Marshall Steam Station Ash Basin

Groundwater Monitoring Program Sampling, Analysis, and Reporting Plan

NPDES Permit NC0004987

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Report Verification

PROJECT: **GROUNDWATER MONITORING PROGRAM**
MARSHALL STEAM STATION
ASH BASIN
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TITLE: **GROUNDWATER MONITORING**
SAMPLING, ANALYSIS, AND REPORTING PLAN

This document has been reviewed for accuracy and quality commensurate with the intended application.

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Section 1 - Introduction

This Groundwater Monitoring Program Sampling, Analysis, and Reporting Plan (Plan) is developed to support the Duke Energy Carolinas, LLC (Duke Energy) requirement for groundwater monitoring around the Marshall Steam Station (MSS) ash basin operated under National Pollutant Discharge Elimination System (NPDES) Permit NC0004987.

This Plan describes the groundwater monitoring network, methodologies of field sampling, record-keeping protocols, laboratory analytical methods, data quality objectives, data validation, and reporting that will be used for the MSS ash basin groundwater monitoring program.

Section 2 - Site Description

2.1 Plant Description

MSS is a coal-fired electricity-generating facility with a capacity of 2,090 megawatts located on the west side of Lake Norman in Catawba County, North Carolina, as shown on Figure 1. MSS is a four-unit station which began commercial operation in 1965.

Lake Norman is part of Duke Energy's Catawba-Wateree Hydroelectric Project (Federal Energy Regulatory Commission Project No. 2232), has a surface area of approximately 32,475 acres, and provides cooling water for the station.

2.2 Ash Basin Description

The coal ash residue from the coal combustion process has historically been disposed of in the MSS ash basin. The ash basin currently receives waste streams from the MSS wastewater and yard drain sump, coal pile runoff, treated flue gas desulfurization (FGD) wastewater, ash removal system, and stormwater. The discharge from the ash basin is permitted by the North Carolina Department of Environment and Natural Resources (NCDENR) Department of Water Resources (DWR) under NPDES Permit NC0004987.

The ash basin system consists of a single cell impounded by an earthen dike located on the southeast end of the ash basin. The ash basin system was constructed in 1965 and is located approximately 2,000 feet northeast of the power plant. The waste boundary for the ash basin encompasses approximately 382 acres.

The full pond elevation for the MSS ash basin is approximately 790 feet. The normal pond elevation of Lake Norman is approximately 760 feet. Figure 2 is shown with an ash basin elevation at 790 feet.

Due to the nature of MSS operations, inflows to the ash basin are highly variable. The inflows from the station to the ash basin are discharged to the northwest portion of the ash basin. The ash basin pond elevation is controlled by the use of concrete stop logs. The discharge from the ash basin is through a concrete discharge tower located in the eastern portion of the ash basin. The concrete discharge tower drains through a 30-inch-diameter slip-lined corrugated metal pipe which discharges into Lake Norman.

Section 3 - Site Geology and Hydrogeology

3.1 Geologic/Soil Framework

MSS and its associated ash basin system are located in the Kings Mountain Belt of the Piedmont physiographic province of North Carolina (Piedmont). The rocks of the Kings Mountain Belt were formed during the late Proterozoic to Early Paleozoic era. The Kings Mountain Belt bedrock consists of metasedimentary and metavolcanic rocks including schist, phyllite, marble, metavolcanic rock, quartzite, and gneiss (North Carolina Geologic Survey 1996).

The soils that overlie the bedrock in the area have generally formed from the in-place weathering of the parent bedrock. The fractured bedrock is overlain by a mantle of unconsolidated material known as regolith. The regolith, where present, includes the soil zone; a zone of weathered, decomposed bedrock known as saprolite; and alluvium. Saprolite, the product of chemical and mechanical weathering of the underlying bedrock, is typically composed of clay and coarser granular material up to boulder size and may reflect the texture of the rock from which it was formed (LeGrand 2004).

Based on a review of the monitoring well installation logs provided by Duke Energy, the soils comprising the saprolite layer on site were characterized as ranging from micaceous clay to gneissic and granitic partially weathered rock. Bedrock encountered on site consists of biotite gneiss, quartz schist, and granite.

