Time of Boring		After 24-Hours				
Monitoring Well	Ground Elevation	TOC Elevation	Northing	Easting	Depth Below Ground Surface	Water Elevation	Depth Below Ground Surface	Water Elevation	Screen Depth Below Ground Surface	Screen Elevation	Unit Screened
GW-18	59.20	62.07	13,763.57	7,977.41	12.50	46.70	12.28	46.92	11.71 - 26.71	47.49 - 32.49	Layer II
GW-21	60.86	62.98	12,136.67	7,615.41	8.98	51.88	8.92	51.94	13.00 - 28.00	47.86 - 32.86	Layer II
MM-12	59.35	62.00	13,799.97	7,874.33	Dry		Dry		5.13 - 10.13	54.22 - 49.22	Layer I (& top of Layer II)

Notes:
1. Elevations are in FEET above mean sea level (MSL)
2. Depths indicated are in FEET
3. TOC = *top of casing* (PVC)
4. Survey data provided by Thomas J. Fields, PLS.
5. Installation information for GW-21 (a.k.a. PZ-110) is included in the *Application for Permit to Construct, Volume I of II, Design Hydrogeologic Report, Phase 5,* Golder Associates Project Number 063-66507.203, dated July 2007.

Prepared By: MSP
Checked By: RLS

TABLE 2

SLUG TEST DATA
East Carolina Regional MSW Landfill
Bertie Co., North Carolina
BLE Project Number J09-1001-62

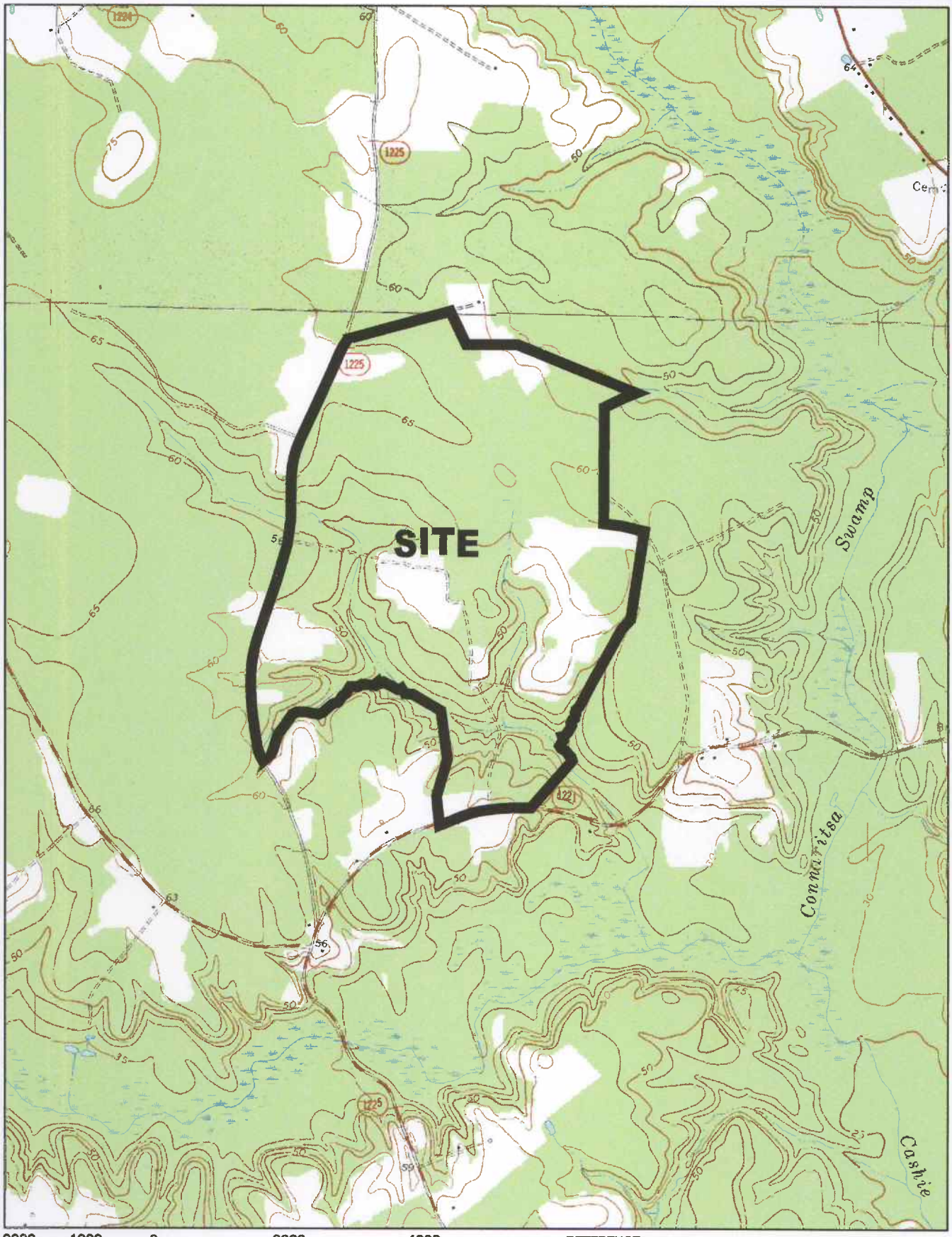
Monitoring Well	Method	Aquifer Unit	K(ft/min)	K(cm/sec)	K(ft/day)	Effective Porosity
GW-18	Bouwer-Rice (1976)	Layer II	1.51E-02	7.65E-03	21.7	36%
GW-21	Bouwer-Rice (1989)	Layer II	1.08E-02	5.48E-03	15.5	Not Tested

Notes:

1. Porosity value for soil was obtained from Figure 4.11 and Table 4.3 of Fetter (1994).
2. K = Hydraulic Conductivity
3. The data was reduced and the hydraulic conductivities calculated using SuperSlug Version 3.0.
4. Installation information for GW-21 (a.k.a. PZ-110) is included in the *Application for Permit to Construct, Volume I of II, Design Hydrogeologic Report, Phase 5,* Golder Associates Project Number 063-66507.203, dated July 2007.

Prepared By: MSP
Checked By: RLS

FIGURES

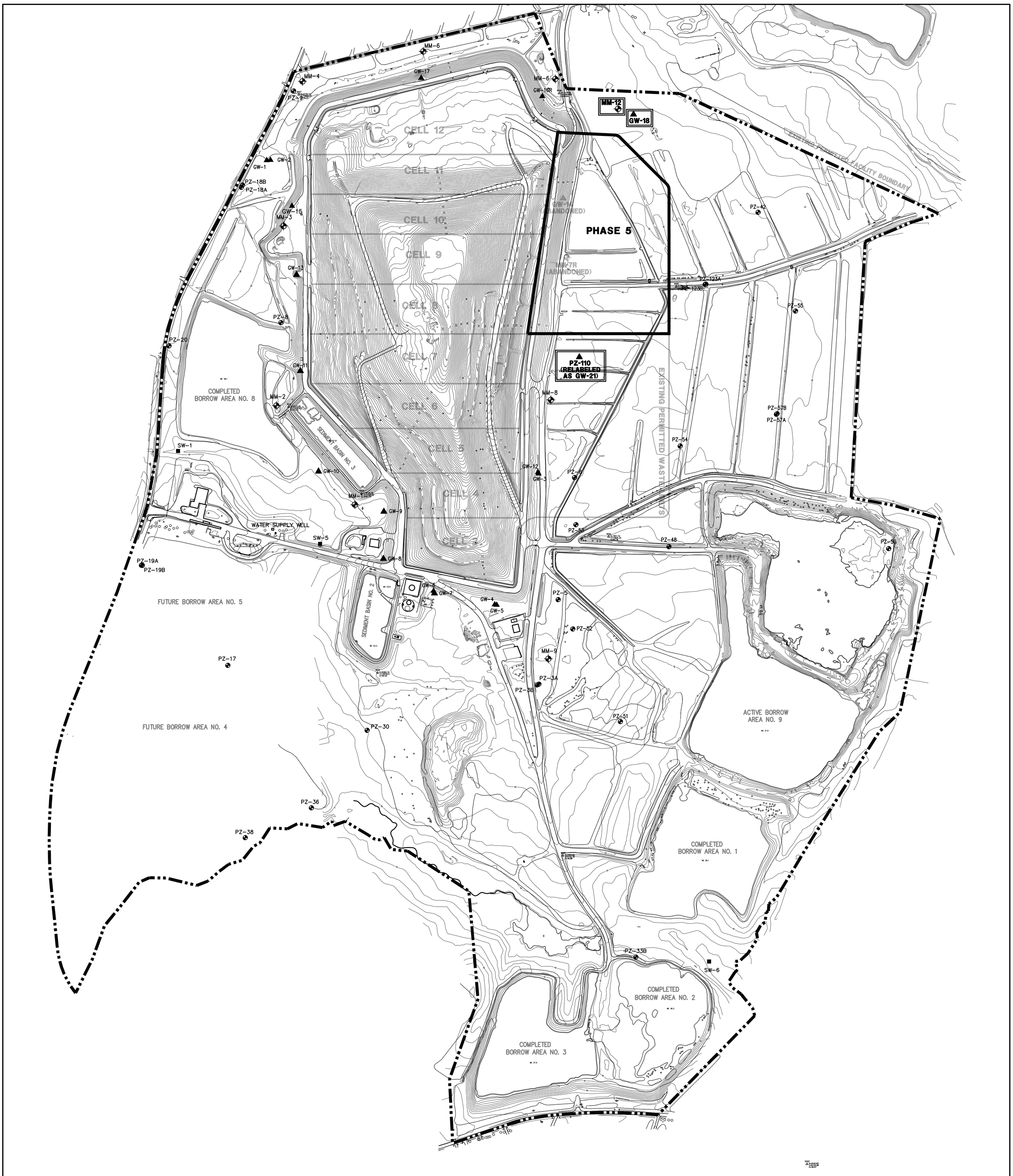


2000 1000 0 2000 4000

APPROXIMATE SCALE IN FEET

REFERENCE:
USGS TOPOGRAPHIC MAP, 7.5 MINUTE SERIES,
AULANDER AND REPUBLICAN, N.C. QUADRANGLES, 1972 AND 1978.

