

Permit No.	Date	DIN
44-07	November 22, 2010	12270

RECEIVED  
November 19, 2010  
Solid Waste Section  
Asheville Regional Office



**NNE A NS ENGINEERING INC**  
GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS

**REPORT OF WELL INSTALLATION  
FOR THE PHASE 3 EXPANSION**

**WHITE OAK LANDFILL  
HAYWOOD COUNTY, NORTH CAROLINA**

**PERMIT NUMBER 44-07**

**PREPARED FOR:**



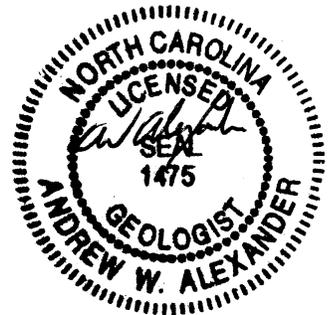
**HAYWOOD COUNTY SOLID WASTE MANAGEMENT DEPARTMENT  
CLYDE, NORTH CAROLINA**

**PREPARED BY:**

**BUNNELL-LAMMONS ENGINEERING, INC.  
GREENVILLE, SOUTH CAROLINA  
ASHEVILLE, NORTH CAROLINA**

**NOVEMBER 12, 2010**

**BLE PROJECT NUMBER J10-1957-17**



November 12, 2010

Haywood County Solid Waste Management  
278 Recycle Road  
Clyde, NC 28721

Attention: Mr. Stephen King  
Director of Solid Waste

**Subject: Report of Well Installation for the Phase 3 Expansion at White Oak Landfill**  
Groundwater Monitoring Wells MW-3r, MW-3Dr, MW-16 & MW-17  
Landfill Gas Monitoring Wells LFG-4r, LFG-7, LFG-8, LFG-9 & LFG-10  
Haywood County, North Carolina  
BLE Project Number J10-1957-17  
Permit Number 44-07

Dear Mr. King:

As authorized by Haywood County's acceptance of our Contract Number P09-0334R4a dated August 2, 2010, Bunnell-Lammons Engineering, Inc. (BLE) has performed required well installation services at the subject site. The purpose of the work was to install the wells as part of the landfill expansion in the Phase 3 area. The enclosed report describes the work performed and documents the well installation as required.

### BACKGROUND INFORMATION

The White Oak Landfill is located in Haywood County, North Carolina (Figure 1). The facility consists of four active, proposed, or closed waste units including:

- 1) MSWLF (Phases 1 & 2),
- 2) MSWLF Expansions (Phases 3 & 4),
- 3) Closed C&D Landfill (Phase 1), and
- 4) a LCID Landfill.

We understand that Haywood County has received a Permit-to-Construct (PTC) new MSW waste unit (Phase 3) from the North Carolina Department of Environment and Natural Resources (NCDENR). The PTC references an approved Environmental Monitoring Plan (EMP) for Phase 3 & 4 which was prepared by BLE [*Environmental Monitoring Plan – Proposed Phase 3 & 4 MSWLF Cell Areas* dated July 11, 2008 (BLE Project No. J07-1957-02)]. Phase 3 construction began in 2009 and as of November 2010 is nearing completion. The Phase 4 unit may be constructed in the future after the required permits are issued.

We understand that the installation of two groundwater monitoring wells designated MW-16 and MW-17 are required as part of the landfill's expansion plans for the Phase 3 area (Figure 2).

Additionally, we understand that three existing groundwater monitoring wells (MW-3, MW-3D and MW-9) were damaged/destroyed during construction and replacements wells must be installed for MW-3 and MW-3D only. We understand that MW-3 and MW-3D replacements are to be renamed MW-3r and MW-3Dr, respectively.

We understand that landfill gas monitoring well LFG-4 was also damaged/destroyed and must be replaced with a well designated LFG-4r. The PTC and other documents also reference new landfill gas monitoring wells which require installation. Those wells are to be designated LFG-7 through LFG-10.

### **SCOPE OF SERVICES PERFORMED**

The required tasks for this assessment were limited to the installation and development of four groundwater monitoring wells and the installation of five landfill gas monitoring wells. The well locations were staked by a North Carolina licensed surveyor retained by Haywood County prior to arrival of our drill crew. We understand that each well location was approved by the North Carolina Division of Waste Management (DWM) as specified in the PTC or designated by McGill Associates (McGill) or by Haywood County. Groundwater monitoring well installations were performed by North Carolina-licensed drillers retained by BLE (North Carolina Registration #3290-A) in general accordance with North Carolina Well Construction Standards Rule 15A NCAC 2C, .0113.

#### **Groundwater Monitoring Well Installation, Development, and Survey**

BLE mobilized a truck-mounted Schramm drill rig to install four monitoring wells (MW-3r, MW-3Dr, MW-16 and MW-17) at the locations shown on Figure 2. The wells were installed via downhole air hammer from September 15-20, 2010. The actual well installation locations and depths were dependent on site conditions and the wells were drilled and installed in general accordance with the approved EMP. The well drilling and installation procedures are included in Appendices A and B. Each well included a surface completion consisting of a 3 by 3 foot by 4-inch thick concrete pad with a lockable well cap and steel stickup cover. North Carolina well construction records (Form GW-1b) are included in Appendix C. Well logs prepared by BLE are included in Appendix D and well construction data are summarized on Table 1. The groundwater levels on Table 1 were measured by Pace Analytical on October 27, 2010 as noted on the table.

BLE provided well development services for each newly installed monitoring well. The monitoring wells were developed to remove fine particles from the sand pack around the well screen. The well development consisted of the following:

1. Place a pump or bailer in the monitoring well;
2. Purge the well; and
3. Intermittently surge the well with a surge block.



Groundwater turbidity was measured periodically during well development using a HF Scientific model DRT-15 Portable Turbidity Meter, or equivalent. Well development logs are included in Appendix E.

The four new groundwater monitoring wells’ location and elevation were surveyed by a North Carolina registered land surveyor provided by McGill under direct contract with Haywood County. The survey data was provided to BLE by McGill and was used to prepare Figure 2 and the well construction summary on Table 1.

**Landfill Gas Monitoring Well Installation and Survey**

BLE mobilized a truck-mounted Schramm drill rig to install five landfill gas monitoring wells (LFG-4r, LFG-7, LFG-8, LFG-9, and LFG-10) at the locations shown on Figure 2. The wells were installed via downhole air hammer from September 14-20, 2010. Landfill gas monitoring wells were installed and constructed in general accordance with the construction diagram titled “Landfill Gas Monitoring Probe – Figure 2” (Appendix F) provided by McGill. The actual well installation locations were dependent on site conditions. Well logs are included in Appendix D and well construction data are summarized on Table 2.

The five new landfill gas monitoring wells’ location and elevation were surveyed by a North Carolina registered land surveyor provided by McGill under direct contract with Haywood County. The survey data was provided to BLE by McGill and was used to prepare Figure 2 and the well construction summary on Table 2.

**CLOSING**

We appreciate the opportunity to serve as your environmental consultant on this project. Please contact us at (864) 288-1265 if you have any questions or comments regarding this report.

Sincerely,  
**BUNNELL-LAMMONS ENGINEERING, INC.**

  
Benjamin P. Nisbeth, P.G.  
Staff Geologist  
Registered, North Carolina #2134

  
Andrew W. Alexander, P.G.  
Senior Hydrogeologist  
Registered, North Carolina #1475

Attachments:      Tables  
                             Figures  
                             Appendices

cc:            Mr. Jeff Bishop – McGill Associates

*c:\awa\active projects\mcgill\haywood county lf\1957-17 wolf phase 3 well install & emp 2010\wolf well install report\white oak landfill well install 1957-17 final.doc*

## **TABLES**

**Table 1**  
**Groundwater Monitoring Well Construction and Groundwater Elevation Data**  
**White Oak Landfill**  
**Haywood County, North Carolina**  
**Permit Number 44-07**  
**BLE Project No. J10-1957-17**

October 27, 2010														
Well	Northing (feet)	Easting (feet)	Meas. Pt. Elevation	Gnd. Surface Elevation	*Depth to Water (bgs)	Depth to Water (bmp)	Water Elevation	Total Borehole Depth (bgs)	Screen Depth (bgs)	Screen Elevation	Well Type	Well Monitors	Top of Rock Depth (bgs)	Top of Rock Elev.
MW-1A	721,096.30	812,481.47	2,520.02	2,517.97	18.29	20.34	2499.68	UK	10.4 - 25.4	2507.6 - 2492.6	UK	Deep Residuum	UK	UK
MW-2	721,460.76	812,309.44	2,496.71	2,494.43	28.78	31.06	2465.65	UK	19.9 - 34.9	2474.5 - 2459.5	UK	Deep Residuum/PWR	UK	UK
MW-2D	721,456.01	812,311.87	2,496.89	2,494.69	28.85	31.05	2465.84	UK	44.6 - 54.6	2450.1 - 2440.1	UK	Bedrock	36.9	2457.8
MW-3r	721,943.38	812,063.70	2,462.61	2,459.53	31.58	34.66	2427.95	41.5	26.3 - 41.3	2433.2 - 2418.2	II	Deep Residuum	NE	NE
MW-3Dr	721,940.67	812,082.82	2,461.89	2,458.42	34.65	38.12	2423.77	65.0	49.8 - 64.8	2408.6 - 2393.6	IIIs	Bedrock	44.0	2414.4
MW-4A	721,693.04	811,976.64	2,493.85	2,491.60	44.13	46.38	2447.47	UK	80.6 - 95.6	2411.0 - 2396.0	UK	Bedrock	23.3	2468.3
MW-8	721,704.50	812,155.03	2,477.33	2,474.84	29.05	31.54	2445.79	UK	31.0 - 41.0	2443.8 - 2433.8	UK	Deep Residuum	UK	UK
MW-11S	719,905.88	811,642.89	2,674.58	UK	UK	83.06	2591.52	UK	UK - UK	UK - UK	UK	UK	UK	UK
MW-11D	719,909.34	811,651.55	2,674.89	2,672.01	80.26	83.14	2591.75	UK	118.0 - 127.6	2554.0 - 2544.4	UK	Bedrock	97.0	2575.0
MW-14	UK	UK	2,711.69	UK	UK	102.95	2608.74	UK	UK - UK	UK - UK	UK	UK	UK	UK
MW-15	UK	UK	2,547.41	UK	UK	9.80	2537.61	UK	UK - UK	UK - UK	UK	UK	UK	UK
MW-16	721,821.98	811,660.70	2,519.35	2,516.07	33.22	36.50	2482.85	41.0	25.8 - 40.8	2490.3 - 2475.3	II	Fill / Residuum	40.0	2476.1
MW-17	721,783.47	811,219.93	2,542.55	2,539.13	53.63	57.05	2485.50	63.0	43.0 - 58.0	2496.1 - 2481.1	II	Bedrock	40.0	2499.1

**Notes:**

All survey data provided by McGill Associates, all units in feet. Data for MW-14 & MW-15 sourced from historical Municipal Engineering reports.