3.2 Hydrogeologic Framework

The groundwater system in the Piedmont Province in most cases is comprised of two interconnected layers or mediums: 1) residuum/saprolite and weathered rock (regolith) overlying, and 2) fractured crystalline bedrock (Heath 1980; Harned and Daniel 1992). Within the regolith layer, a thoroughly weathered and structureless material termed residuum occurs near the ground surface with the degree of weathering decreasing with depth. The residuum grades into a coarser-grained material that retains the structure of the parent bedrock and is termed saprolite. Beneath the saprolite, partially weathered bedrock occurs with depth until sound bedrock is encountered. This mantle of residual soil, saprolite, and weathered rock is a hydrogeologic unit that covers and crosses various types of rock (LeGrand 1988). It provides an intergranular medium through which the recharge and discharge of water from the underlying fractured rock occurs. The bedrock layer consists of fractured, nonporous crystalline bedrock. The fractures control both the hydraulic conductivity and storage capacity of the rock mass.

A transition zone at the base of the regolith has been interpreted to be present in many areas of the Piedmont. The zone consists of partially weathered/fractured bedrock and lesser amounts of saprolite that grades into bedrock and has been described as “being the most permeable part of the system, even slightly more permeable than the soil zone” (Harned and Daniel 1992). The zone thins and thickens within short distances and its boundaries may be difficult to distinguish.

It has been suggested that the zone may serve as a conduit of rapid flow and transmission of contaminated water (Harned and Daniel 1992).

Piedmont topography is characterized by gently rounded sloped hills and valleys. Recharge typically occurs on upland areas and slopes while groundwater discharge is concentrated in surface water bodies and lowland areas. LeGrand's (1988, 2004) conceptual model of the groundwater setting in the Piedmont incorporates the above two medium systems into an entity that is useful for the description of groundwater conditions. That entity is the surface drainage basin that contains a perennial stream or river (LeGrand 1988). Each basin is similar to adjacent basins and the conditions are generally repetitive from basin to basin. Within a basin, movement of groundwater is generally restricted to the area extending from the drainage divides to a perennial stream or river (Slope-Aquifer System; LeGrand 1988, 2004). Rarely does groundwater move beneath a perennial stream or river to another more distant stream (LeGrand 2004).

Therefore, in most cases in the Piedmont, the groundwater system is a two-medium system (LeGrand 1988) restricted to the local drainage basin. The groundwater occurs in a system composed of two interconnected layers: residuum/saprolite and weathered rock overlying fractured crystalline rock separated by the transition zone. Typically, the residuum/saprolite is partly saturated and the water table fluctuates within it. Water movement is generally through the fractured bedrock. The near-surface fractured crystalline rocks can form extensive aquifers. The character of such aquifers results from the combined effects of the rock type, fracture system, topography, and weathering. Topography exerts an influence on both weathering and the opening of fractures while the weathering of the crystalline rock modifies both transmissive and storage characteristics.

The aquifer system in the Piedmont typically exists in an unconfined or semi-confined condition in the bedrock zone. Under natural conditions, the general direction of groundwater flow can be approximated from the surface topography. Groundwater moves both vertically down through the regolith and parallel to the bedrock surface to areas where groundwater discharges as seepage into streams, lakes, or other surface water bodies.

A surface water divide is located to the west of the MSS ash basin approximately along Sherrills Ford Road to the west of the ash basin (Figure 2). A surface water divide is also located approximately along Island Ford Road to the north of the ash basin. Lake Norman is located to the southeast of the ash basin. The geology/groundwater conditions at the site are expected to be generally consistent with the characteristics of the conceptual groundwater model developed by LeGrand for the Piedmont region.

Section 4 - Monitoring Program

4.1 Regulatory Requirements for Groundwater Monitoring

The NPDES program regulates wastewater discharges to surface waters to ensure that surface water quality standards are maintained. MSS operates under NPDES Permit NC0004987 which authorizes discharge of cooling water and intake screen backwash (Outfall 001), treated wastewater (consisting of metal cleaning wastes, coal pile runoff, ash transport water, domestic wastewater, low volume wastes, and FGD wet scrubber wastewater) (Outfall 002), yard sump overflows (Outfalls 002A and 002B), and non-contact cooling water from the induced draft fan control house (Outfall 003) to the Catawba River (Lake Norman) in accordance with effluent limitations, monitoring requirements, and other conditions set forth in the permit. The NPDES permitting program requires that permits be renewed every 5 years.

The MSS NPDES permit requires groundwater monitoring. Permit Condition A (11) Attachment XX, Version 1.1, dated June 15, 2011, lists the groundwater monitoring wells to be sampled, the parameters and constituents to be measured and analyzed, and the requirements for sampling frequency and results reporting. Attachment XX also provides requirements for well location and well construction. A copy of Attachment XX is included as Appendix B.