DRAWN: ACE	DATE: 12-17-09	BLE INC. BUNNELL-LAMMONS ENGINEERING, INC. 6004 PONDERS COURT GREENVILLE, SOUTH CAROLINA 29615 PHONE: (864)288-1265 FAX: (864)288-4430	SITE LOCATION MAP EAST CAROLINA LANDFILL BERTIE COUNTY, NORTH CAROLINA	FIGURE
CHECKED: MSP	CAD: ECLF62-SLM			1
APPROVED:	JOB NO: J09-1001-62			



MONITORING SYSTEM LEGEND

- GW–1 ▲ SURVEYED LOCATION OF GROUNDWATER MONITORING WELL
- SW–1 ■ APPROXIMATE LOCATION OF SURFACE WATER MONITORING POINT
- PZ–1 SURVEYED LOCATION OF EXISTING GROUNDWATER PIEZOMETER
- GW-12 ▲ SURVEYED LOCATION OF RECENTLY INSTALLED MONITORING WELL OR PROBE

TOPOGRAPHIC LEGEND

- 630 GROUND SURFACE CONTOUR IN FEET ABOVE MSL CONTOUR INTERVAL = 2 FEET.
- PROPERTY BOUNDARY
- STREAM OR CREEK

GENERAL MAP REFERENCE

300 150 0 300 600
APPROXIMATE SCALE IN FEET

REFERENCES:

1) TOPOGRAPHY AND SURFACE FEATURES PROVIDED BY SPATIAL DATA. DATE OF PHOTOGRAPH: MARCH 2009.
2) PROPERTY BOUNDARY AND WELL LOCATIONS PROVIDED BY THOMAS J. FIELDS, RLS, RALPH A. TRUE, RLS, DRAPER–ARDEN ASSOC., RLS. AND DONALDSON, GARRETT AND ASSOCIATES, RLS.
3) DRAWING TITLED "SURVEY AND BOUNDARY SURVEY, EAST CAROLINA LANDFILL", DATED NOVEMBER 1996, PREPARED BY HHNT.
4) MEAN SEA LEVEL ELEVATION (MSL) IS REFERENCED TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD).

REVISIONS		
No.	DESCRIPTION	BY

DRAWN	ACE
CHECKED	MSP
APPROVED	

DATE	12–17–09
FILE	ECLF 1001–62 INSTALL
JOB NO:	J09–1001–62

BLE INC.
BUNNELL-LAMMONS ENGINEERING, INC.
6004 PONDERS COURT
GREENVILLE, SOUTH CAROLINA 29615
PHONE: (864)288–1265 FAX: (864)288–4430

SITE TOPOGRAPHIC MAP AND AS–BUILT BORING LOCATION PLAN
EAST CAROLINA REGIONAL MSW LANDFILL
BERTIE COUNTY, NORTH CAROLINA

FIGURE NO. 2

APPENDICES

APPENDIX A

Survey Data

From the office of
Wright and Fields Land Surveying
1340 Albemarle Road, Suite C
P.O. Box 933, Troy, North Carolina 27371
Ph.: 910-572-2449 FAX: 910-572-4137

Listed below are the coordinates and elevations for two new Monitoring Wells located at the East Carolina Environmental Site in Bertie County, North Carolina:

Item	Northing	Easting	Elevation	Top of Pipe Elevation
GW-18	13,763.57 FT	7,977.41 FT	59.55 FT	62.07 FT
Disk	13,762.84 FT	7,977.77 FT	59.53 FT	----------
Ground	13,761.80 FT	7,978.16 FT	59.20 FT	----------
MM-12	13,799.97 FT	7,874.33 FT	59.53 FT	62.00FT
Disk	13,799.13 FT	7,874.62 FT	59.50 FT	----------
Ground	13,798.02 FT	7,874.82 FT	59.35 FT	----------

I, Thomas J. Fields, PLS-2906, certify that this report of data was prepared from an actual field survey done by me on July 21st, 2009 and is in all respects correct to the best of my knowledge and belief. This report was prepared in accordance with Board Rule Section 21 NCAC 56 .1600 – Standards of Practice for Land Surveying in North Carolina. Witness my original signature and official stamp or seal this the 22nd day of July 2009.

Thomas J. Fields

Thomas J. Fields, PLS-2906

NORTH CAROLINA PROFESSIONAL SEAL L-2906 LAND SURVEYOR THOMAS JEFFREY FIELDS

APPENDIX B

North Carolina Well Installation Forms

NON RESIDENTIAL WELL CONSTRUCTION RECORD

North Carolina Department of Environment and Natural Resources- Division of Water Quality

WELL CONTRACTOR CERTIFICATION # 3362-A

1. WELL CONTRACTOR:

Joe Smith
Well Contractor (Individual) Name

Landprobe
Well Contractor Company Name

STREET ADDRESS 6004 Ponders Court

Greenville | SC | 29615
City or Town | State | Zip Code

(864)- 288-1265
Area code- Phone number

2. WELL INFORMATION:

SITE WELL ID #(if applicable) GW-18

WELL CONSTRUCTION PERMIT#(if applicable)

OTHER ASSOCIATED PERMIT #(if applicable)

3. WELL USE (Check Applicable Box) Monitoring ☑ Municipal/Public ☐ Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐ Irrigation ☐ Other ☐ (list use)

DATE DRILLED 3-22-09

TIME COMPLETED 5:00 AM ☐ PM ☑

4. WELL LOCATION:

CITY: Aulander COUNTY Bertie

(see Figure 1 attached)
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

TOPOGRAPHIC / LAND SETTING:
☐ Slope ☐ Valley ☑ Flat ☐ Ridge ☐ Other
(check appropriate box)

LATITUDE 36 7' 24.84"
LONGITUDE 77 3' 37.59"

May be in degrees, minutes, seconds or in a decimal format

Latitude/longitude source: ☑ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map and attached to this form if not using GPS)

5. FACILITY- is the name of the business where the well is located.

FACILITY ID #(if applicable)

NAME OF FACILITY East Carolina Regional Landfill

STREET ADDRESS 1922 Republican Road

Aulander | NC | 27805
City or Town | State | Zip Code

CONTACT PERSON Charles Forth

MAILING ADDRESS as above

City or Town | State | Zip Code

(252)- 348-3322
Area code - Phone number

6. WELL DETAILS:

a. **TOTAL DEPTH:** 29.78 feet btoc

b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☑

c. **WATER LEVEL** Below Top of Casing: 14.98 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 2.87 FT. Above Land Surface*
*Top of casing terminated at/or below land surface may require a variance in accordance with 15A NCAC 2C .0118.

e. **YIELD (gpm):** _____ **METHOD OF TEST** _____

f. **DISINFECTION: Type** none **Amount** _____

g. **WATER ZONES** (depth):

From 12.3	To 24.5	From	To
From	To	From	To
From	To	From	To

7. CASING:

From	To	Ft.	Diameter	Thickness/Weight	Material
0	11.71		2.0"	Sch40	PVC

8. GROUT:

From	To	Ft.	Material	Method
0	5.0		bent. grout	Gravity
5.0	10.0		bent. chips	Gravity

9. SCREEN:

From	To	Ft.	Diameter	Slot Size	Material
11.71	26.71		2.0" in.	0.010 in.	PVC
			in.	in.	
			in.	in.	

10. SAND/GRAVEL PACK:

From	To	Ft.	Size	Material
10.0	27.5		#1	silica sand

11.DRILLING LOG

From	To	Formation Description
0	7.5	brown and gray sandy, silty CLAY
7.5	24.5	orange and gray silty SAND
24.5	27.5	dark gray sandy, silty CLAY

12. REMARKS:

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

SIGNATURE OF CERTIFIED WELL CONTRACTOR — DATE 3-25-09

Joe Smith
PRINTED NAME OF PERSON CONSTRUCTING THE WELL

Submit the original to the Division of Water Quality within 30 days. Attn: Information Mgt., 1617 Mail Service Center – Raleigh, NC 27699-1617 Phone No. (919) 733-7015 ext 568.

Form GW-1b
Rev.12/07

WELL CONSTRUCTION RECORD

North Carolina – Department of Environmental and Natural Resources – Division of Water Quality – Groundwater Section

WELL CONTRACTOR (INDIVIDUAL) NAME (print) MIKE MCCONAHEY CERTIFICATION # 2402

WELL CONTRACTOR COMPANY NAME GEOLOGIC EXPLORATION., INC. PHONE # (704) 872-7686

STATE WELL CONSTRUCTION PERMIT# _____ (if applicable) ASSOCIATED WQ PERMIT# _____ (if applicable)

1. WELL USE (Check Applicable Box): Residential ☐ Municipal/Public ☐ Industrial ☐ Agricultural ☐
Monitoring ☒ Recovery ☐ Heat Pump Water Injection ☐ Other ☐ If Other, list Use _____

2. WELL LOCATION:
Nearest Town: AULANDER County BERTIE
1922 REPUBLICAN ROAD
(Street Name, Numbers, Community, Subdivision, Lot No., Zip Code)

Topographic/Land setting
☐ Ridge ☐ Slope ☐ Valley ☒ Flat
(check appropriate box)
Latitude/longitude of well location
_____
(degrees/minutes/seconds)
Latitude/longitude source: ☐ GPS ☐ Topographic map
(check box)

3. OWNER: REPUBLIC SERVICES OF NORTH CAROLINA
Address 1220 COMMERCE STREET
(Street or Route No.)
CONOVER NC 28613
City or Town State Zip Code
( )
Area Code – Phone Number

4. DATE DRILLED 05-17-05
5. TOTAL DEPTH: 28.0 FT
6. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒
7. STATIC WATER LEVEL Below Top of Casing: 9.0 FT.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 2.5 FT. Above Land Surface*
*Top of casing terminated at/or below land surface requires a variance in accordance with 15A NCAC 2C .0118.
9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth): N/A
11. DISINFECTION: Type N/A Amount _____

DEPTH From	DEPTH To	DRILLING LOG Formation Description
0.0	1.0	WEEDS & TOPSOIL
1.0	4.0	Tan/ Brown / Red Sandy Silty Clay
4.0	12.0	Tan / White Sandy Silty Clay
12.0	28.0	TAN / ORANGE SILTY SAND

12. CASING:

	Depth From	To	Ft	Diameter	Wall Thickness or Weight/Ft.	Material
	0.0	13.0	Ft	2 INCH	SCH 40	PVC
			Ft.			
			Ft.			