\*DTW from bgs values have been calculated from survey data provided by McGill Associates.

All values shown to the nearest 0.1-ft have been rounded.

Water levels were measured on 10/27/10 by Pace Analytical.

MW-4A was lowered 4.59 feet by Haywood County. All bgs referenced depths for MW-4A have been adjusted accordingly on this table.

Measuring Point Elevation is top of casing.

II = Type II well

IIIs = Type III screened well

NE = Not encountered

UK = Unknown, information is not available

**Table 2**  
**Landfill Gas Monitoring Well Construction Data**  
**White Oak Landfill**  
**Haywood County, North Carolina**  
**Permit Number 44-07**  
**BLE Project No. J10-1957-17**

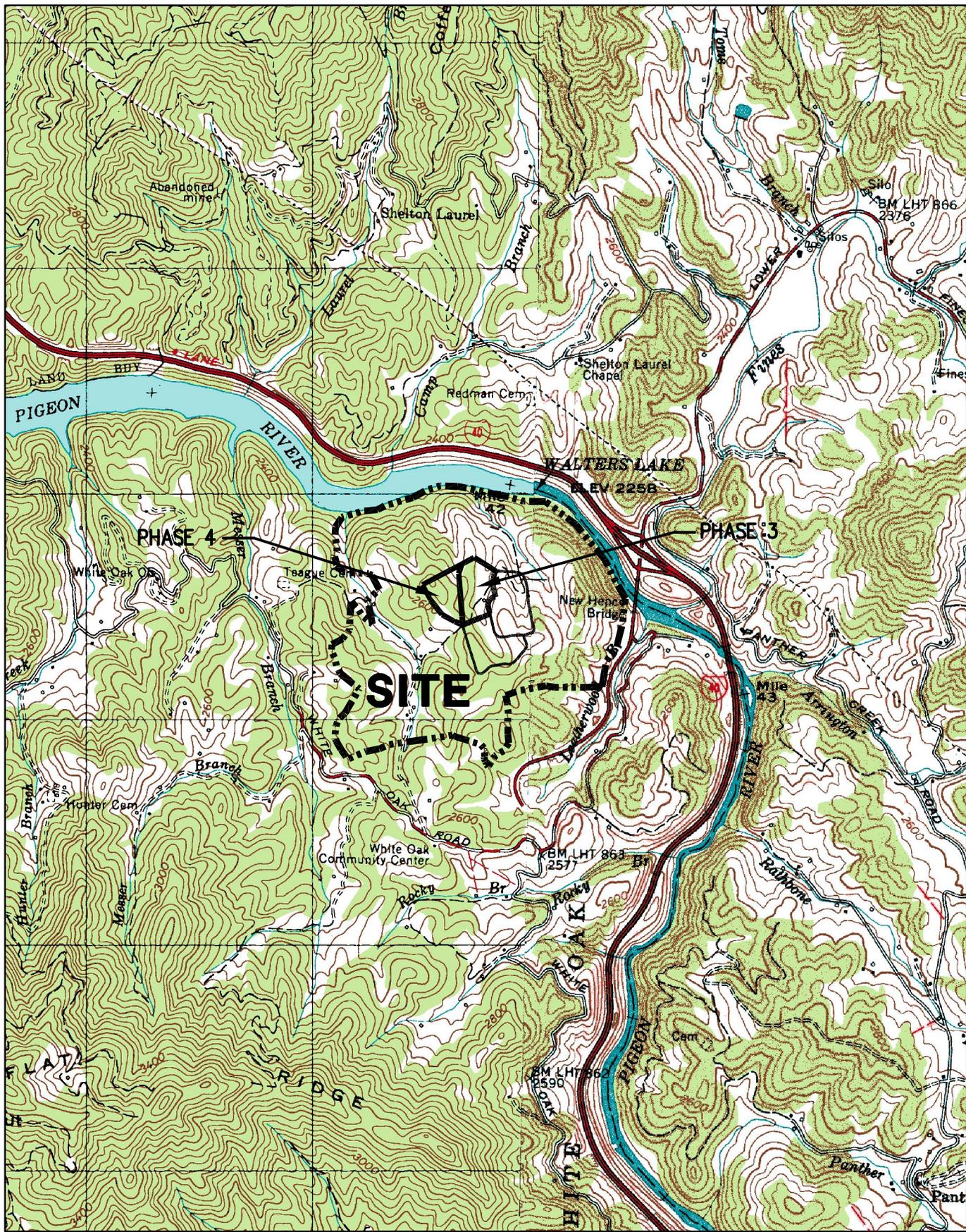
<b>Well</b>	<b>Northing (feet)</b>	<b>Easting (feet)</b>	<b>Meas. Pt. Elevation</b>	<b>Gnd. Surface Elevation</b>	<b>Total Borehole Depth (bgs)</b>	<b>Perf. Pipe Depth (bgs)</b>	<b>Perf. Pipe Elevation</b>
LFG-1	721,397.45	812,396.57	2,497.63	2,495.07	UK	UK - UK	UK - UK
LFG-2	721,618.88	812,271.02	2,480.98	2,478.83	UK	UK - UK	UK - UK
LFG-4r	721,946.20	812,056.65	2,462.44	2,459.33	6.0	4.5 - 5.5	2454.8 - 2453.8
LFG-7	722,087.04	811,784.52	2,465.71	2,462.35	6.0	4.5 - 5.5	2457.9 - 2456.9
LFG-8	722,043.59	811,358.63	2,526.91	2,523.75	6.0	4.5 - 5.5	2519.3 - 2518.3
LFG-9	721,908.00	810,663.65	2,569.28	2,566.09	6.0	4.5 - 5.5	2561.6 - 2560.6
LFG-10	721,504.35	810,573.11	2,616.30	2,613.12	6.0	4.5 - 5.5	2608.6 - 2607.6

Notes:

All survey data provided by McGill Associates, all units in feet.  
All values shown to the nearest 0.1-ft have been rounded.

UK = Unknown, information is not available.  
Measuring Point Elevation is top of casing.

## **FIGURES**



REFERENCE:  
 USGS TOPOGRAPHIC MAP, 7.5 MINUTE SERIES,  
 COVE CREEK GAP AND FINES CREEK, N.C. QUADRANGLES, 1967.

DRAWN:	ACE	DATE:	06-20-10
CHECKED:	TJB	CAD:	WHITEOAK17-SLM
APPROVED:		JOB NO:	J10-1957-17

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

SITE LOCATION MAP  
 WHITE OAK LANDFILL  
 HAYWOOD COUNTY, NORTH CAROLINA

FIGURE

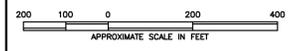
**1**



- LEGEND**
- EXISTING GROUNDWATER MONITORING WELL
  - ⊗ EXISTING LANDFILL GAS MONITORING WELL
  - SURFACE WATER SAMPLING LOCATION
  - PROPOSED SURFACE WATER SAMPLING LOCATION FOR PHASE 4
  - △ PROPOSED GROUNDWATER MONITORING WELL LOCATION FOR PHASE 4
  - 2465.65 GROUNDWATER ELEVATION (IN FEET)
  - (2591.75) GROUNDWATER ELEVATION IN A DEEP ZONE (IN FEET)
  - 2560** GROUNDWATER ELEVATION CONTOUR CONTOUR INTERVAL = 20 FEET
  - GROUNDWATER FLOW DIRECTION
  - FENCE
  - SURFACE WATER
  - - - PHASE BOUNDARY OR WASTE UNITS
  - · - · - PROPERTY LINE

NOTE:  
WELLS IN DEEP ZONE NOT USED FOR CONTOURING PURPOSES.

REFERENCES:  
DRAWING TITLED "ENVIRONMENTAL MONITORING PLAN AS-BUILT INFORMATION" (OCTOBER 2010) PROVIDED BY MCGILL ASSOCIATES.  
LOCATION OF AND SURVEY DATA FOR MW-14 AND MW-15 SOURCED FROM HISTORICAL REPORTS BY MUNICIPAL ENGINEERING.



REVISIONS		BY
No.	DESCRIPTION	

DRAWN: ACE	DATE: 10-19-10
CHECKED: AWA	CAD FILE: HCWOLF17-WM102710
APPROVED: MSP	JOB NO: J10-1957-17



**BUNNELL-LAMMONS ENGINEERING, INC.**  
6004 POWERS COURT  
GREENVILLE, SOUTH CAROLINA 29615  
PHONE: 864-659-2968 FAX: 864-659-4450

GROUNDWATER ELEVATION CONTOUR MAP - OCTOBER 27, 2010  
WHITE OAK LANDFILL  
HAYWOOD COUNTY, NORTH CAROLINA

## **APPENDICES**

## **APPENDIX A**

### **DRILLING PROCEDURES**

#### **Air Hammer Drilling**

Air drilled borings were advanced through unconsolidated and consolidated materials using a downhole air hammer and compressed air to remove the soil and rock cuttings. The pneumatic drill hammer rapidly strikes the soil or rock while the drill pipe is slowly rotated. The drill hammers are typically constructed of alloy steel with tungsten-carbide inserts that provide the chipping or cutting surfaces. An in-line air filter is attached to the air compressor on the rig to remove oil from the air and to prevent oil contamination in the borehole.