The compliance boundary for groundwater quality at the MSS ash basin site is defined in accordance with 15A NCAC 02L .0107(a) as being established at either 500 feet from the waste boundary or at the property boundary, whichever is closer to the source.

Sampling at the compliance groundwater wells commenced in February 2011. Analytical results have been submitted to the NCDENR Department of Water Resources (DWR) before the last day of the month following the date of sampling for all monitoring wells. In the future, analytical results will be submitted to the DWR within 60 days of the date of sampling for all monitoring wells.

4.2 Description of Groundwater Monitoring System

The groundwater monitoring for the MSS ash basin consists of the following monitoring wells: MW-4, MW-4D, MW-10S, MW-10D, MW-11S, MW-11D, MW-12S, MW-12D, MW-13S, MW-13D, MW-14S, and MW-14D. With the exception of monitoring wells MW-4 and MW-4D, the compliance monitoring wells were installed in July and August 2010. Monitoring well MW-4 was installed by Duke Energy in 1989 as part of the Marshall Dry Ash Landfill (Permit No. 1804) groundwater monitoring network. Monitoring well MW-4D was installed by Duke Energy in 2006 prior to the installation of the ash basin compliance monitoring wells as part of a voluntary monitoring system. Based on the locations of monitoring wells MW-4 and MW-4D relative to the ash basin, they were incorporated into the ash basin compliance monitoring network. Well construction data is provided in Table 1. A copy of the boring logs and monitoring well construction records are provided in Appendix A.

The locations for the compliance boundary monitoring wells were selected in consultation with the DWR Aquifer Protection Section. The locations of the monitoring wells, the waste boundary, and the compliance boundary are shown on Figure 2. A summary of the monitoring well location data is included in Appendix C. Based on the slope-aquifer system conceptual model, groundwater at the site is expected to flow downward from the topographic divides along Sherrills Ford Road on the west side of the ash basin and Island Ford Road on the north side of the ash basin. As described below, the wells provide monitoring data on the groundwater adjacent to the ash basin.

Monitoring wells MW-4[1], MW-10S[2], MW-11S, MW-12S, MW-13S, and MW-14S were installed by rotary drilling methods using hollow stem augers, with the well screen installed above auger refusal to monitor the shallow aquifer within the saprolite layer. These wells were installed with screen lengths of either 10 feet or 15 feet. The screens were installed with screen intervals ranging from 3 feet to 18 feet below ground surface (bgs) at MW-13S and 37 feet to 52 feet bgs at MW-11S.

Monitoring wells MW-10D, MW-11D, MW-12D, MW-13D, and MW-14D were installed by rotary drilling methods using hollow stem augers and by rock coring techniques (HQ diameter barrel). Monitoring well MW-4D[3] was installed using hollow stem augers and rock coring techniques with an NQ diameter barrel. These monitoring wells were installed in the fractured rock transition zone with screen lengths of 5 feet. The screens were installed with screen intervals ranging from 41.5 feet to 46.5 feet bgs at MW-13D and 90 feet to 95 feet bgs at MW-12D.

The monitoring wells at MSS are equipped with dedicated bladder-type pumps.

Groundwater monitoring wells MW-6S, MW-6D, MW-7S, MW-7D, MW-8S, MW-8D, MW-9S, and MW-9D were installed by Duke Energy in 2006 as part of a voluntary monitoring system. No groundwater samples are currently collected from these wells under the compliance monitoring program.

4.3 Monitoring Frequency

The monitoring wells will be sampled three times per year in February, June, and October.

4.4 Sample Parameters and Methods

The monitoring program consists of sampling and analysis for parameters and constituents identified in Attachment XX of the NPDES permit (Appendix B).

The parameters and constituents and the analytical methods are presented in Table 2.

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[1] Duke Power Company, Marshall Steam Station, Dry Ash Landfill, Monitoring Well Drill Records, July 1989.

[2] Wells other than MW-4 and MW-4D have the boring log and well record found in MACTEC's Ash Basin Monitoring Well Installation Report (MACTEC Project No. 6228-10-5284) dated August 26, 2010.

[3] S&ME, Inc., Ash Basin Monitoring Well Installation, Duke Power—Marshall Steam Station, S&ME Project No. 1356-06-834, December 4, 2006.

The analytical results will be compared to the 2L Standards for the parameter or constituent.

4.5 Data Quality Objectives

The overall Quality Assurance (QA) objective is to ensure that reliable data of known and acceptable quality are provided. All measurements will be documented to yield results that are representative of the groundwater quality. Data will be calculated and reported in units as required by the NCDENR.