13. Grout:

	Depth From	To	Ft.	Material	Method
	1.0	8.0	Ft.	Portland Bentonite	Slurry
			Ft.		

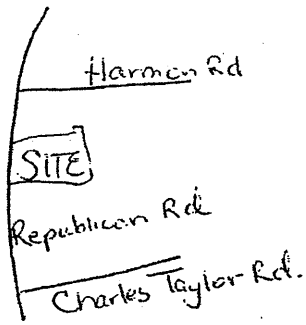
14. SCREEN:

	Depth From	To	Ft.	Diameter	Slot Size	Material
	13.0	28.0	Ft.	2 INCH in.	.010 in.	PVC
			Ft.	in.	in.	

15. SAND/GRAVEL PACK:

	Depth From	To	Ft.	Size	Material
	11.0	28.0	Ft.	20-40	FINE SILICA SAND
			Ft.		

LOCATION SKETCH
Show direction and distance in miles from at least two State Roads or County Roads, inculed the road numbers and common road names.



16. REMARKS: PZ-110 (GW-21) BENTONITE SEAL FROM 8.0 TO 11.0 FEET

I DO HEARBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER

Mike McC[illegible] 6/15/06
SIGNATURE OF PERSON CONSTRUCTING THE WELL DATE

Submit the original to the Division of Water Quality, Groundwater Section, 1636 Mail Service Center – Raleigh, NC 27699-1636 Phone No. (919) 733-3221, within 30 days.

GW-1 REV. 07/2001

APPENDIX C

Drilling Procedures

APPENDIX C

Drilling Procedures

Soil Test Boring

A soil test boring was advanced by mechanically twisting a continuous flight of steel hollow-stem augers into the soil. Soil sampling and penetration testing was performed in general accordance with ASTM D 1586. At regular intervals, soil samples were obtained with a standard 1.375-inch inside diameter (ID), 2-inch outside diameter (OD), stainless steel split-tube sampler. The sampler was first seated 6-inches to penetrate any loose cuttings, and then driven an additional 12 inches with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final 12 inches was recorded and designated the penetration resistance.

General

A North Carolina registered driller performed the drilling and well installation activities. A North Carolina registered geologist examined the soil and rock samples and prepared a boring log. The down-hole equipment was steam cleaned prior to drilling activities.

APPENDIX D

Field Logs

TEST BORING REPORT

BORING NO. GW-18

PROJECT: East Carolina Regional MSW Landfill - Bertie Co., NC
CLIENT: Republic Services of NC, LLC
CONTRACTOR: BLE
EQUIPMENT USED: CME-750 ATV

BLE JOB NO. J09-1001-62
PAGE NO. 1 of 2
LOCATION:
ELEVATION: 59.20
DATE START: 3/22/09
DATE FINISH: 3/22/09
DRILLER: J. Smith
PREPARED BY: M. Preddy

GROUND WATER		DEPTH TO:		
DATE	HRS AFT COMP	WATER	BOT. OF CASING	BOT. OF HOLE
	TOB	12.5		
	24	12.28		

	CASING	SAMPLER	CORE BARREL
TYPE	HSA	Split Spoon	XXX
SIZE ID/OD	8.25" OD	2" ID	XXX
HAMMER WT	XXX	140 lb	XXX
HAMMER FALL	XXX	30 "	XXX

DEPTH IN FEET	CASING BLOWS PER FT	SAMPLER BLOWS PER 6"	SAMPLE NUMBER	USCS	FIELD CLASSIFICATION AND REMARKS
					topsoil
	4	1 1 3	CL	SS-1	soft brown sli moist F. sdy si CLAY
5	11	3 4 7	CH	SS-2	stiff gray + red-br (mottled) sli moist F. sdy si CLAY
	10	2 5 5	CH	SS-3	as above
	7	4 3		SS-4	
10		4	SM		loose orange sli moist si F. SAND
	6	2 3 3	SM	SS-5	loose orange sli moist si F. SAND
15	5	1 2 3	SM	SS-6	loose lt. gray wet si F. SAND
	14	3 4 10	SM	SS-7	Firm orange wet sli cly si F-M SAND
20	7	3 3 4	SM	SS-8	Loose orange wet cly si F-M SAND

WELL: Grout; 2" PVC; Bent.; Sand; 5.0; 10.0; 11.71

BLOWS/FT	DENSITY	BLOWS/FT	CONSISTANCY	SAMPLE ID		WELL DESCRIPTION
0-4	VERY LOOSE	0-2	VERY SOFT	SS	SPLIT SPOON	STICKUP = 2.87
5-10	LOOSE	3-4	SOFT	HP	HYDROPUNCH	TOP SAND = 10.0
11-20	FIRM	5-8	FIRM	UD	UNDISTURBED TUBE	TOP BENT. = 5.0
21-30	VERY FIRM	9-15	STIFF	G	GRAB	SCREEN = 11.71 - 26.71
31-50	DENSE	16-30	VERY STIFF	C	COMPOSITE	SCREEN LENGTH = 15.0
51+	VERY DENSE	31-50	HARD	B	BAG	END CAP = 0.2
		51+	VERY HARD	NR	NO RECOVERY	WELL TD = 26.91

TEST BORING REPORT

East Carolina Regional MSW Landfill - Bertie Co., NC **J09-1001-62**

BORING NO. CW-18

PAGE 2 OF 2

DEPTH IN FEET	CASING BLOWS PER FT	SAMPLER BLOWS PER 6"	SAMPLE NUMBER	USCS	FIELD CLASSIFICATION AND REMARKS	WELL
	2	2 1 1	SM	SS-9	v. loose orange wet sli cly si F-M SAND	
		1 1 2		SS-10		
25	3		CH		soft to Firm dk gray & gray wet F. sdy si CLAY	
	8	7 4 4	CH	SS-11		26.71 26.91 27.5
				SS-12		
30						
				SS-13		
				SS-14		
35						
				SS-15		
				SS-16		
40						
				SS-17		
				SS-18		
45						

BLOWS/FT	DENSITY	BLOWS/FT	CONSISTANCY	SAMPLE ID		WELL MATERIALS
0-4	VERY LOOSE	0-2	VERY SOFT	SS	SPLIT SPOON	SAND =
5-10	LOOSE	3-4	SOFT	HP	HYDROPUNCH	
11-20	FIRM	5-8	FIRM	UD	UNDISTURBED TUBE	BENTONITE =
21-30	VERY FIRM	9-15	STIFF	G	GRAB	
31-50	DENSE	16-30	VERY STIFF	C	COMPOSITE	GROUT =
51+	VERY DENSE	31-50	HARD	B	BAG	WELL O.D. =
		51+	VERY HARD	NR	NO RECOVERY	WELL TYPE =

TEST BORING REPORT

BORING NO. MM-12

PROJECT:	East Carolina Regional MSW Landfill - Bertie Co., NC
CLIENT:	Republic Services of NC, LLC
CONTRACTOR:	BLE
EQUIPMENT USED:	CME-750 ATV

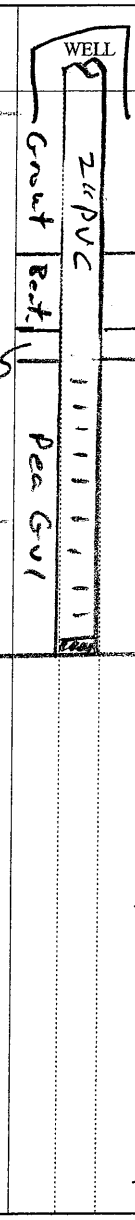
BLE JOB NO.	J09-1001-62
PAGE NO.	1 of 1
LOCATION:	
ELEVATION:	59.35
DATE START:	3/22/09
DATE FINISH:	3/22/09
DRILLER:	J. Smith
PREPARED BY:	M. Preddy

GROUND WATER		DEPTH TO:		
DATE	HRS AFT COMP	WATER	BOT. OF CASING	BOT. OF HOLE

	CASING	SAMPLER	CORE BARREL
TYPE	HSA	Split Spoon	XXX
SIZE ID/OD	8.25" OD	2" ID	XXX
HAMMER WT	XXX	140 lb	XXX
HAMMER FALL	XXX	30 "	XXX

DEPTH IN FEET	CASING BLOWS PER FT	SAMPLER BLOWS PER 6"	SAMPLE NUMBER	USCS	FIELD CLASSIFICATION AND REMARKS
					Topsoil
5	8	2 3 5	SS-1	CL	Firm gray + red-br (mottled) sl moist si CLAY
10	6	2 3 3	SS-2	SM	loose gray moist cly si F-m SAND
15			SS-3		
20			SS-4		