Representative portions of the soil samples were placed in glass jars or plastic bags. The samples were examined by a geologist to verify the technician's and/or driller's field classifications and Soil Boring Records were prepared. Soil borings were advanced to their required termination depths for monitoring well installation.

#### **General**

To help prevent cross-contamination between borings, all downhole drilling equipment was steam cleaned prior to drilling each boring.

## **APPENDIX B**

### **WELL INSTALLATION PROCEDURES**

#### **Type II Monitoring Well**

Type II groundwater monitoring wells consist of 2-inch Schedule 40 polyvinyl chloride (PVC) casing with flush-threaded joints installed in the borehole. The bottom section of each well consists of a manufactured well screen with 0.01-inch wide machined slots. The well screen was installed to the approximate termination depth of the borehole.

#### **Type III Monitoring Well**

In the Type III groundwater monitoring well installation, a 10-inch nominal diameter boring was advanced through the overburden soils using air rotary techniques to the depth of the bedrock surface. A 6-inch diameter PVC casing was installed to the termination depth of the borehole into the bedrock. The annular space between the hole and the 6-inch casing was tremie grouted with a cement grout mixture to near ground surface. The grout was allowed to set-up and cure for 24 hours. After the grout cured, the boring was advanced into the underlying bedrock using air-hammer procedures described in Appendix A. A monitoring well was installed, constructed of 2-inch PVC Schedule 40 casing with flush-threaded joints and a manufactured well screen with 0.01-inch wide machined slots. The well screen length was determined by the site geologist.

#### **General**

In the Type II and Type III wells, a washed sand filter pack was emplaced around the outside of the pipe from the bottom of the well casing to from three to five feet above the top of the well screen. The sand filter pack was used to stabilize the formation and to help yield a less turbid groundwater sample.

A two-foot thick (minimum) bentonite seal was installed on top of the sand filter pack to seal the monitoring well at the desired level. The well annulus was then grouted to the surface with a cement grout mixture. A lockable PVC cap and a protective steel cover was placed over each well.

**APPENDIX C**

**NCDWQ WELL CONSTRUCTION RECORD GW-1B FORMS  
FOR GROUNDWATER MONITORING WELLS**





# NON RESIDENTIAL WELL CONSTRUCTION RECORD

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

WELL CONTRACTOR CERTIFICATION # 3290-A

**1. WELL CONTRACTOR:**

Brunson L. (Marty) King  
Well Contractor (Individual) Name  
Landprobe, LLC  
Well Contractor Company Name  
6004 Ponders Court  
Street Address  
Greenville SC 29615  
City or Town State Zip Code  
(864) 527-9324  
Area code Phone number

**2. WELL INFORMATION:**

WELL CONSTRUCTION PERMIT# \_\_\_\_\_  
OTHER ASSOCIATED PERMIT#(if applicable) \_\_\_\_\_  
SITE WELL ID #(if applicable) MW-3Dr

**3. WELL USE (Check One Box) Monitoring**  Municipal/Public

Industrial/Commercial  Agricultural  Recovery  Injection   
Irrigation  Other  (list use) \_\_\_\_\_  
DATE DRILLED 9/17/2010

**4. WELL LOCATION:**

White Oak Landfill  
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)  
CITY: Waynesville COUNTY Havwood  
TOPOGRAPHIC / LAND SETTING: (check appropriate box)  
 Slope  Valley  Flat  Ridge  Other \_\_\_\_\_  
LATITUDE 35 ° 40.07 ' DM  OR \_\_\_\_\_ DD  
LONGITUDE 83 ° 00.03 ' DM  OR \_\_\_\_\_ DD  
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 (Name of the business where the well is located.)**

White Oak Landfill 44-07  
Facility Name Facility ID# (if applicable)  
3898 Fines Creek Road  
Street Address  
Waynesville NC 28785  
City or Town State Zip Code  
Mr. Stephen King  
Contact Name  
278 Recycle Road  
Mailing Address  
Clvde NC 28721  
City or Town State Zip Code  
(828) 627-8042  
Area code Phone number

**6. WELL DETAILS:**

a. TOTAL DEPTH: 65.0 feet  
b. DOES WELL REPLACE EXISTING WELL? YES  NO   
c. WATER LEVEL Below Top of Casing: 38.12 FT.  
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 3.47 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): n/a METHOD OF TEST n/a

f. DISINFECTION: Type n/a Amount \_\_\_\_\_

g. WATER ZONES (depth):  
Top \_\_\_\_\_ Bottom \_\_\_\_\_ Top \_\_\_\_\_ Bottom \_\_\_\_\_  
Top \_\_\_\_\_ Bottom \_\_\_\_\_ Top \_\_\_\_\_ Bottom \_\_\_\_\_  
Top \_\_\_\_\_ Bottom \_\_\_\_\_ Top \_\_\_\_\_ Bottom \_\_\_\_\_

7. CASING:		Depth	Diameter	Thickness/Weight	Material
Top	Bottom	<u>0.0</u>	<u>49.8</u> Ft.	<u>2"</u> <u>Sch 40</u>	<u>PVC</u>
Top	Bottom	<u>0.0</u>	<u>46.0</u> Ft.	<u>6"</u> <u>Sch 40</u>	<u>PVC</u>
Top	Bottom	_____	_____ Ft.	_____	_____

8. GROUT:		Depth	Material	Method
Top	Bottom	<u>45.2</u>	<u>0.0</u> Ft.	<u>Cement</u> <u>Tremie</u>
Top	Bottom	_____	_____ Ft.	_____
Top	Bottom	_____	_____ Ft.	_____

9. SCREEN:		Depth	Diameter	Slot Size	Material
Top	Bottom	<u>49.8</u>	<u>64.8</u> Ft.	<u>2"</u> in. <u>0.010</u> in.	<u>PVC</u>
Top	Bottom	_____	_____ Ft.	_____ in.	_____
Top	Bottom	_____	_____ Ft.	_____ in.	_____

10. SAND/GRAVEL PACK:		Depth	Size	Material
Top	Bottom	<u>65.0</u>	<u>47.7</u> Ft.	<u>#2</u> <u>Sand</u>
Top	Bottom	_____	_____ Ft.	_____
Top	Bottom	_____	_____ Ft.	_____

11. DRILLING LOG		Formation Description
Top	Bottom	
_____	_____	<u>SEE BLE WELL LOG</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

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.

Marty King 9/28/10  
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Brunson L. (Marty) King  
PRINTED NAME OF PERSON CONSTRUCTING THE WELL





**APPENDIX D**

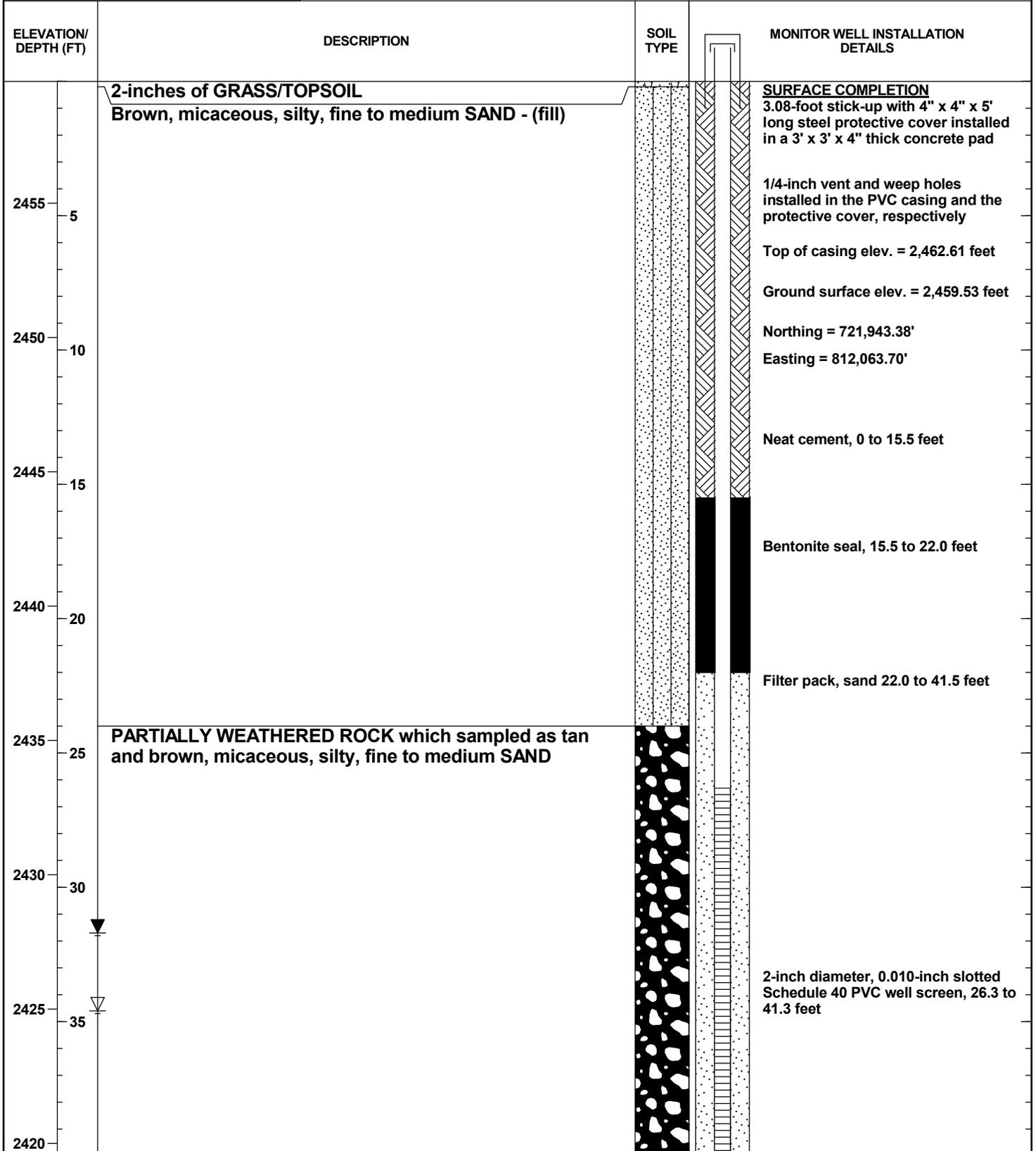
**WELL CONSTRUCTION AND BORING LOGS**



# GROUNDWATER MONITORING WELL NO. MW-3r

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Haywood County White Oak MSW Landfill PROJECT NO.: J10-1957-17  
 CLIENT: Haywood County START: 9-15-10 END: 9-20-10  
 LOCATION: Haywood County, North Carolina ELEVATION: 2459.53  
 DRILLER: Landprobe, M. King LOGGED BY: B. Nisbeth  
 DRILLING METHOD: Schramm T450WS; 6-inch diameter air rotary hammer  
 DEPTH TO - WATER> INITIAL:  $\nabla$  34.60 AFTER 22 HOURS:  $\nabla$  31.70 CAVING:  $\otimes$