The analytical QA objectives for precision, accuracy, and completeness have been established by the laboratory(s) in accordance with the Environmental Protection Agency (EPA) or other accepted agencies for each measurement variable where possible. The objectives are outlined in the Duke Energy Analytical Laboratory Procedures Manual and are available upon request.

Appropriate methods have been selected to meet applicable standards for groundwater quality. Instances may occur, however, in which the condition of the sample will not allow detection of the desired limits for various parameters either because of matrix interference or high analyte concentrations requiring sample dilution. The laboratory(s) will provide sufficient documentation with each data package to notify reviewers about any analytical problems with the data, if needed.

Section 5 - Sampling Procedures

5.1 Sampling Equipment

Development, purging, and sampling equipment shall be selected to ensure that materials are compatible with the sample parameters and comply with state and federal regulatory requirements for sampling. Positive-gas-displacement fluorocarbon resin bladder pumps are installed in each monitoring well as dedicated purging and sampling systems.

5.1.1 Equipment Cleaning Procedures

Dedicated sampling equipment has been installed in each monitoring well. In the event non-dedicated equipment is used between monitoring wells, equipment will be cleaned before use and between wells in accordance with standard EPA-approved cleaning procedures for field equipment. This standard is outlined in the Standard Operating Procedures and Quality Assurance Manual, Engineering Support Branch, EPA Region IV, February 1, 1991.

5.2 Groundwater Sampling

5.2.1 Development of Monitoring Wells

All 12 monitoring wells addressed in this sampling plan have been developed.

If new monitoring wells are installed, they will be developed prior to initial sampling. Development removes silt that has settled into the bottom of the well following installation and removes fine silt and clay particles from the well screen and sand-pack surrounding the screen. Well development is necessary to eliminate potential clogging and enhance well performance. Development involves removing an estimated ten or more well volumes from the well using a positive-gas-displacement fluorocarbon resin bladder pump with up-and-down agitation to loosen particles from the well screen. After development of a well, a true well depth is recorded referencing the top of well casing (TOC).

5.2.2 Groundwater Level and Total Depth Measurements

Water level measurements shall be collected and recorded to determine the groundwater elevations and groundwater flow direction and to calculate the volume of standing water in the well. All monitoring wells have been surveyed to determine the elevation of the TOC. All depth and water level measurements shall be referencing the TOC and recorded to the nearest one-hundredth of a foot.

Water level measurements shall be made with an electronic measuring device consisting of a spool of dual-conductor wire and sensor. When the sensor comes in contact with water, the circuit is closed and a meter light and/or buzzer are attached to the spool to signal the contact. The sensor is lowered further until it rests on the bottom of the well to determine the total depth of the well referencing the TOC. The depth and water level measurements shall be used to verify that the well has not filled with silt and to calculate the volume of water in the well.

The volume of well water (in gallons) is calculated using the following equation:

$$V = h * \pi * r^2 * (7.48052 \text{ gal/ft}^3)$$

Where:

V = volume of water in the well screen and casing (gallons)

h = height of standing water (feet) = total well depth - water level

r = radius of well casing (feet)

For example, a 2-inch-diameter casing will have a volume of 0.1631 gallons per foot.

In dedicated sampling systems, an accurate well depth is determined, as indicated above, after development of the well and prior to installation of the dedicated bladder pump. The well depth will be re-measured any time the dedicated sampling system is removed for repair or replacement. The well depth, water level measurement, and calculated well volume are recorded on the Groundwater Monitoring Data Sheet (Figure 4).

5.2.3 Well Purging and Sampling

The selection of purging technique is dependent on the hydrogeologic properties of the aquifer and hydraulic characteristics of each well. Hydraulic conductivity, water column, well volume, screen length, and other information are evaluated to select the purging technique to acquire groundwater representative of the aquifer conditions. The Groundwater Monitoring Data Sheet (Figure 4) is used to record purging methods and measurements.

A multi-parameter water quality monitoring instrument is used to measure field stabilization or indicator parameters for determining representative groundwater during purging. These instruments measure pH, specific conductance, temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP). Instrument calibration must be performed and documented before and after each sampling event. The pH subsystem will be calibrated with two pH standards (pH 7.0 and 4.0) bracketing the expected groundwater pH. The specific conductance subsystem will be calibrated using two standards bracketing the expected groundwater conductivity. Calibration results will be recorded on a Field Sampling Calibration Form (Figure 5).

Various well purging techniques are described below. The purging method utilized at any particular well will be selected after considering the characteristics of the well and the purging method(s) used during previous sampling events.