WELL



BLOWS/FT	DENSITY	BLOWS/FT	CONSISTANCY	SAMPLE ID		WELL DESCRIPTION
0-4	VERY LOOSE	0-2	VERY SOFT	SS	SPLIT SPOON	STICKUP = 2.65
5-10	LOOSE	3-4	SOFT	HP	HYDROPUNCH	TOP SAND = 4.5
11-20	FIRM	5-8	FIRM	UD	UNDISTURBED TUBE	TOP BENT. = 3.0
21-30	VERY FIRM	9-15	STIFF	G	GRAB	SCREEN = 5.13 - 10.13
31-50	DENSE	16-30	VERY STIFF	C	COMPOSITE	SCREEN LENGTH = 5
51+	VERY DENSE	31-50	HARD	B	BAG	END CAP = 0.2
		51+	VERY HARD	NR	NO RECOVERY	WELL TD = 10.33

Top Pea Gvl = 5.0

Project Name	East Carolina UT	Project Number	0636507.201
Project Location		Client	Republic Services
Drilling Company	Geologic Exploration	Driller Name	Mike McConaghey
Ground Elevation		Rig Type	Deidrich D-50 Turbo
oundwater elevation		Logged By	Dusty Reedy
Date Start/Finish	5-17-06/5-18-06	Total Depth	28

(GW-21)
BORING NO. PZ-110

Page 1 of 2

Elev. Ft.	Depth ft.	Sample Type & No.	Blows per 6"	Pen in.	Rec %	Remarks	Graphic Log (USCS)	Soil and Rock Descriptions
			1					Topsoil - black fine grained sandy silt to 0.5 ft.
			0			weight of hammer		Changes to gray fine grained sandy clay.
			1		100			
			4					
	2		4					Orange and gray mottled fine grained sandy clay.
			4					
			8		100			
			11					
	4		4					Same material
			5					
			8		100			
			11					
	6		10					Same material to 7.75 ft. changes to a light
			10					gray clayey silt.
			11		100			
			14					
	8		4					Light gray fine grained sandy clay with abundant
			2					sand. Changes @ 9.75 ft to medium
			3		100			grained silty sand.
			7					
	10		5					Light gray and orange medium grained
			4					silty sand, saturated.
			5		100			
			5					
	12		4					Same material to 12.75 ft. changes to an
			5		90			orange medium grained silty sand that
			8					shows some layering, wet
			7					
	14		3					Same material to 15.9 ft, changes to a
			6		90			poorly sorted pink sand, saturated.
			6					
			7					
	16		4					~~Same~~ Pink, tan, and orange poorly sorted medium
			7		80			grained sand, saturated.
			7					
			10					

Blows per 6 in. - 140lb hammer falling 30 in. to drive a 2.0 in. OD split spoon sampler.
P - Penetration Length of Sampler or Core Barrel
R - Recovery Length of Sample
RQD - Length of Sound Cores >4in./Length Cored %
S - Split Spoon Sample
U - Undisturbed Samples

Notes: (Rig Type, drilling method, bit or auger size, PSI, Equipment Failures, possible contamination, deviations from drilling plan, drilling difficulties, ect.)

6" ID HSA

Golder Associates

Project Name	East Carolina LF	Project Number	0636507.201
Project Location		Client	Republic Services
Drilling Company	Geologic Exploration	Driller Name	Mike McConaughey
Ground Elevation		Rig Type	Deidrich D-50 Turbo
Groundwater elevation		Logged By	Dusty Roach
Date Start/Finish	5-17-06 / 5-18-06	Total Depth	28

(GW-21)
BORING NO. PZ-110

Elev. Ft.	Depth ft.	Sample Type & No.	Blows per 6"	Pen in.	Rec %	Remarks	Graphic Log (USCS)	Soil and Rock Descriptions
			6 8 8 14		100			Same material, layering present saturated
	20		3 4 5 8		80			Same material without layering
	22		8 8 10 13		90			Same material
	24		3 3 5 6		100			Same material to 25.9 ft, becomes coarse grained with tan sandy clay at 26 ft.
	26		4 5 5 12		100			Sandy clay to 26.25 ft, changes back to tan medium grained, poorly sorted sand. Changes @ 27.25 ft to fine grained light gray sandy clay. changes @ 27.75 ft to layered gray fine grained silty sand.
	28		4 6 5 5		100			Medium grained poorly sorted, sandy clay layers from 29 to 29.25 ft and 29.75 to 29.90 ft.
	30		3 2 2 2		100			poorly grained poorly sorted sand, orange. changes to a blue gray fat clay @ 31.75
	32							Boring terminated @ 28 ft. Last spoon to 32
	34							

Blows per 6 in. - 140lb hammer falling 30 in. to drive a 2.0 in. OD split spoon sampler.
Pen - Penetration Length of Sampler or Core Barrel
Rec - Recovery Length of Sample
RQD - Lenght of Sound Cores >4in./Length Cored %
S - Split Spoon Sample
U - Undisturbed Samples

Notes: (Rig Type, drilling method, bit or auger size, PSI, Equipment Failures, possible contamination, deviations from drilling plan, drilling difficulties, ect.)

6" ID HSA

31
10
21

Golder Associates

APPENDIX E

Boring Logs and Installation Diagrams

KEY TO SOIL CLASSIFICATIONS AND CONSISTENCY DESCRIPTIONS

BUNNELL-LAMMONS ENGINEERING, INC.
GREENVILLE, SOUTH CAROLINA

Penetration Resistance* Blows per Foot	Relative Density
SANDS	
0 to 4	Very Loose
5 to 10	Loose
11 to 20	Firm
21 to 30	Very Firm
31 to 50	Dense
over 50	Very Dense

Penetration Resistance* Blows per Foot	Consistency
SILTS and CLAYS	
0 to 2	Very Soft
3 to 4	Soft
5 to 8	Firm
9 to 15	Stiff
16 to 30	Very Stiff
31 to 50	Hard
over 50	Very Hard

*ASTM D 1586

Particle Size Identification

Boulder: Greater than 300 mm
Cobble: 75 to 300 mm
Gravel:
Coarse - 19 to 75 mm
Fine - 4.75 to 19 mm
Sand:
Coarse - 2 to 4.75 mm
Medium - 0.425 to 2 mm
Fine - 0.075 to 0.425 mm
Silt & Clay: Less than 0.075 mm

KEY TO DRILLING SYMBOLS

Grab Sample

Split Spoon Sample

Undisturbed Sample

NR = No reaction to HCL

NA = Not applicable

NS = No sample

Groundwater Table at Time of Drilling

Groundwater Table 24 Hours after Completion of Drilling

KEY TO SOIL CLASSIFICATIONS

Well-graded Gravel
GW

Low Plasticity Clay
CL

Clayey Silt
MH

Silty Sand
SM

Poorly-graded Gravel
GP

Sandy Clay
CLS

Sandy Silt
MLS

Topsoil
TOPSOIL

Partially Weathered Rock
BLDRCBBL

Silty Clay
CL-ML

Sand
SW

Trash
MUCKPEAT

High Plasticity Clay
CH

Silt
ML

Clayey Sand
SC

Fill
FILL

Poorly Graded Sand
SP

Bedrock
BEDROCK

Limestone
LIMESTONE

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. GW-18

PROJECT: East Carolina Regional MSW Landfill — PROJECT NO.: J09-1001-62

CLIENT: Republic Services of NC, LLC — START: 3-22-09 END: 3-22-09

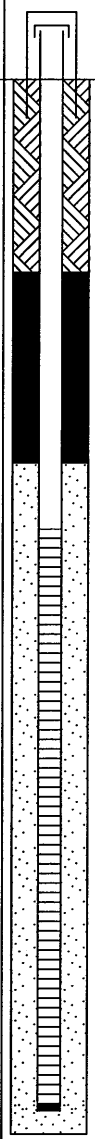
LOCATION: Bertie County, North Carolina — ELEVATION: 59.20

DRILLER: Landprobe, J. Smith — LOGGED BY: M. Preddy

DRILLING METHOD: CME 750 ATV; 8.25-inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: 12.5 AFTER 24 HOURS: 12.28 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)
	6-inches of TOPSOIL			
2	Soft, brown, slightly moist, fine sandy, silty CLAY		1 1 3	
55 4	Stiff, gray and reddish-brown (mottled), slightly moist, fine sandy, silty CLAY		3 4 7	
6			2 5 5	
8				
50 10			4 3 4	
	Loose, orange, slightly moist, silty, fine SAND			
12			2 3 3	
45 14	Loose, light gray, wet, silty, fine SAND		1 2 3	
16	Firm, orange, wet, slightly clayey, silty, fine to medium SAND		3 4 10	
18	Loose, orange, wet, clayey, silty, fine to medium SAND		3 3 4	
40 20	Very loose, orange, wet, slightly clayey, silty, fine to medium SAND			
22			2 1 1	
35 24			1 1 2	
	Soft to firm, dark gray and gray, wet, fine sandy, silty CLAY			
26			7 4 4	
28	Boring terminated at 27.5 feet. Groundwater encountered at 12.5 feet at time of drilling and at 12.28 feet after 24 hours.			
30 30				
32				
25 34				
36				
38				
20				



MONITOR WELL INSTALLATION DETAILS

Neat cement, 0 to 5.0 feet

Bentonite seal, 5.0 to 10.0 feet

Filter pack, sand 10.0 to 27.5 feet

2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 11.71 to 26.71 feet

Pipe cap

Total well depth, 26.91 feet

SURFACE COMPLETION

4" x 4" stand-up locking steel cover with a 3' x 3' concrete pad at the base with survey pin

1/4-inch weep and vent holes installed in steel cover and well casing, respectively

PVC stick-up = 2.87 feet

Top of PVC casing elev. = 62.07 feet

Ground surface elev. = 59.20 feet

Survey pin elev. = 59.53 feet

Northing = 13,763.57'

Easting = 7,977.41'

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MM-12

PROJECT: East Carolina Regional MSW Landfill — PROJECT NO.: J09-1001-62

CLIENT: Republic Services of NC, LLC — START: 3-22-09 END: 3-22-09

LOCATION: Bertie County, North Carolina — ELEVATION: 59.35

DRILLER: Landprobe, J. Smith — LOGGED BY: M. Preddy

DRILLING METHOD: CME 750 ATV; 8.25-inch OD hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ _____ CAVING> _____

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	STANDARD PENETRATION RESULTS BLOWS/FOOT (2 5 10 20 30 40 50 70 90)
	6-inches of TOPSOIL			
	Firm, gray and reddish-brown (mottled), slightly moist, silty CLAY		2 3 5	
	Loose, gray moist, clayey, silty, fine to medium SAND		2 3 3	
	Boring terminated at 10.33 feet. No groundwater encountered at time of drilling.			