# GROUNDWATER MONITORING WELL NO. MW-3r

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Haywood County White Oak MSW Landfill PROJECT NO.: J10-1957-17  
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 DRILLING METHOD: Schramm T450WS; 6-inch diameter air rotary hammer  
 DEPTH TO - WATER> INITIAL: ▽ 34.60 AFTER 22 HOURS: ▽ 31.70 CAVING> ▣

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	MONITOR WELL INSTALLATION DETAILS
2415 45  2410 50  2405 55  2400 60  2395 65  2390 70  2385 75  2380	<p>Tan and brown, micaceous, silty, fine to medium SAND (partially weathered rock) with layers of soil - (residuum)</p> <p>Boring terminated at 41.5 feet. Groundwater encountered at 34.60 feet at time of drilling and at 31.70 feet after 22 hours.</p>		<p>Pipe cap</p> <p>Total well depth, 41.5 feet</p>

GEOI\_WELLNB\_1957-17.GPJ 11/3/10



# GROUNDWATER MONITORING WELL NO. MW-3Dr

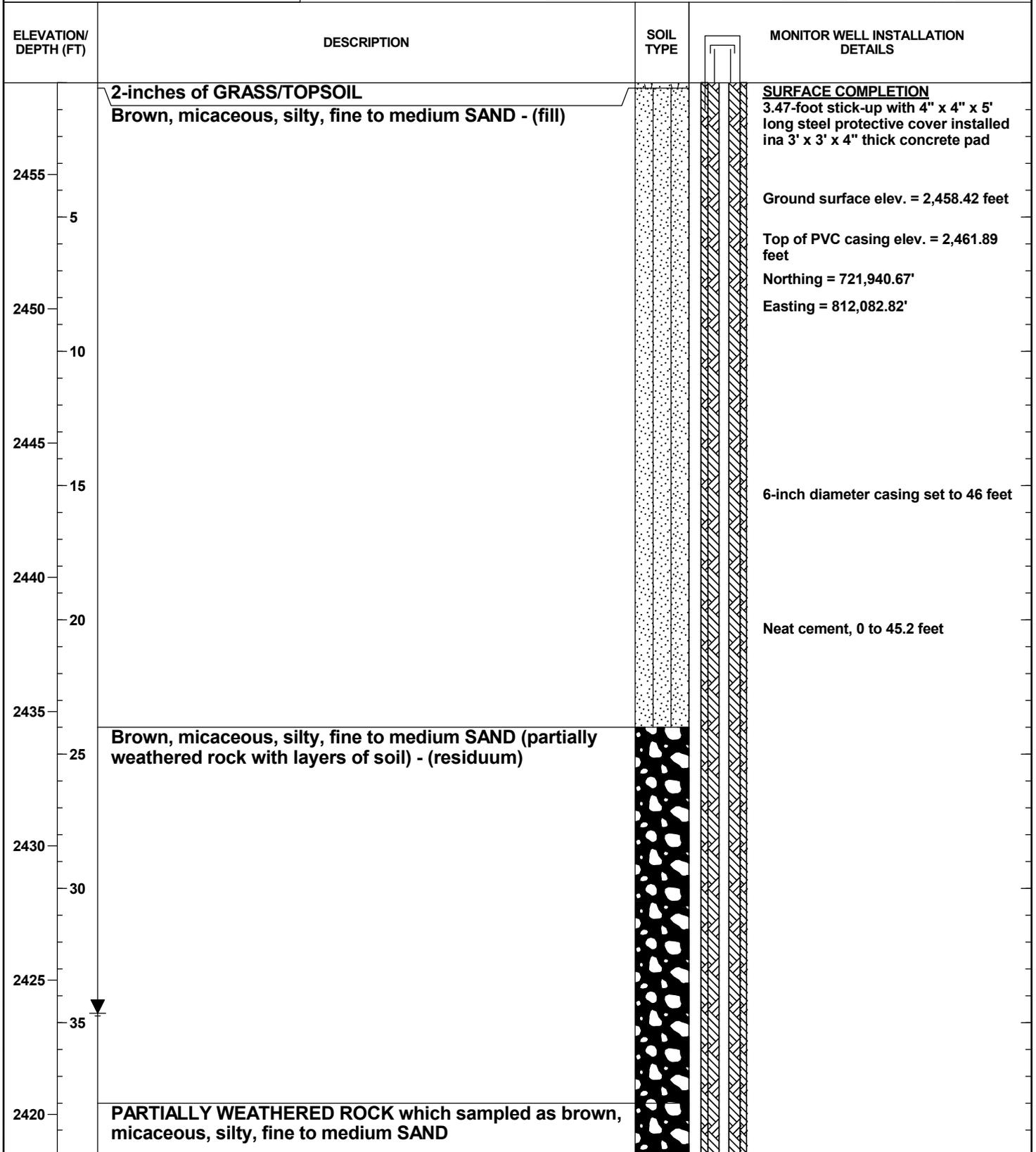
**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Haywood County White Oak MSW Landfill  
CLIENT: Haywood County  
LOCATION: Haywood County, North Carolina  
DRILLER: Landprobe, M. King

PROJECT NO.: J10-1957-17  
START: 9-17-10 END: 9-20-10  
ELEVATION: 2458.42  
LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch and 10-inch diameter air rotary hammer

DEPTH TO - WATER> INITIAL:  $\nabla$  43.20 AFTER 24 HOURS:  $\nabla$  34.65 CAVING>

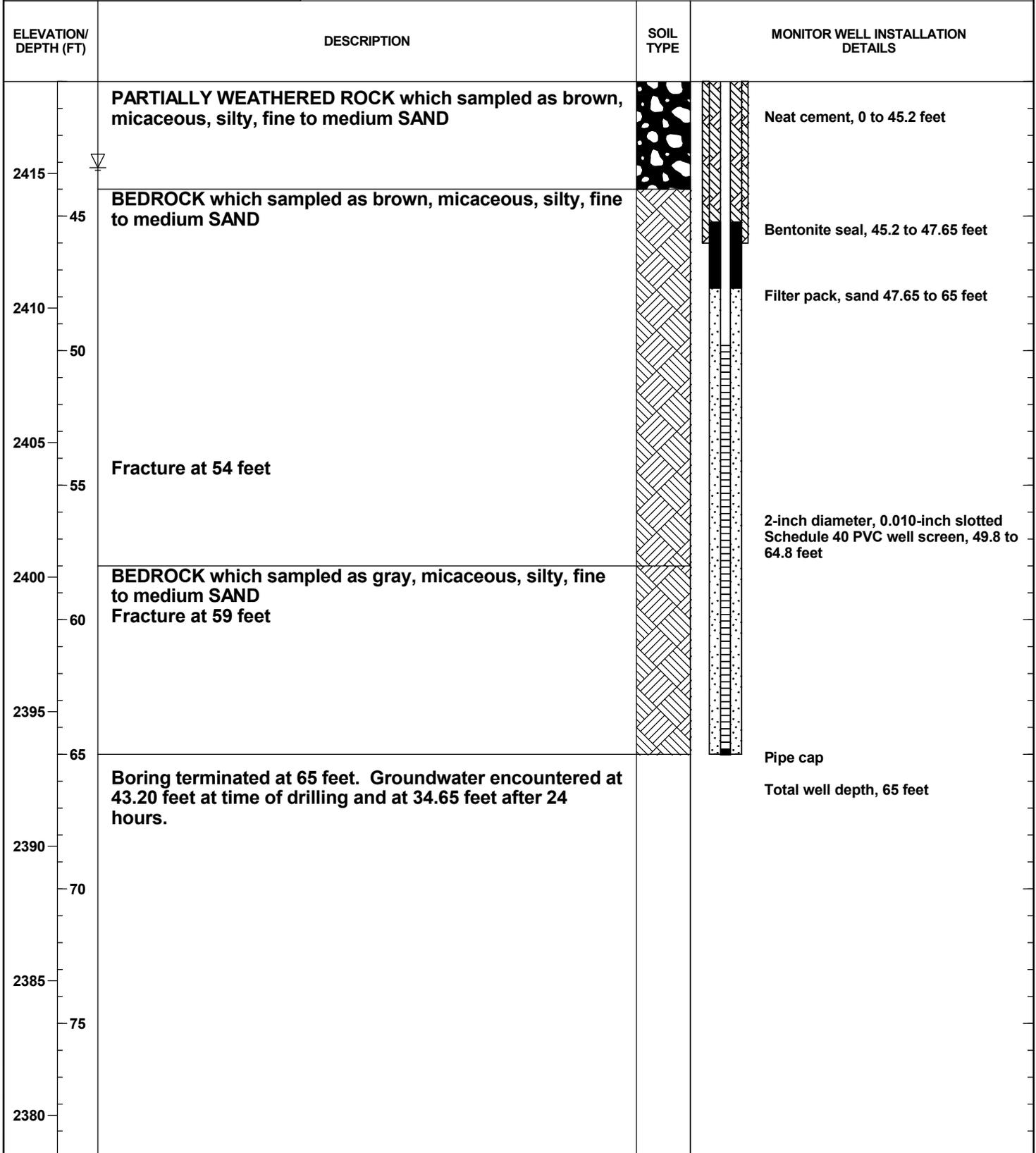




# GROUNDWATER MONITORING WELL NO. MW-3Dr

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Haywood County White Oak MSW Landfill PROJECT NO.: J10-1957-17  
 CLIENT: Haywood County START: 9-17-10 END: 9-20-10  
 LOCATION: Haywood County, North Carolina ELEVATION: 2458.42  
 DRILLER: Landprobe, M. King LOGGED BY: B. Nisbeth  
 DRILLING METHOD: Schramm T450WS; 6-inch and 10-inch diameter air rotary hammer  
 DEPTH TO - WATER> INITIAL: ▽ 43.20 AFTER 24 HOURS: ▽ 34.65 CAVING> ▨