CONVENTIONAL PURGING

This technique entails removing one equivalent well volume and measuring the indicator parameters (temperature, pH, and specific conductance). When the parameters have stabilized to within ±0.2 pH units and ±10 percent for temperature and conductivity over three to five well volumes, representative groundwater has been achieved for sampling. It is acceptable to begin sampling after five complete well volumes have been removed, even when indicator parameters have not stabilized. Groundwater is pumped into a graduated container to measure the volume

of water purged. Under normal rates of recovery, samples should be collected immediately after purging in accordance with EPA guidelines.

For low-yield wells incapable of yielding three to five well volumes in a reasonable amount of time (e.g., 2 hours or less), groundwater is purged to the elevation of the pump intake while measuring indicator parameters. Typically, low-yield wells are evacuated to dryness one time and sampled when sufficient water level recovery occurs. Turbidity is not a required stabilization parameter, but turbidity levels of 10 nephelometric turbidity units (NTU) or less should be targeted.

LOW-FLOW PURGING

Low-flow purging and sampling are appropriate when the recharge rate of the well approximates or equals the discharge rate of the pump with minimal drawdown of the water column (≤ 1 foot).

During low-flow purging and sampling, groundwater is pumped into a flow-through chamber at flow rates that minimize or stabilize water level drawdown within the well. Indicator parameters are measured over time (usually at 5-minute intervals). When parameters have stabilized within ±0.2 pH units; ±10 percent for temperature, conductivity, and DO; and ±10 millivolts (mV) for ORP over three consecutive readings; representative groundwater has been achieved for sampling. Turbidity is not a required stabilization parameter, but turbidity levels of 10 NTU or less should be targeted.

MODIFIED LOW-FLOW PURGING

This technique is considered a viable option particularly in the Piedmont region due to the likely presence of fine-grained soils where water level drawdown cannot be stabilized while pumping. When the well recharge rate is less than the pump discharge rate, excessive drawdown (>1 foot) of the water column occurs and mixes with stagnant water located above the screened interval. One equivalent well volume is removed initially before measuring indicator parameters. Frequently, removal of the initial well volume reduces the hydraulic head and allows for matching of the recharge rate with the pumping rate providing stabilization of drawdown. Indicator parameters should be measured at 5-minute intervals using a flow-through chamber attached to a multi-parameter water quality instrument. When parameters have stabilized to within ±0.2 pH units; ±10 percent for temperature, conductivity, and DO; and ±10 mV for ORP over three consecutive readings; representative groundwater has been achieved for sampling. Turbidity is not a required stabilization parameter, but turbidity levels of 10 NTU or less should be targeted.

VERY LOW-YIELD WELL PURGING

This technique provides the best option for monitoring wells that historically purge to dryness and do not sufficiently recharge to provide adequate volume for sample collection. Wells that yield less than 100 milliliters per minute (mL/min) frequently incur significant drawdown during well purging. Therefore, if the well yield is less than 100 mL/min, the volume of the pumping system (i.e., the pump bladder, tubing, and flow-through chamber) shall be calculated and two pumping system volumes shall be removed. Indicator parameters will be measured and recorded initially, and then sample collection will begin.

5.3 Sample Collection

Groundwater samples are collected after representative groundwater has been determined by purging and stabilizing the indicator parameters.

Sampling personnel wear clean, disposable, non-powdered nitrile gloves at each location. Samples are collected in the order of the volatilization sensitivity of the parameters:

- Metals, metalloids, and selenium
- Sulfate and chloride
- Total dissolved solids

After collection, samples will be preserved and stored according to parameter-specific methods and delivered to the laboratory under proper Chain-of-Custody (COC) procedures. All pertinent notations, water-level measurements, removed well volumes, and indicator parameters shall be documented on the Groundwater Monitoring Data Sheet (Figure 4).

5.4 Sample Containers, Volume, Preservation, and Holding Time

All sample containers supplied by the laboratory for the collection of groundwater samples shall be new and pre-cleaned as approved by EPA procedures appropriate for the parameters of interest. Table 3 summarizes the sample containers, sample volume, preservation procedures, and holding times required for each type of sample and parameter. Sample containers will be kept closed until used. All sample containers will be provided by Duke Energy or vendor laboratories.

5.5 Sample Tracking

The COC procedures allow for tracing the possession and handling of individual samples from the time of field collection through laboratory analysis and report preparation. Samples shall be pre-logged prior to sample collection. This process assigns a unique tracking number for each sample and generates corresponding labels. An example of the COC Record is provided as Figure 6.