Elevation scale: 55, 50, 45, 40, 35, 30, 25, 20

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38

MONITOR WELL INSTALLATION DETAILS

Neat cement, 0 to 3.0 feet

Bentonite seal, 3.0 to 4.5 feet

#2 filter sand, 4.5 to 5.0 feet

Pea gravel, 5.0 to 10.33 feet

2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 5.13 to 10.13 feet

Pipe cap

Total well depth, 10.33 feet

SURFACE COMPLETION
4" x 4" stand-up locking steel cover with a 3' x 3' concrete pad at the base with survey pin

1/4-inch weep and vent holes installed in steel cover and well casing, respectively

PVC stick-up = 2.65 feet

Top of PVC casing elev. = 62.00 feet

Ground surface elev. = 59.35 feet
Survey pin elev. = 59.50 feet

Northing = 13,799.97'

Easting = 7,874.33'

GEOT_WELL 1001-62.GPJ 12/7/09

RECORD OF BOREHOLE PZ-110/0803-GW-21

SHEET 1 of 1

PROJECT: East Carolina Environmental
PROJECT NUMBER: 063-6507.201
DRILLED DEPTH: 32.0 ft
LOCATION: Aulander, NC

DRILL RIG: Deidrich D-50 Turbo
DATE STARTED: 5/17/06
DATE COMPLETED: 5/18/06

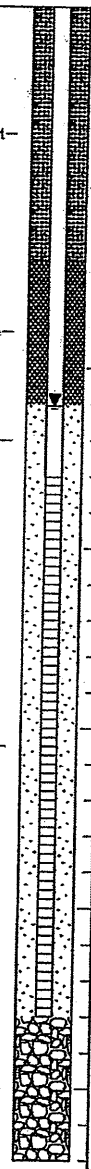
NORTHING: 867,828.0
EASTING: 2,572,575.0
GS ELEVATION: 61.0 ft
TOC ELEVATION: 63.0 ft

DEPTH W.L.: 11.0 ft
ELEVATION W.L.: 51.9 ft
DATE W.L.: 5/19/06
TIME W.L.: 7:42 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)
0	60	0.0 - 0.5 SILTY SAND - black fine grained silty sand	SM		60.5
		0.5 - 7.8 LEAN CLAY - gray fine grained sandy clay. Orange and gray mottled fine grained sandy clay at 2 ft, moist	CL		0.5
5	55				53.3
		7.8 - 8.0 CLAYEY SILT - light gray clayey silt	ML		8.0
		8.0 - 9.8 LEAN CLAY - light gray fine grained sandy clay with abundant sand	CL		51.3
10	50	9.8 - 15.9 SILTY SAND - medium grained silty sand. Light gray and orange medium grained silty sand at 10 ft, saturated. Orange medium grained silty sand with some layering at 12.75 ft, wet	SM		9.8
15	45	15.9 - 25.9 WELL GRADED SAND - pink, tan, and orange poorly sorted medium grained sand, saturated. Layering at 18 ft. No layering visible at 20 ft	SW		45.1 / 15.9
20	40				
25	35	25.9 - 26.3 LEAN CLAY - tan sandy clay with coarse grained sand	CL		35.1
			SW		26.3
		26.3 - 27.3 WELL GRADED SAND - tan poorly sorted medium grained sand	CL		33.8 / 33.3
		27.3 - 27.8 LEAN CLAY - light gray fine grained sandy clay	SM		27.8
30	30	27.8 - 30.0 SILTY SAND - gray fine grained silty sand with layering. Augers terminated at 28 ft. Medium grained sandy clay layers from 29 to 29.25 ft and 29.75 to 29.9 ft	SW		31.0 / 30.0
		30.0 - 31.8 WELL GRADED SAND - orange poorly sorted sand	CH		29.3
35	25	31.8 - 32.0 FAT CLAY - blue gray fat clay. Boring completed at 32.0 ft			
40					

SAMPLES NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC
	SPT	1-0-1-4	1	100.0 / 2.0
	SPT	4-4-8-11	12	100.0 / 2.0
	SPT	4-5-8-11	13	100.0 / 2.0
	SPT	10-10-11-14	21	100.0 / 2.0
	SPT	4-2-3-7	5	100.0 / 2.0
	SPT	5-4-5-5	9	100.0 / 2.0
	SPT	4-5-8-7	13	90.0 / 2.0
	SPT	3-6-6-7	12	90.0 / 2.0
	SPT	4-7-7-10	14	80.0 / 2.0
	SPT	6-8-8-14	16	100.0 / 2.0
	SPT	3-4-5-8	9	80.0 / 2.0
	SPT	8-8-10-13	18	90.0 / 2.0
	SPT	3-3-5-6	8	100.0 / 2.0
	SPT	4-5-5-12	10	100.0 / 2.0
	SPT	4-6-5-5	11	100.0 / 2.0
	SPT	3-2-2-2	4	100.0 / 2.0

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -1.96-13 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 13-28 ft
Material: PVC
Diameter: 2-inch
Slot Size: .010-inch
End Cap: Threaded

FILTER PACK
Interval: 11-28 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 7-11 ft
Type: 3/8 Bentonite chip

ANNULUS SEAL
Interval: 0-7 ft
Type: Portland/Bentonite mix

WELL COMPLETION
Pad: 3x3x0.5 ft concrete
Protective Casing: 4-inch Aluminum

DRILLING METHODS
Type: 4.25-inch ID Hollow Stem Augers

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: Geologic Exploration
DRILLER: Mike McConahey

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 11/10/06

Golder Associates

APPENDIX F

Monitoring Well & Probe Installation Procedures

APPENDIX F

Monitoring Well & Probe Installation Procedures

Groundwater Monitoring Well

The groundwater monitoring well consists of 2-inch polyvinyl chloride (PVC) Schedule 40 casing with flush-threaded joints installed in an 8.25-inch nominal diameter augered borehole. The bottom 15-foot section of the well was a manufactured well screen with 0.01-inch wide machined slots. Washed sand backfill was placed around the outside of the pipe to approximately 2 feet above the top of the well screen. The sand backfill is used to stabilize the formation and to help yield a less turbid groundwater sample. A bentonite seal was installed on top of the sand backfill to seal the monitoring well at the desired level. The borehole was grouted with a cement/bentonite grout to the ground surface. A PVC cap and a lockable 4-inch diameter stand-up protective steel cover were placed over the well. A 3-foot by 3-foot sloped concrete pad was put at the base of the well. The well was constructed with a vent hole in the PVC casing near the top of the well and a weep hole near the base of the outer protective steel cover. A monitoring well construction record is attached in Appendix E.

Methane Monitoring Probe

The methane monitoring probe consists of 2-inch PVC pipe (Schedule 40 with flush-threaded joints) inserted into an 8.25-inch diameter augered borehole. The bottom 5-foot section of the probe is manufactured well screen with 0.020-inch wide slots. The screened section of the probe extends from about 3.2 to 8.2 feet depth. In the probe, washed pea gravel backfill was placed around the outside of the pipe to the top of the probe screen. 0.6-feet of sand was then placed on top of the pea gravel, followed by a 1.0-foot thick bentonite seal on top of the sand backfill to seal the monitoring probe at the desired level. The remaining annulus was then grouted to the surface with a cement/bentonite grout mixture. The surface completion of the probe consisted of a PVC cap and a lockable 4" x 4" x 5' standup protective steel cover, with a 3-foot by 3-foot concrete pad at the base of the steel cover. The probe was constructed with a weep hole near the base of the outer protective steel cover. A monitoring probe construction record is attached in Appendix E.

APPENDIX G

Slug Test Procedures and Results

APPENDIX G

Slug Test Procedures and Results

A slug test was performed in the field on the well to estimate the average hydraulic conductivity of the water table aquifer. Hydraulic conductivity is a constant of proportionality relating to the ease with which a fluid passes through a porous medium. This data can be used to estimate the groundwater flow velocity beneath the site. The field procedure was as follows:

- Measure the static groundwater elevation in the well to be tested;
- Affect an instantaneous change to the static water level in the well by removing a known volume of water; and
- Measure the rate at which the water level recovers to its original level.