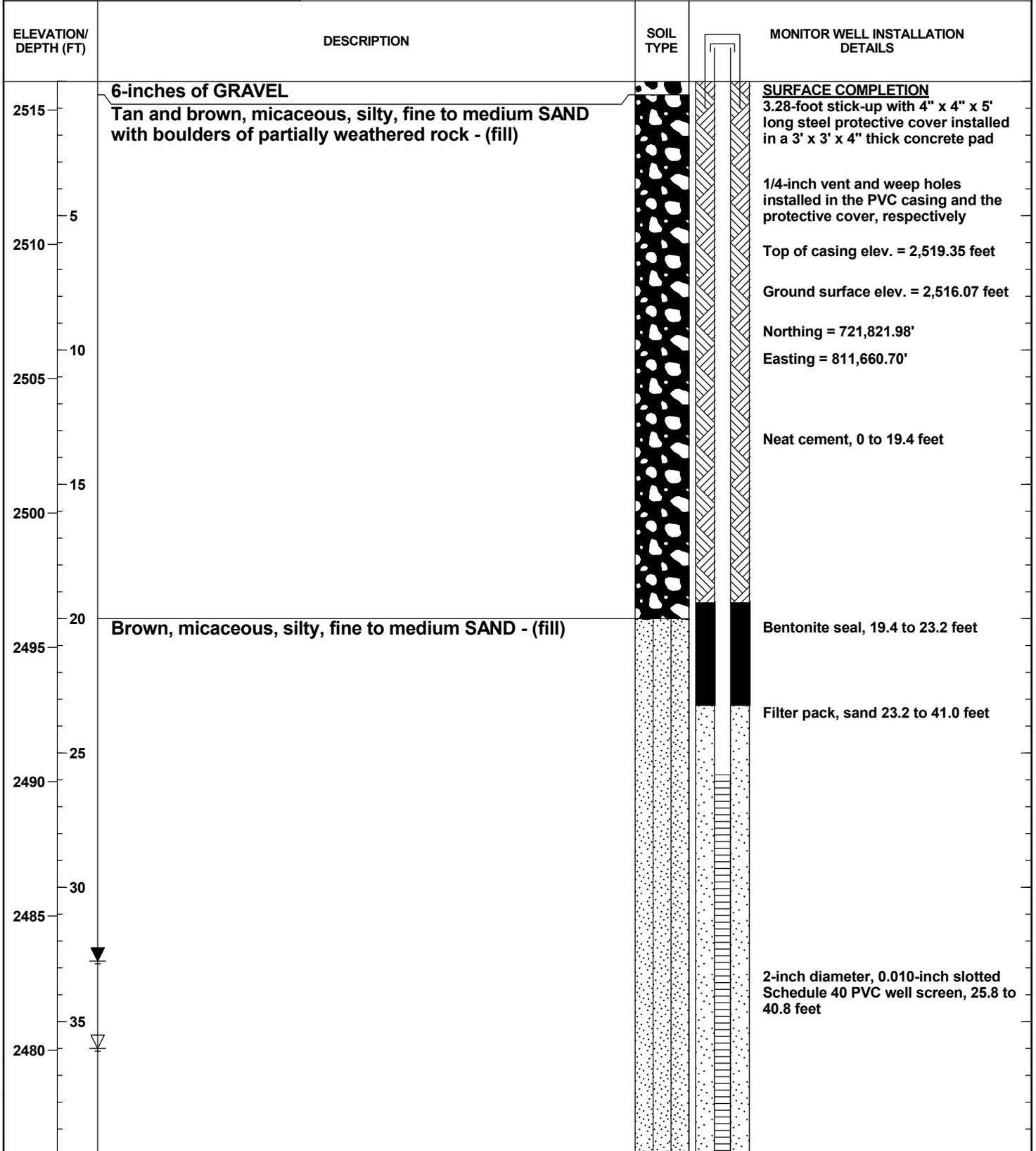
GEOI\_WELLNB\_1957-17.GPJ 11/9/10



# GROUNDWATER MONITORING WELL NO. MW-16

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Haywood County White Oak MSW Landfill PROJECT NO.: J10-1957-17  
 CLIENT: Haywood County START: 9-15-10 END: 9-20-10  
 LOCATION: Haywood County, North Carolina ELEVATION: 2516.07  
 DRILLER: Landprobe, M. King LOGGED BY: B. Nisbeth  
 DRILLING METHOD: Schramm T450WS; 6-inch diameter air rotary hammer  
 DEPTH TO - WATER> INITIAL: ▽ 36.0 AFTER 18 HOURS: ▽ 32.75 CAVING> ▨



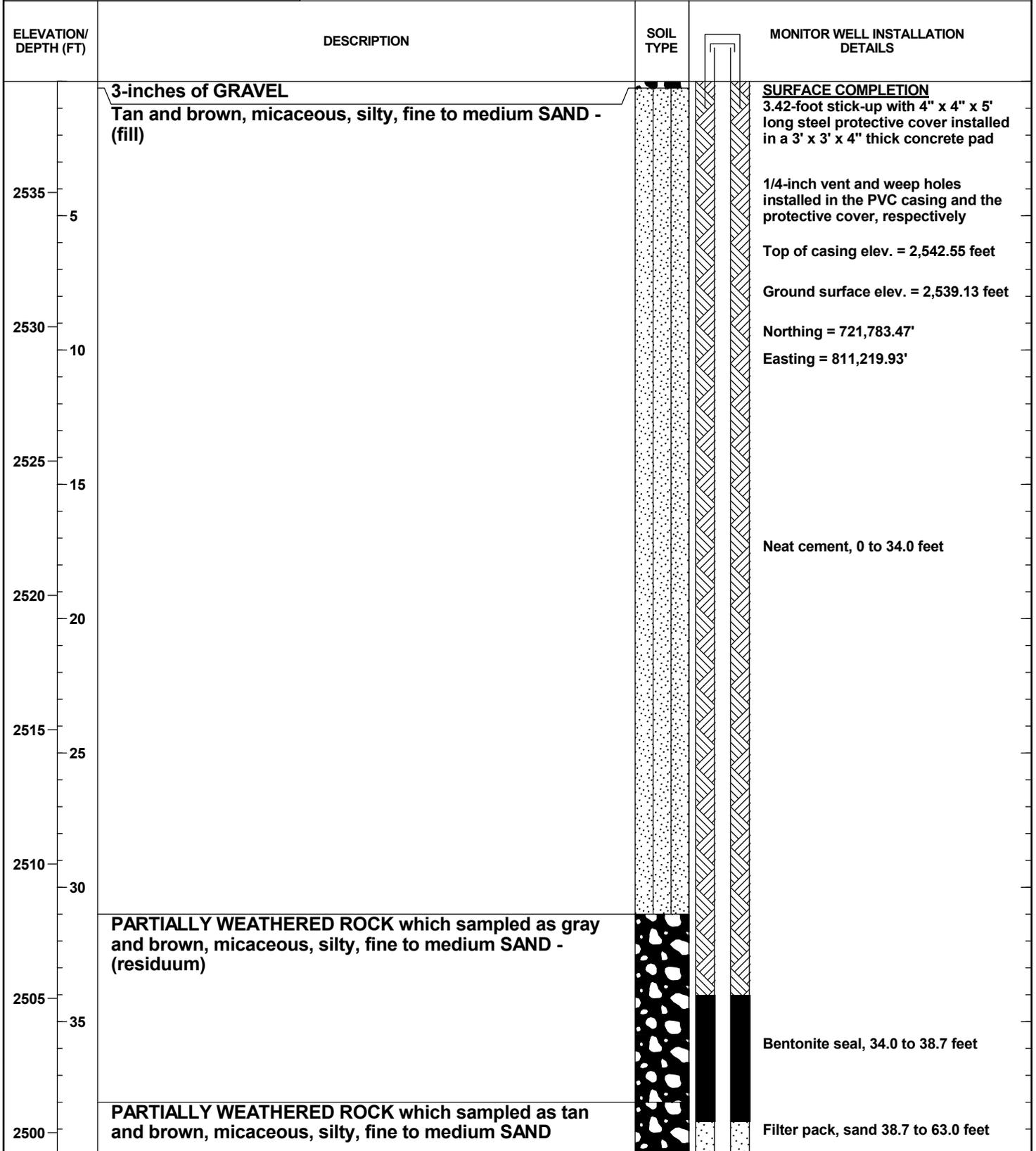




# GROUNDWATER MONITORING WELL NO. MW-17

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Haywood County White Oak MSW Landfill PROJECT NO.: J10-1957-17  
 CLIENT: Haywood County START: 9-15-10 END: 9-20-10  
 LOCATION: Haywood County, North Carolina ELEVATION: 2539.13  
 DRILLER: Landprobe, M. King LOGGED BY: B. Nisbeth  
 DRILLING METHOD: Schramm T450WS; 6-inch diameter air rotary hammer  
 DEPTH TO - WATER> INITIAL: ▽ 60.0 AFTER 23 HOURS: ▽ 48.65 CAVING> ▣