5.6 Sample Labeling

Sample containers shall be pre-labeled and organized prior to field activities as part of the pre-sampling staging process. As samples are collected, the sampling personnel shall write the following information directly on the label: sampling date and time, and initials of sample collector. This information is also recorded on the Groundwater Monitoring Data Sheet (Figure 4) and the COC Record (Figure 6).

5.7 Field Documentation

Field documentation from each sampling event is recorded on the Groundwater Monitoring Data Sheets (Figure 4), the Field Sampling Calibration Form (Figure 5), and the Chain-of-Custody Record (Figure 6). Additionally, a Groundwater Sampling Site Checklist (Figure 7) is completed indicating information about the monitoring well such as proper identification (ID) tag and

condition of protective casing and pad. Field notations shall be made during the course of the field work to document the following information as applicable:

- Identification of well
- Well depth
- Static water level depth and measurement technique
- Presence of immiscible layers and detection method
- Well yield – high or low
- Purge volume or pumping rate
- Sample identification numbers
- Well evacuation procedure/equipment
- Sample withdrawal procedure/equipment
- Date and time of collection
- Types of sample containers used
- Identification of replicates or blind samples
- Preservative(s) used
- Parameters requested for analysis
- Field analysis data and methods
- Sample distribution and transporter
- Field observations during sampling event
- Name of sample collector(s)
- Climatic conditions including estimate of air temperature

This field notation information will be entered on the Groundwater Monitoring Data Sheets (Figure 4), the Field Sampling Calibration Form (Figure 5), or the Chain-of-Custody Record and Analysis Request Form (Figure 6) which are filled out for each sampling event. These documents will be arranged and filed by project and date. Recorded entries will be made on electronic forms or on paper forms in indelible ink. Errors on paper documents will be corrected by drawing a line through the error, initialing and dating the correction, and starting a new entry on the next line (if necessary).

5.8 Chain-of-Custody Record

The COC Record (Figure 6) accompanies the sample(s), traces sample possession from time of collection to delivery to the laboratory(s), and clearly identifies which sample containers have been designated for each requested analysis. The record includes the following types of information:

- Sample identification number
- Signature of collector
- Date and time of collection
- Sample type (e.g., groundwater, immiscible layer)
- Identification of well
- Number of containers
- Parameters requested for analysis
- Preservative(s) used
- Signature of persons involved in the chain of possession
- Inclusive dates of possession

5.9 Sample Custody, Shipment, and Laboratory Receipt

For the purpose of these procedures, a sample is considered in custody if it is:

- In actual possession of the responsible person
- In view, after being in physical possession
- Locked or sealed in a manner so that no one can tamper with it after having been in physical custody or in a secured area restricted to authorized personnel

All samples shall be maintained in the custody of the sampling crew during the sampling event. At the end of each sampling day and prior to the transfer of the samples off site, entries shall be completed on the COC form for all samples. Upon transfer of custody, the COC form is signed by a sampling crew member, including the date and time. If outside vendor laboratories are utilized, samples shall be delivered to these facilities by Duke Energy personnel or courier.

All COC forms received by the laboratory(s) shall be signed and dated by the respective supervising scientist(s) or their designee (at the Duke Energy lab) or the laboratory sample custodian (at vendor labs) immediately following receipt by the laboratory.

The analysts at the laboratory(s) maintain a sample tracking record that will follow each sample through all stages of laboratory processing. The sample tracking records show the date of sample extraction or preparation and analysis. These records are used to determine compliance with holding time limits during lab audits and data validation.

Custody procedures followed by Duke Energy laboratory personnel are described in detail in the Duke Energy Laboratory Services Procedures Manual.

Section 6 - Analytical Methods

The main analytical laboratory used in this program is the Duke Energy Laboratory Services Laboratory: N.C. Drinking Water (NC37804) and Wastewater (#248) Certifications. The organizational structure and staff qualifications of the laboratory are discussed in its generic Quality Assurance Program (QAP). The QAP and the Analytical Laboratory Procedures Manual are available for review upon request.

Vendor laboratories that meet EPA and North Carolina certification requirements may be used for analyses with approval by Duke Energy.

The analytical methods used for the samples analyzed for this Groundwater Monitoring Program are listed in Table 2. Specific conductance, field pH, and temperature are measured in the field according to the Duke Energy Groundwater Monitoring and Sample Collection Procedure or the instrument manufacturer instructions.

Section 7 - Internal Quality Control Checks

Internal laboratory QC checks used by the laboratories are described in each laboratory's generic QAP and procedures manual. Using the internal laboratory QC checks, the laboratories demonstrate the ability to produce acceptable results using the methods specified.