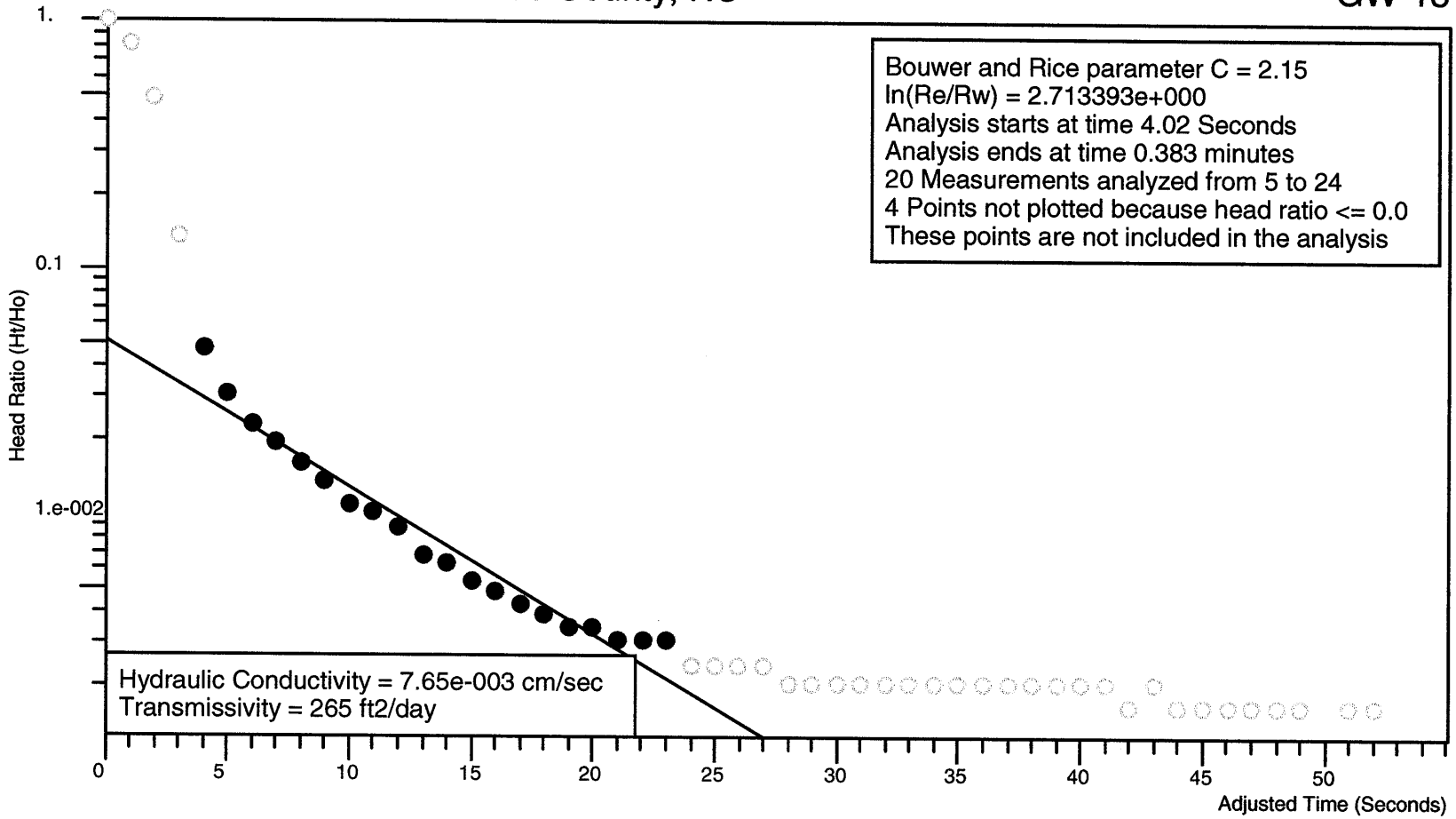
The resulting slug test data (time versus water level) was reduced and hydraulic conductivity was calculated using the Bouwer and Rice Method for partially penetrating wells in unconfined aquifers.

Rising Head Slug test June 3, 2009

East Carolina MSW Landfill Bertie County, NC

Bouwer and Rice Graph

GW-18



Ho is 4.85 feet at 0. Seconds

Project Number: J09-1001-62 for Republic

Analysis by Bunnell-Lammons Engineering, Inc.

Rising Head Slug test

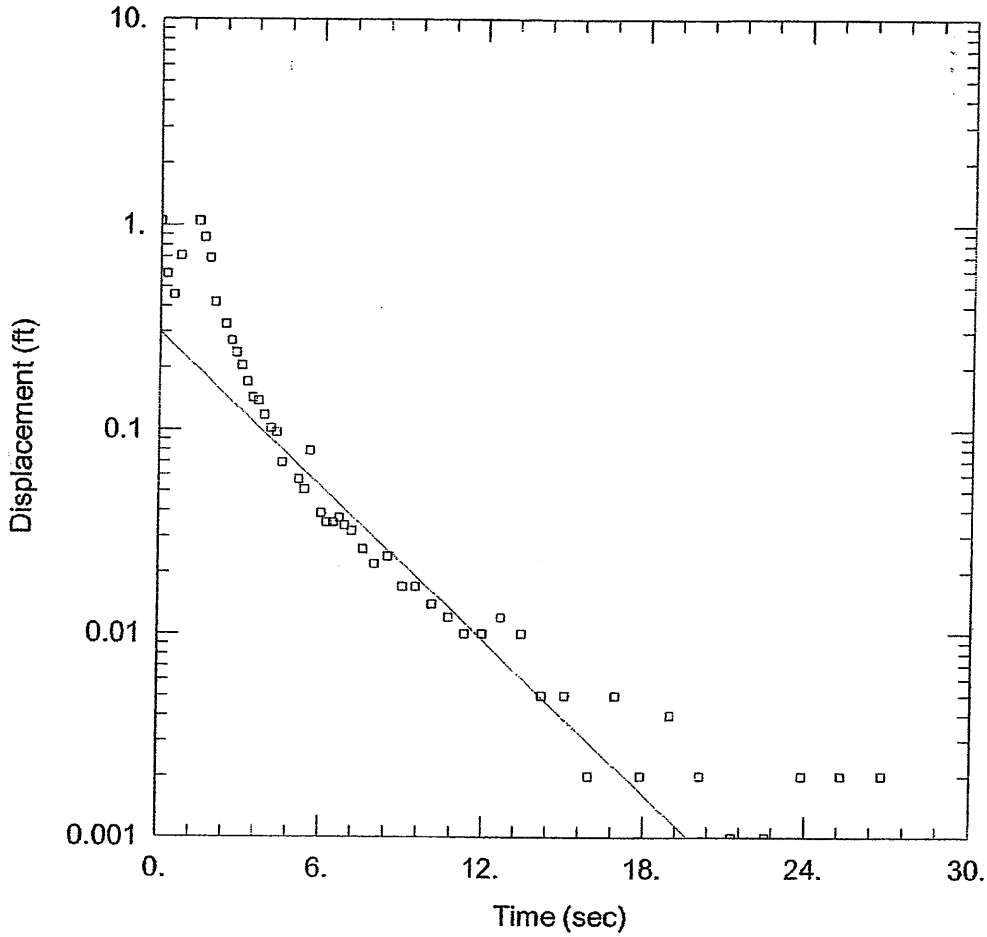
Site Name:	East Carolina MSW Landfill
Location:	Bertie County, NC
Test Date:	June 3, 2009
Client:	Republic
Project Number:	J09-1001-62
Import File:	C:\Public PC058\Projects\East Carolina\J09-1001-62\6-2-09 slugs\Review\EC

Well Label:	GW-18
Aquifer Thickness:	12.2 feet
Screen Length:	14.6 feet
Casing Radius:	8.33e-002 feet
Effective Radius:	0.344 feet
Static Water Level:	0. feet
Water Table to Screen Bottom:	14.6 feet
Anisotropy Ratio:	1.
Time Adjustment:	0. Seconds

Test starts with trial 0
There are 56 time and drawdown measurements
Maximum head is 4.85 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	0.	0.	4.85	4.85	1.
2	1.7e-002	1.7e-002	3.96	3.96	0.816
3	3.3e-002	3.3e-002	2.37	2.37	0.488
4	5.e-002	5.e-002	0.658	0.658	0.136
5	6.7e-002	6.7e-002	0.229	0.229	4.72e-002
6	8.3e-002	8.3e-002	0.149	0.149	3.07e-002
7	0.1	0.1	0.113	0.113	2.33e-002
8	0.117	0.117	9.4e-002	9.4e-002	1.94e-002
9	0.133	0.133	7.8e-002	7.8e-002	1.61e-002
10	0.15	0.15	6.6e-002	6.6e-002	1.36e-002
11	0.167	0.167	5.4e-002	5.4e-002	1.11e-002
12	0.183	0.183	5.e-002	5.e-002	1.03e-002
13	0.2	0.2	4.3e-002	4.3e-002	8.86e-003
14	0.217	0.217	3.3e-002	3.3e-002	6.8e-003
15	0.233	0.233	3.1e-002	3.1e-002	6.39e-003
16	0.25	0.25	2.6e-002	2.6e-002	5.36e-003
17	0.267	0.267	2.4e-002	2.4e-002	4.95e-003
18	0.283	0.283	2.1e-002	2.1e-002	4.33e-003
19	0.3	0.3	1.9e-002	1.9e-002	3.92e-003
20	0.317	0.317	1.7e-002	1.7e-002	3.5e-003
21	0.333	0.333	1.7e-002	1.7e-002	3.5e-003
22	0.35	0.35	1.5e-002	1.5e-002	3.09e-003
23	0.367	0.367	1.5e-002	1.5e-002	3.09e-003
24	0.383	0.383	1.5e-002	1.5e-002	3.09e-003
25	0.4	0.4	1.2e-002	1.2e-002	2.47e-003
26	0.417	0.417	1.2e-002	1.2e-002	2.47e-003
27	0.433	0.433	1.2e-002	1.2e-002	2.47e-003
28	0.45	0.45	1.2e-002	1.2e-002	2.47e-003
29	0.467	0.467	1.e-002	1.e-002	2.06e-003
30	0.483	0.483	1.e-002	1.e-002	2.06e-003
31	0.5	0.5	1.e-002	1.e-002	2.06e-003
32	0.517	0.517	1.e-002	1.e-002	2.06e-003
33	0.533	0.533	1.e-002	1.e-002	2.06e-003