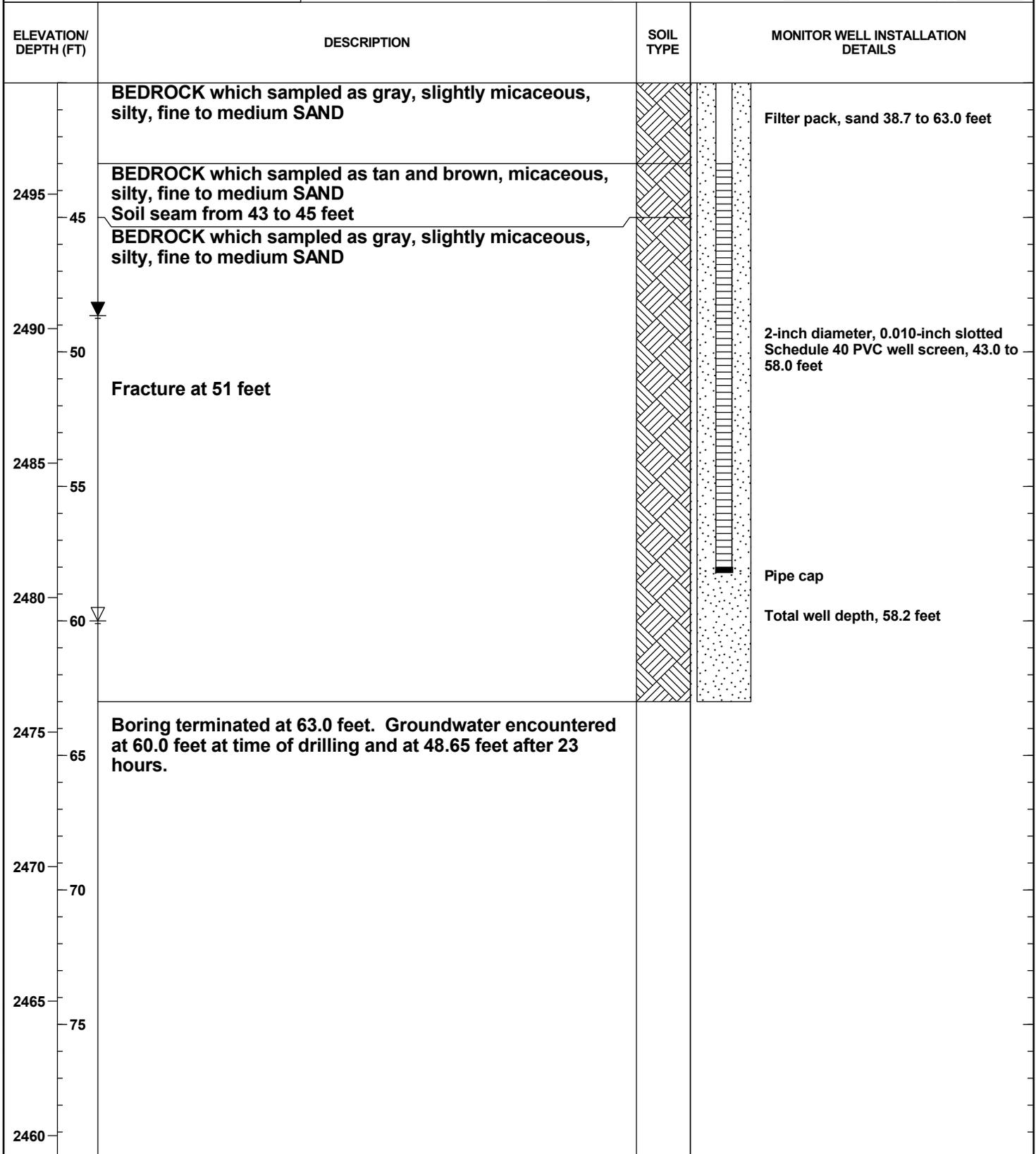




# GROUNDWATER MONITORING WELL NO. MW-17

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Haywood County White Oak MSW Landfill PROJECT NO.: J10-1957-17  
 CLIENT: Haywood County START: 9-15-10 END: 9-20-10  
 LOCATION: Haywood County, North Carolina ELEVATION: 2539.13  
 DRILLER: Landprobe, M. King LOGGED BY: B. Nisbeth  
 DRILLING METHOD: Schramm T450WS; 6-inch diameter air rotary hammer  
 DEPTH TO - WATER> INITIAL: ▽ 60.0 AFTER 23 HOURS: ▽ 48.65 CAVING> ▨

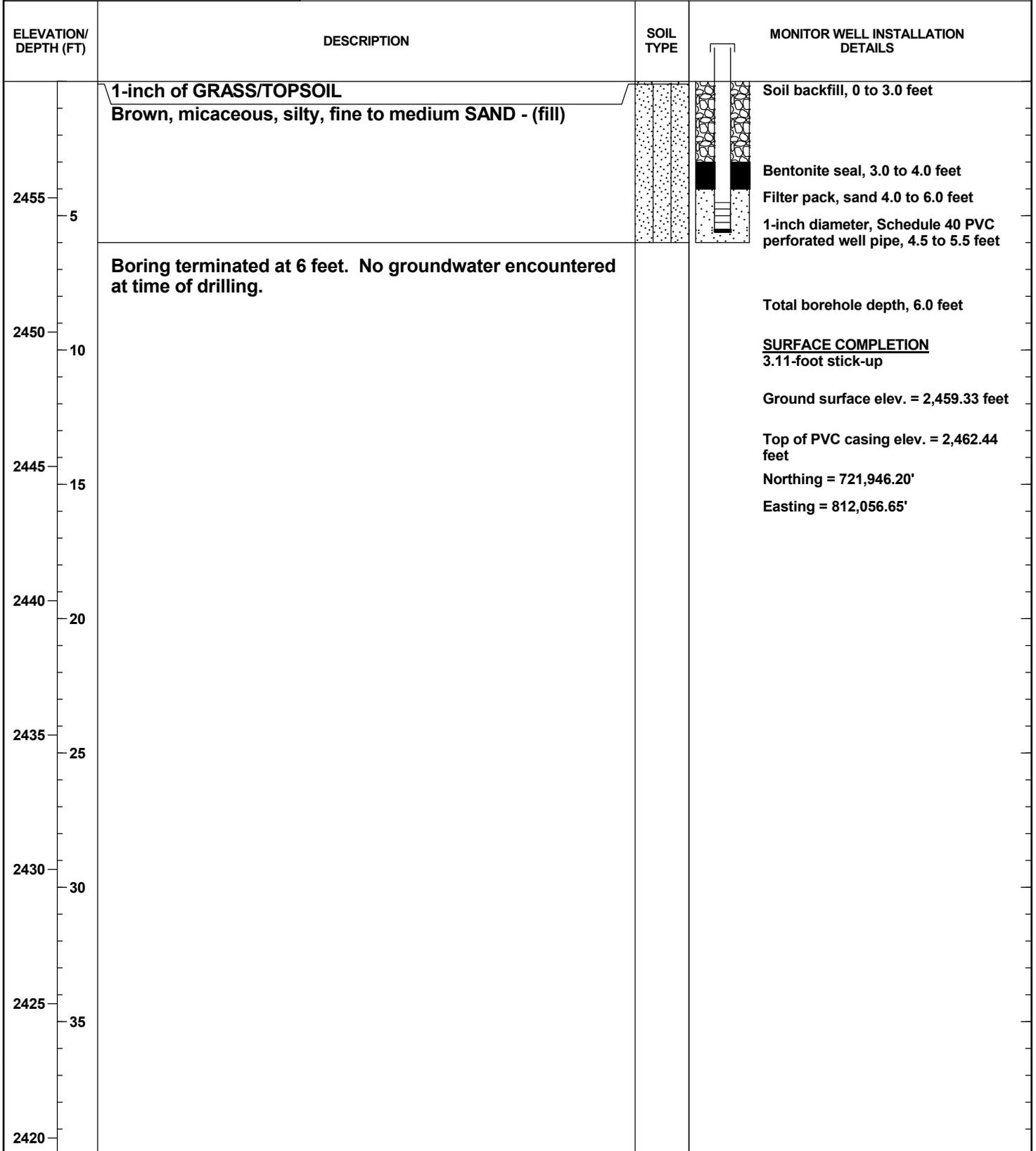




# METHANE MONITORING WELL NO. LFG-4r

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Haywood County White Oak MSW Landfill PROJECT NO.: J10-1957-17  
 CLIENT: Haywood County START: 9-14-10 END: 9-16-10  
 LOCATION: Haywood County, North Carolina ELEVATION: 2459.33  
 DRILLER: Landprobe, M. King LOGGED BY: B. Nisbeth  
 DRILLING METHOD: Schramm T450WS; 6-inch diameter air rotary hammer  
 DEPTH TO - WATER> INITIAL: AFTER 24 HOURS: CAVING>