Internal quality control checks for sampling procedures and laboratory analyses will be conducted with each sampling event. These checks will consist of the preparation and submittal of field blanks, trip (travel) blanks, and/or field replicates for analysis of all parameters at frequencies described in the laboratory(s) procedures manuals.

The field QC blanks and replicates that may be included as internal QC checks are described below. The specific type and number of blanks used may vary depending on the sampling event and will be determined by the Duke Energy field sampling personnel:

- Field Blanks: A field blank consists of a sample container filled in the field with organic-free, deionized, or distilled water prepared and preserved in the same manner as the samples. The field blank is transported to the laboratory with the samples and analyzed along with the field samples for the constituents of interest to check for contamination imparted to the samples by the sample container, preservative, or other exogenous sources. Field blanks are typically utilized for each sampling event. The field blanks are typically analyzed for major anions, cations, and metals.

- Trip Blanks: A trip (travel) blank is a sample container filled with organic-free water in the laboratory that travels unopened with the sample bottles. Trip blanks are typically utilized when sampling for volatile organic compounds. The trip blank is returned to the laboratory with the field samples and analyzed along with the field samples for parameters of interest.

- Equipment Blanks: If non-dedicated equipment is used between wells, it is recommended that equipment blanks be collected. The field equipment is cleaned following documented cleaning protocols. An aliquot of the final control rinse water is passed over the cleaned equipment directly into a sample container and submitted for analyses.

- Field Replicates: A field replicate is a duplicate sample prepared at the sampling locations from equal portions of all sample aliquots combined to make the sample. Both the field replicate and the sample are collected at the same time, in the same container type, preserved in the same way, and analyzed by the same laboratory as a measure of sampling and analytical precision.

Section 8 - Validation of Field Data Package

The field data package includes all of the field records and measurements developed by the sampling team personnel. The field data package validation will be performed by Duke Energy personnel. The procedure for validation consists of the following:

- A review of field data contained on the Groundwater Monitoring Data Sheets for completeness.
- Verification that equipment blanks, field blanks, and trip blanks were properly prepared, identified, and analyzed.
- A check of the Field Sampling Calibration Form for equipment calibration and instrument conditions.
- A review of the COC Record for proper completion, signatures of field personnel and the laboratory sample custodian, dates and times, and for verification that the correct analyses were specified.

Section 9 - Validation of Laboratory Data

The laboratory will perform a validation review of the submitted samples and analytical results to ensure that the laboratory QA/QC requirements are acceptable.

Section 10 - Report Submittal

A report of the monitoring results for all wells will be submitted to the DWR within 60 days of the date of sampling. The monitoring results will be submitted on NCDENR Form GW-59CCR.

The DWR will be notified in the event that vendor lab analyses have not been completed within this time frame. All Groundwater Monitoring Data Sheets, Field Calibration Forms, Chain-of-Custody Records, Laboratory QA data, and Data Validation Checklists shall be kept on file by Duke Energy and are available upon request.

Section 11 - References

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Figures

NOTES:
1. SOURCE: USGS TOPOGRAPHIC MAP - LAKE NORMAN NORTH QUADRANGLE. CREATED 1993. UPDATED 2011.
2. MAP DOES NOT REFLECT REALIGNMENT OF STEAM PLANT ROAD.

SCALE (FEET)