34	0.55	0.55	1.e-002	1.e-002	2.06e-003
35	0.567	0.567	1.e-002	1.e-002	2.06e-003
36	0.583	0.583	1.e-002	1.e-002	2.06e-003
37	0.6	0.6	1.e-002	1.e-002	2.06e-003
38	0.617	0.617	1.e-002	1.e-002	2.06e-003
39	0.633	0.633	1.e-002	1.e-002	2.06e-003
40	0.65	0.65	1.e-002	1.e-002	2.06e-003
41	0.667	0.667	1.e-002	1.e-002	2.06e-003
42	0.683	0.683	1.e-002	1.e-002	2.06e-003
43	0.7	0.7	8.e-003	8.e-003	1.65e-003
44	0.717	0.717	1.e-002	1.e-002	2.06e-003
45	0.733	0.733	8.e-003	8.e-003	1.65e-003
46	0.75	0.75	8.e-003	8.e-003	1.65e-003
47	0.767	0.767	8.e-003	8.e-003	1.65e-003
48	0.783	0.783	8.e-003	8.e-003	1.65e-003
49	0.8	0.8	8.e-003	8.e-003	1.65e-003
50	0.817	0.817	8.e-003	8.e-003	1.65e-003
51	0.833	0.833	6.e-003	6.e-003	1.24e-003
52	0.85	0.85	8.e-003	8.e-003	1.65e-003
53	0.867	0.867	8.e-003	8.e-003	1.65e-003
54	0.883	0.883	6.e-003	6.e-003	1.24e-003
55	0.9	0.9	6.e-003	6.e-003	1.24e-003
56	0.917	0.917	6.e-003	6.e-003	1.24e-003



WELL TEST ANALYSIS

Data Set: C:\...\PZ-110 Rising.aqt
Date: 12/03/06 Time: 12:27:41

PROJECT INFORMATION

Company: Golder Associates Inc.
Client: Republic Services,NC
Project: 063-6507.201
Location: East Carolina Landfill
Test Well: PZ-110 Rising
Test Date: 10/31/06

AQUIFER DATA

Saturated Thickness: 22. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (PZ-110)

Initial Displacement: 1.043 ft
Total Well Penetration Depth: 28. ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.81 ft
Screen Length: 15. ft
Well Radius: 0.083 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.005478 cm/sec
y0 = 0.2976 ft

Data Set: C:\Documents and Settings\dreedy\My Documents\Phase 5 Application for Permit to Construct\Phase 5
Date: 12/03/06
Time: 12:27:46

PROJECT INFORMATION

Company: Golder Associates Inc.
Client: Republic Services,NC
Project: 063-6507.201
Location: East Carolina Landfill
Test Date: 10/31/06
Test Well: PZ-110 Rising

AQUIFER DATA

Saturated Thickness: 22. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: PZ-110

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.043 ft
Static Water Column Height: 20.81 ft
Casing Radius: 0.083 ft
Well Radius: 0.083 ft
Well Skin Radius: 0.3438 ft
Screen Length: 15. ft
Total Well Penetration Depth: 28. ft

No. of Observations: 51

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.25	0.578	7.14	0.032
0.5	0.455	7.56	0.026
0.75	0.707	7.98	0.022
1.416	1.043	8.46	0.024
1.62	0.872	9.	0.017
1.823	0.69	9.48	0.017
2.03	0.419	10.08	0.014
2.433	0.326	10.68	0.012
2.636	0.272	11.28	0.01
2.839	0.237	11.96	0.01
3.044	0.205	12.66	0.012
3.25	0.172	13.44	0.01
3.458	0.144	14.22	0.005
3.672	0.139	15.06	0.005
3.886	0.118	15.96	0.002
4.128	0.102	16.92	0.005
4.338	0.097	17.88	0.002
4.551	0.069	18.96	0.004
5.185	0.057	20.1	0.002
5.389	0.051	21.3	0.001
5.592	0.079	22.56	0.001
6.019	0.039	23.88	0.002
6.223	0.035	25.32	0.002
6.462	0.035	26.82	0.002
6.667	0.037	28.38	0.
6.872	0.034		

SOLUTION

Slug Test
Aquifer Model: Confined

Solution Method: Bouwer-Rice
ln(Re/rw): 4.447

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.005478	cm/sec
y0	0.2976	ft

T = T*b = 3.674 cm²/sec

AUTOMATIC ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
K	0.007414	0.0009721	+/- 0.001954	7.627	cm/sec
y0	0.8987	0.08986	+/- 0.1806	10.	ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

T = T*b = 4.971 cm²/sec

Parameter Correlations

	K	y0
K	1.00	0.75
y0	0.75	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . . . . 0.7043 ft^2
Variance . . . . . 0.01437 ft^2
Std. Deviation . . . . . 0.1199 ft
Mean . . . . . -0.008007 ft
No. of Residuals 51
No. of Estimates 2

APPENDIX H

Soils Laboratory Test Procedures and Results

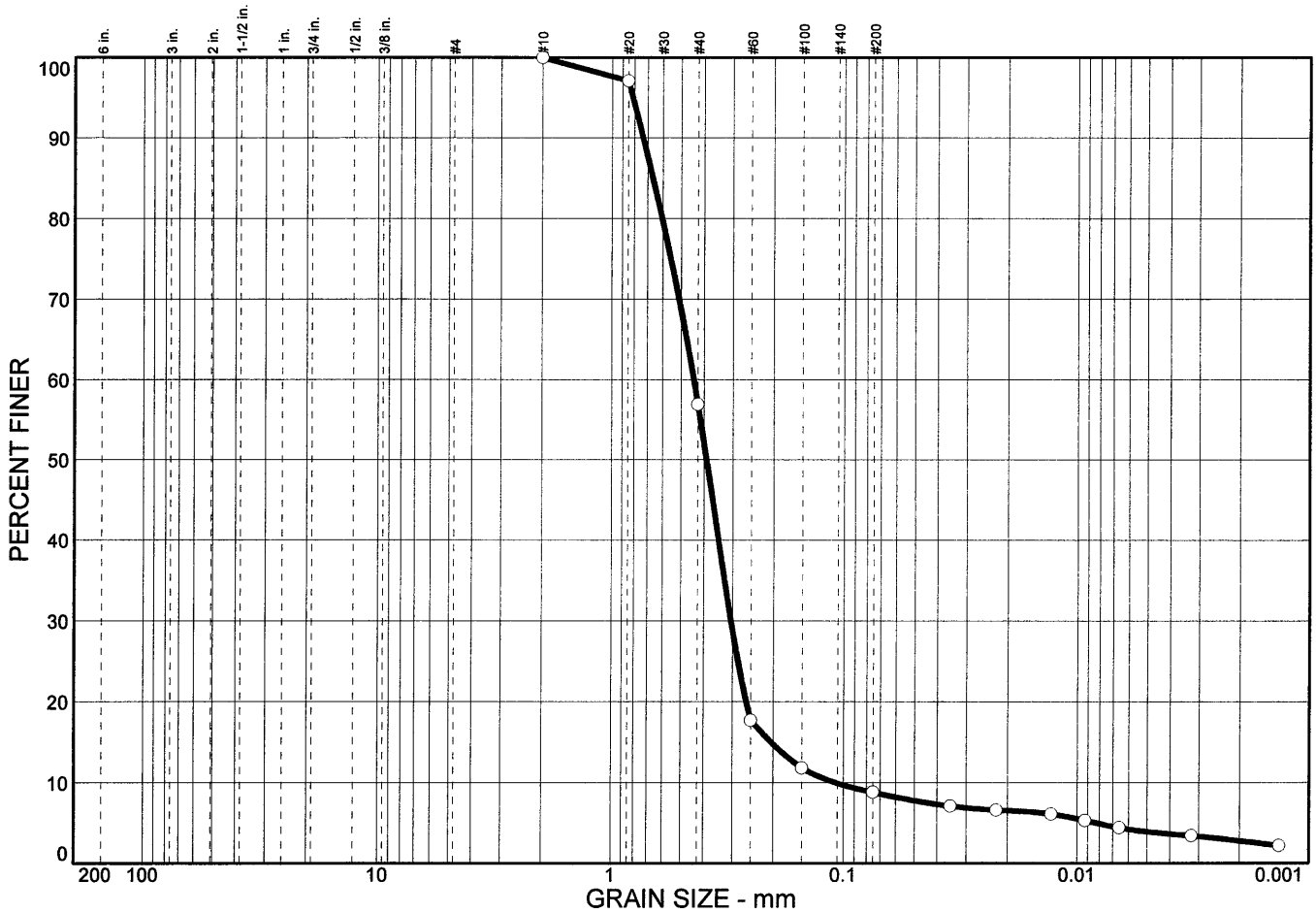
APPENDIX H

Soils Laboratory Test Procedures and Results

Particle Size Distribution

The distribution of soils coarser than the No. 200 (75-um) sieve is determined by passing a representative specimen through a standard set of nested sieves. The weight of material retained on each sieve is determined and the percentage retained (or passing) is calculated. A specimen may be washed through only the No. 200 sieve, if the full range of particle sizes is not required. The percentage of material passing the No. 200 sieve is reported. The distribution of materials finer than No. 200 sieve is determined by use of the Hydrometer. The particle sizes and distribution are computed from the time rate of settlement of the different size particles while suspended in water. These tests are performed in accordance with ASTM D 421, D 422, and D 1140.

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.0	43.1	48.1	4.9	3.9

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	Boring	GW-18	16.0-17.5	Light brown fi.-med. SAND	SP-SM

Particle Size Distribution Report

Bunnell Lammons Engineering, Inc.