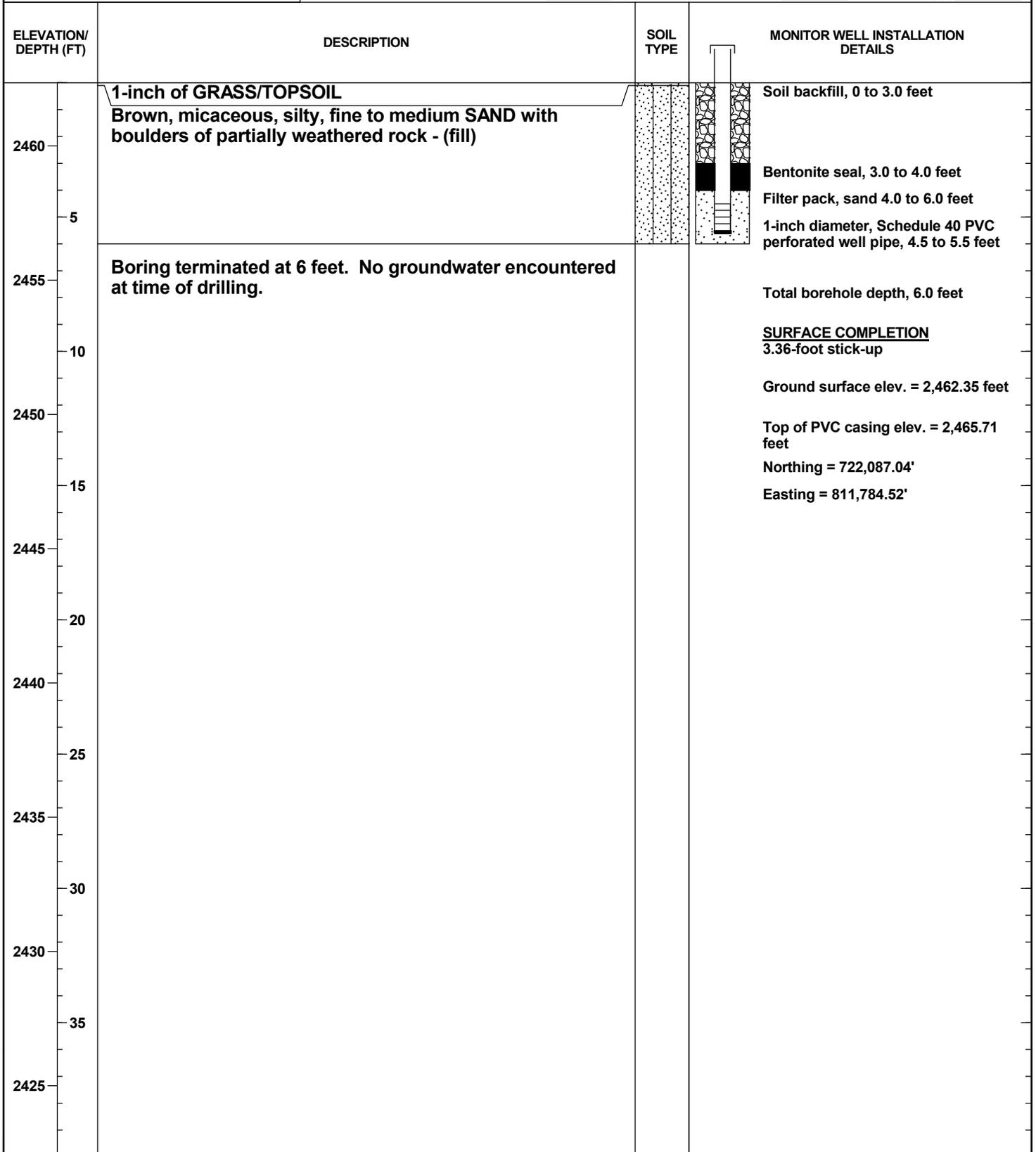
GEOI\_WELLNB\_1957-17.GPJ 11/4/10



# METHANE MONITORING WELL NO. LFG-7

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Haywood County White Oak MSW Landfill PROJECT NO.: J10-1957-17  
 CLIENT: Haywood County START: 9-14-10 END: 9-16-10  
 LOCATION: Haywood County, North Carolina ELEVATION: 2462.35  
 DRILLER: Landprobe, M. King LOGGED BY: B. Nisbeth  
 DRILLING METHOD: Schramm T450WS; 6-inch diameter air rotary hammer  
 DEPTH TO - WATER> INITIAL: AFTER 24 HOURS: CAVING>

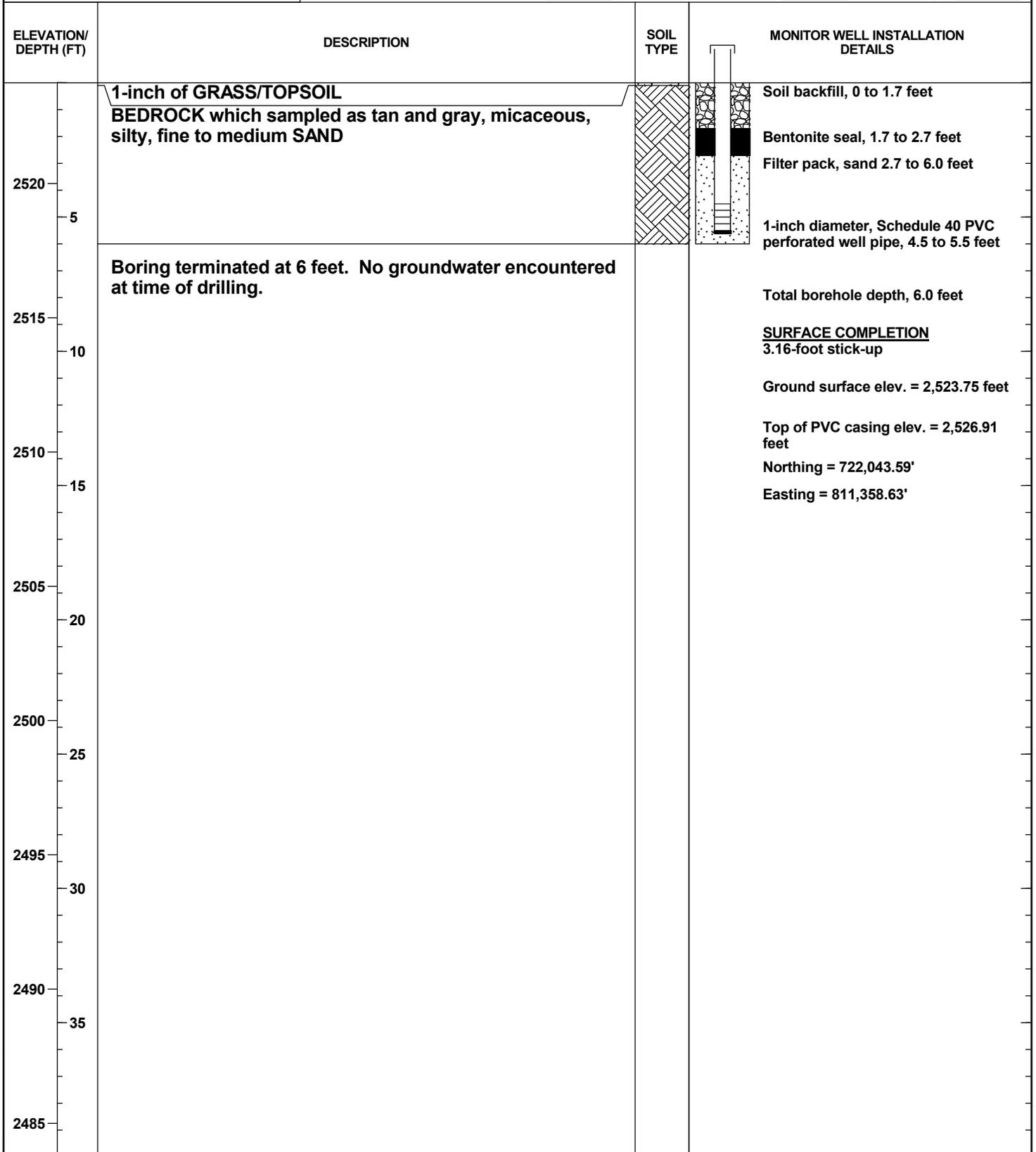




# METHANE MONITORING WELL NO. LFG-8

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Haywood County White Oak MSW Landfill PROJECT NO.: J10-1957-17  
 CLIENT: Haywood County START: 9-14-10 END: 9-16-10  
 LOCATION: Haywood County, North Carolina ELEVATION: 2523.75  
 DRILLER: Landprobe, M. King LOGGED BY: B. Nisbeth  
 DRILLING METHOD: Schramm T450WS; 6-inch diameter air rotary hammer  
 DEPTH TO - WATER> INITIAL: AFTER 24 HOURS: CAVING>



GEOI\_WELLNB\_1957-17.GPJ 11/4/10



# METHANE MONITORING WELL NO. LFG-9

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Haywood County White Oak MSW Landfill PROJECT NO.: J10-1957-17  
 CLIENT: Haywood County START: 9-15-10 END: 9-20-10  
 LOCATION: Haywood County, North Carolina ELEVATION: 2566.09  
 DRILLER: Landprobe, M. King LOGGED BY: B. Nisbeth  
 DRILLING METHOD: Schramm T450WS; 6-inch diameter air rotary hammer  
 DEPTH TO - WATER> INITIAL: ▽ AFTER 24 HOURS: ▽ CAVING> ⊗

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	MONITOR WELL INSTALLATION DETAILS
2565  5 2560	<p>No grass or topsoil Brown, micaceous, silty, fine to medium SAND - (residuum)</p>		<p>Soil backfill, 0 to 3.0 feet</p> <p>Bentonite seal, 3.0 to 4.0 feet</p> <p>Filter pack, sand 4.0 to 6.0 feet</p> <p>1-inch diameter, Schedule 40 PVC perforated well pipe, 4.5 to 5.5 feet</p>
<p>10 2555  15 2550  20 2545  25 2540  30 2535  35 2530</p>	<p>Boring terminated at 6 feet. No groundwater encountered at time of drilling.</p>		<p>Total borehole depth, 6.0 feet</p> <p><u>SURFACE COMPLETION</u> 3.19-foot stick-up</p> <p>Ground surface elev. = 2,566.09 feet</p> <p>Top of PVC casing elev. = 2,569.28 feet</p> <p>Northing = 721,908.00'</p> <p>Easting = 810,663.65'</p>