Greenville, SC

Client: HHNT-Republic

Project: East Carolina Landfill

Project No.: J09-1001-62

Figure

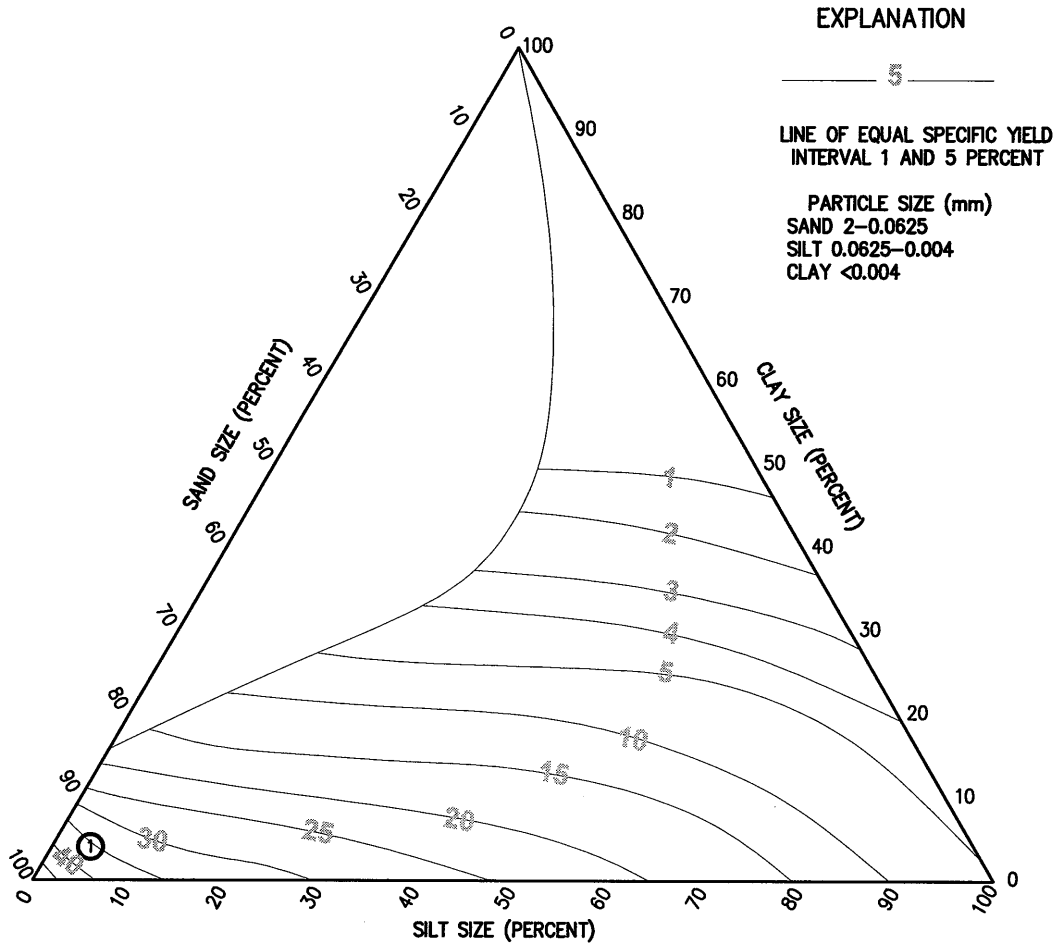


FIGURE 4.11 FROM FETTER, C.W., 1994, APPLIED HYDROGEOLOGY
TEXTURAL CLASSIFICATION TRIANGLE FOR UNCONSOLIDATED MATERIALS SHOWING THE RELATION BETWEEN PARTICAL SIZE AND SPECIFIC YIELD. SOURCE: A.I. JOHNSON, U.S. GEOLOGICAL SURVEY WATER–SUPPLY PAPER 1662–D, 1967.

ID#	BORING	DEPTH (FT)
1	GW–18	16.0 – 17.5

DRAWN: ACE	DATE: 12–03–09	BLE INC. BUNNELL-LAMMONS ENGINEERING, INC. 6004 PONDERS COURT GREENVILLE, SOUTH CAROLINA 29615 PHONE: (864)288–1265 FAX: (864)288–4430	EFFECTIVE POROSITY ESTIMATION EAST CAROLINA REGIONAL MSW LANDFILL BERTIE COUNTY, NORTH CAROLINA	FIGURE
CHECKED: MSP	CAD: ECLF 1001–62 EFF POROS			H-1
APPROVED:	JOB NO: J09–1001–62			

APPENDIX I

Monitoring Well Development Forms

MONITORING WELL DEVELOPMENT LOG

DATE	6/2/09-6/3-09	TOTAL WELL DEPTH (TWD); TOP OF CASING =	29.61 1/100 ft
PERSONNEL	Ivan A. Irizarry	DEPTH TO GROUND WATER (DGW) =	14.96 1/100 ft
SITE	East Carolina MSW Landfill	LENGTH OF WATER COLUMN (LWC) = TWD - DGW =	14.65 1/100 ft
JOB #	J09-1001-62	1 CASING VOLUME (CV) = LWC x 0.17 =	2.5 gallons
WELL ID	GW-18	NUMBER CV REMOVED =	155 CV
		TOTAL VOLUME OF WATER REMOVED =	385 gallons
		METHOD OF WELL DEVELOPMENT =	Surge Block, Pump
		WELL YIELD =	Very High

TIME	ELAPSED DEV. TIME (hrs)	VOLUME PURGED event (gallons)	VOLUME PURGED total (gallons)	SURGE	WATER TEMP (C)	pH (units)	SPECIF. COND. (µmho/cm)	TURBIDITY (NTU)	COLOR (subjective)	PURGING METHOD
1445	0	0	0	-	27.3	4.96	244.0	2000	Brown	Pump
1500	0:15	15	15	-	17.1	4.78	194.8	587	Light Brown	Pump
1510	0:25	15	30	-	18.1	4.70	185.1	686	Brown	Pump
1515	0:30	15	45	Surge	18.9	4.67	197.5	3000	Light Brown	Pump
1525	0:40	15	60	-	17.8	4.52	100.0	651	Brown	Pump
1530	0:45	15	75	Surge	17.2	4.73	100.7	3000	Brown	Pump
1535	0:50	15	90	-	18.4	4.79	172.7	593	Light Brown	Pump
1545	1:00	15	105	-	16.6	4.81	168.1	137	Brown	Pump
1555	1:10	25	130	Surge	17.5	4.89	158.0	1000	Brown	Pump
1600	1:15	15	145	-	17.8	4.78	158.7	140	Brown	Pump
1610	1:25	15	160	-	17.8	4.86	160.8	310	Brown	Pump
1625	1:40	20	180	Surge	18.6	5.00	130	8000	Brown	Pump
1630	1:45	30	210	-	17.8	4.88	156.6	133	Brown	Pump
1645	2:00	30	240	-	17.3	4.68	152.3	128	Light Brown	Pump
Continue Development on 6/3/2009										
1145	2:00	0	240	-	23.0	5.07	180.2	2000	Brown	Pump
1150	2:05	15	255	-	16.2	4.69	164.7	590	Brown	Pump
1155	2:10	15	270	Surge	17.5	4.69	151.8	248	Brown	Pump
1205	2:20	15	285	-	16.4	4.70	162.0	561	Brown	Pump
1215	2:30	25	310	Surge	16.4	4.76	153.9	134	Slight Clear	Pump
1225	2:40	25	335	-	16.7	4.69	151.3	31.6	Light Brown	Pump
1235	2:50	25	360	Surge	17.5	4.71	146.2	131	Slight Clear	Pump
1245	3:00	25	385	-	17.0	4.70	143.0	15.03	Clear	Pump

Notes:

MONITORING WELL DEVELOPMENT DATA SHEET

Golder Associates

Project: Republic Waste--East Carolina
Date: 06/28/06
Casing Type: PVC
Well/Boring Number PZ-110
Casing Diameter in inches (Dr): 2
Screened Interval: 13-28 ft
Riser Elevation: 2.12 ft
Total Well Depth (Lw) in feet: 24 ft
Depth to Water (Lf) in feet: 10.72 ft
Time of Measurement: 8:28

Volume of water in well, using $V=0.041\ (Dr)^2\ (Lw - Lf) =$ 2.18 Gallons

FIELD MEASUREMENT OF PHYSICAL PARAMETERS

	Temp (C)	pH	Conductivity (µS/cm)	Clarity/ Color	Volume (gallons)	Water Level (ft)	Time
Before Development					2.2	10.72	8:28
After Purging							
1 Well Vol	17.74	4.14	593		2.2	10.82	8:33
2 Well Vol	17.38	4.14	342		4.4	10.87	8:38
3 Well Vol	17.37	4.13	351		6.6	10.87	8:44
4 Well Vol	17.38	4.06	343		8.8	10.88	8:50
5 Well Vol	17.46	4.01	361		10	10.88	8:57
6 Well Vol	17.46	4.01	587		12.2	10.88	9:02
7 Well Vol	17.47	4.01	585		14.4	10.88	9:06
8 Well Vol	17.44	4	582		16.6	10.88	9:11
9 Well Vol	17.56	4.11	355		18.8	10.88	9:15
10 Well Vol	17.47	4.2	301		20	10.88	9:19
11 Well Vol	17.53	4.23	278		22.2	10.88	9:24
12 Well Vol	17.51	4.28	262		24.4	10.88	9:27
13 Well Vol	17.53	4.39	245		26.6	10.88	9:30
14 Well Vol	17.41	4.42	260		28.8	10.88	9:35
15 Well Vol	17.44	4.67	224		30	10.88	9:40
16 Well Vol	17.4	4.59	234		32.2	10.88	9:44
17 Well Vol	17.4	4.58	230		34.4	10.88	9:47
18 Well Vol	17.38	4.6	222		36.6	10.88	9:50

(Fill in one or more of the above columns depending on available equipment)

Method of purging (bailer or pump) pump
If pumped, pumping rate: 250 ml/10 sec
Well Purged Dry no
Continuous Recharge yes
Notes concerning condition of well, odors, color, etc.:

Developer's Signature