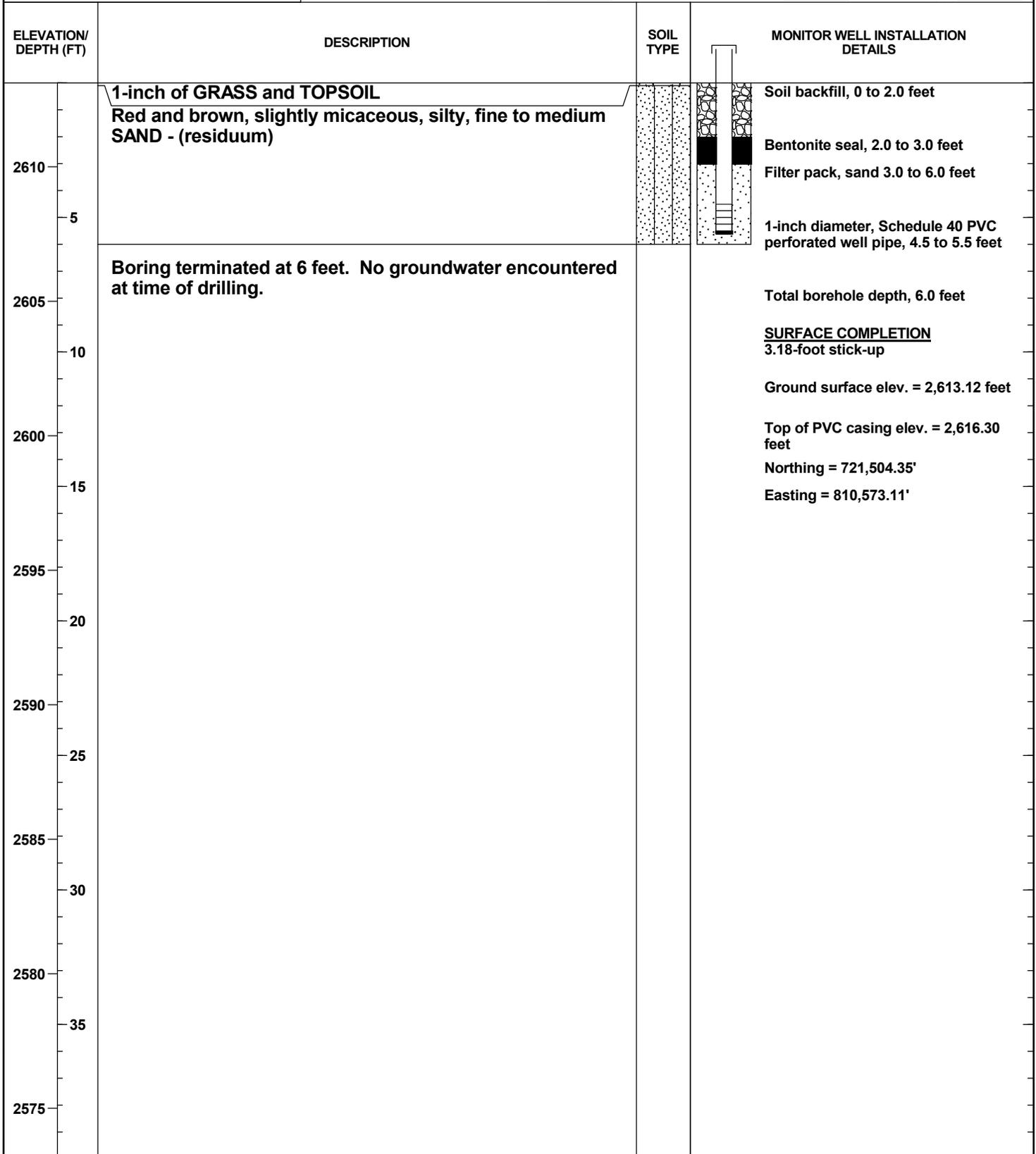
GEOI\_WELLNB\_1957-17.GPJ 11/4/10



# METHANE MONITORING WELL NO. LFG-10

**BUNNELL-LAMMONS  
ENGINEERING, INC.**  
GEOTECHNICAL AND ENVIRONMENTAL  
CONSULTANTS

PROJECT: Haywood County White Oak MSW Landfill PROJECT NO.: J10-1957-17  
 CLIENT: Haywood County START: 9-15-10 END: 9-16-10  
 LOCATION: Haywood County, North Carolina ELEVATION: 2613.12  
 DRILLER: Landprobe, M. King LOGGED BY: B. Nisbeth  
 DRILLING METHOD: Schramm T450WS; 6-inch diameter air rotary hammer  
 DEPTH TO - WATER> INITIAL: AFTER 24 HOURS: CAVING>



GEOT\_WELLNB\_1957-17.GPJ 11/4/10

**APPENDIX E**

**MONITORING WELL DEVELOPMENT LOGS**





## MONITORING WELL DEVELOPMENT LOG

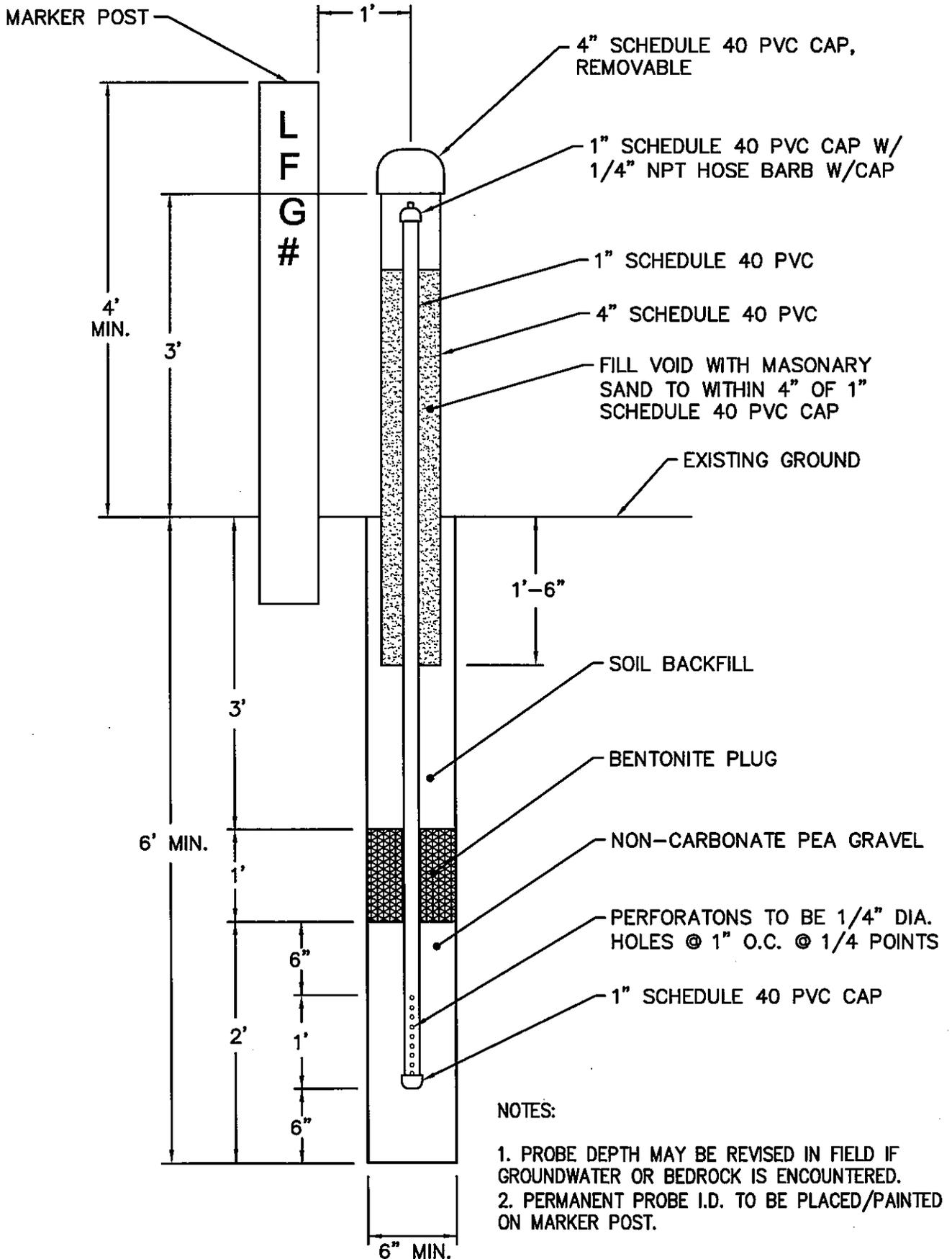
<b>DATE</b>	9/24/2010	<b>TOTAL WELL DEPTH (TWD); TOP OF CASING =</b>	44.65	1/100 ft
<b>PERSONNEL</b>	BPN	<b>DEPTH TO GROUND WATER (DGW) =</b>	36.22	1/100 ft
<b>SITE</b>	<u>White Oak Landfill</u>	<b>LENGTH OF WATER COLUMN (LWC) = TWD - DGW =</b>	8.43	1/100 ft
<b>JOB #</b>	<u>1957-17</u>	<b>1 CASING VOLUME (CV) = LWC x 0.17 =</b>	1.43	gallons
<b>WELL ID</b>	MW-16	<b><u>90.9</u> WELL VOLUMES = CV x <u>90.9</u> =</b>	130.00	gallons
<b>WEATHER</b>	Clear	<b>TOTAL VOLUME OF WATER REMOVED =</b>	130.00	gallons
<b>AIR TEMP.</b>	75°F	<b>METHOD OF WELL DEVELOPMENT =</b>	Monsoon Pump	

TIME	VOLUME PURGED (gallons)	WATER TEMP (°C)	pH (units)	Eh	SPECIF. COND. (umho/cm)	TURBIDITY NTU	SAND CONTENT (%)	Remarks
1045	0.0	16.7	5		21.7	1500		Surged Initially
1055	5.0	15.9	5		28.1	1035		
1105	10.0	15.8	5		29.6	375		
1112	15.0	15.8	5		30.0	655		
1127	20.0	16.7	5		28.3	1450		Surged @ 20 gal
1152	30.0	16.1	5		26.0	880		
1207	40.0	15.9	5		27.6	940		
1227	50.0	16.3	5		28.1	230		
1251	60.0	16.9	5		28.5	1200		Surged @ 60 gal
1310	70.0	16.2	5		27.0	980		
1324	80.0	16.1	5		27.8	120		
1341	90.0	16.3	5		28.0	50		
1355	100.0	16.2	5		27.3	25		
1412	110.0	16.2	5		27.6	14		
1450	130.0	16.3	5		28.6	6		



**APPENDIX F**

**“LANDFILL GAS MONITORING PROBE – FIGURE 2”  
CONSTRUCTION SPECIFICATION PREPARED BY MCGILL**



## LANDFILL GAS MONITORING PROBE

NOT TO SCALE

**FIGURE 2**