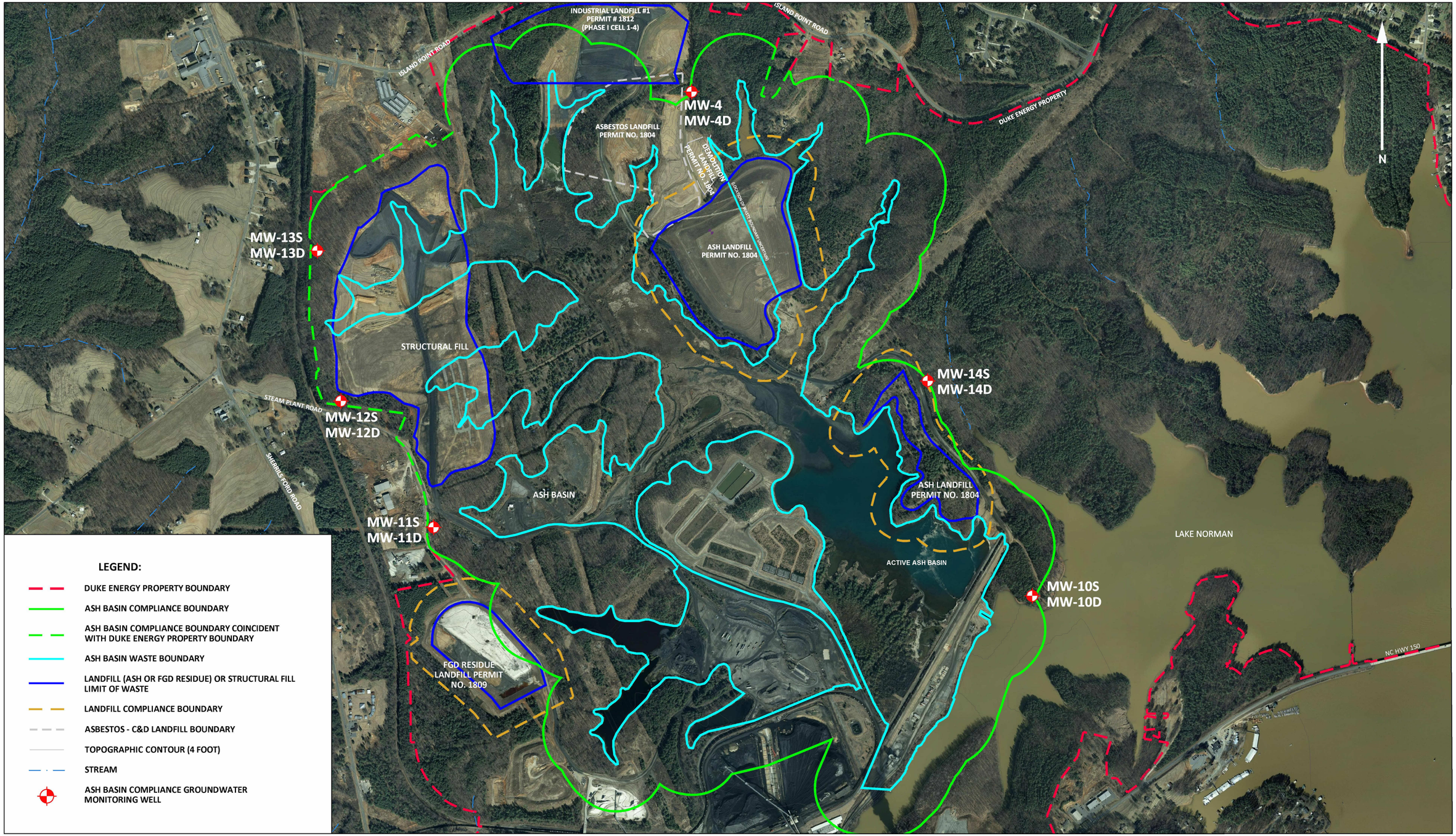
1,000 0 1,000 2,000

License Number: F-0116
440 South Church Street Charlotte, NC 28202

SITE LOCATION MAP
DUKE ENERGY CAROLINAS, LLC
MARSHALL STEAM STATION ASH BASIN
NPDES PERMIT #NC0004987
CATAWBA COUNTY, NORTH CAROLINA

DATE
OCT. 10, 2014

FIGURE
1



NOTES:
1. PARCEL DATA FOR THE SITE WAS OBTAINED FROM DUKE ENERGY REAL ESTATE AND IS APPROXIMATE.
2. ASH WASTE BOUNDARY, STRUCTURAL FILL, AND LANDFILL BOUNDARIES WERE PROVIDED BY DUKE ENERGY AND ARE APPROXIMATE.
3. AS-BUILT MONITORING WELL LOCATIONS PROVIDED BY DUKE ENERGY.
4. SHALLOW MONITORING WELLS (S) - WELL SCREEN INSTALLED ACROSS THE SURFICIAL WATER TABLE.
5. DEEP MONITORING WELLS (D) - WELL SCREEN INSTALLED IN THE TRANSITION ZONE BETWEEN COMPETENT BEDROCK AND THE REGOLITH.
6. TOPOGRAPHY DATA FOR THE SITE WAS OBTAINED FROM NC DOT GEOGRAPHIC INFORMATION SYSTEM (GIS) WEB SITE.
7. ORTHOPHOTOGRAPHY WAS OBTAINED FROM NC ONEMAP GIS WEB SITE (DATED 2009).
8. THE ASH BASIN COMPLIANCE BOUNDARY IS ESTABLISHED ACCORDING TO THE DEFINITION FOUND IN 15A NCAC 02L .0107 (a).

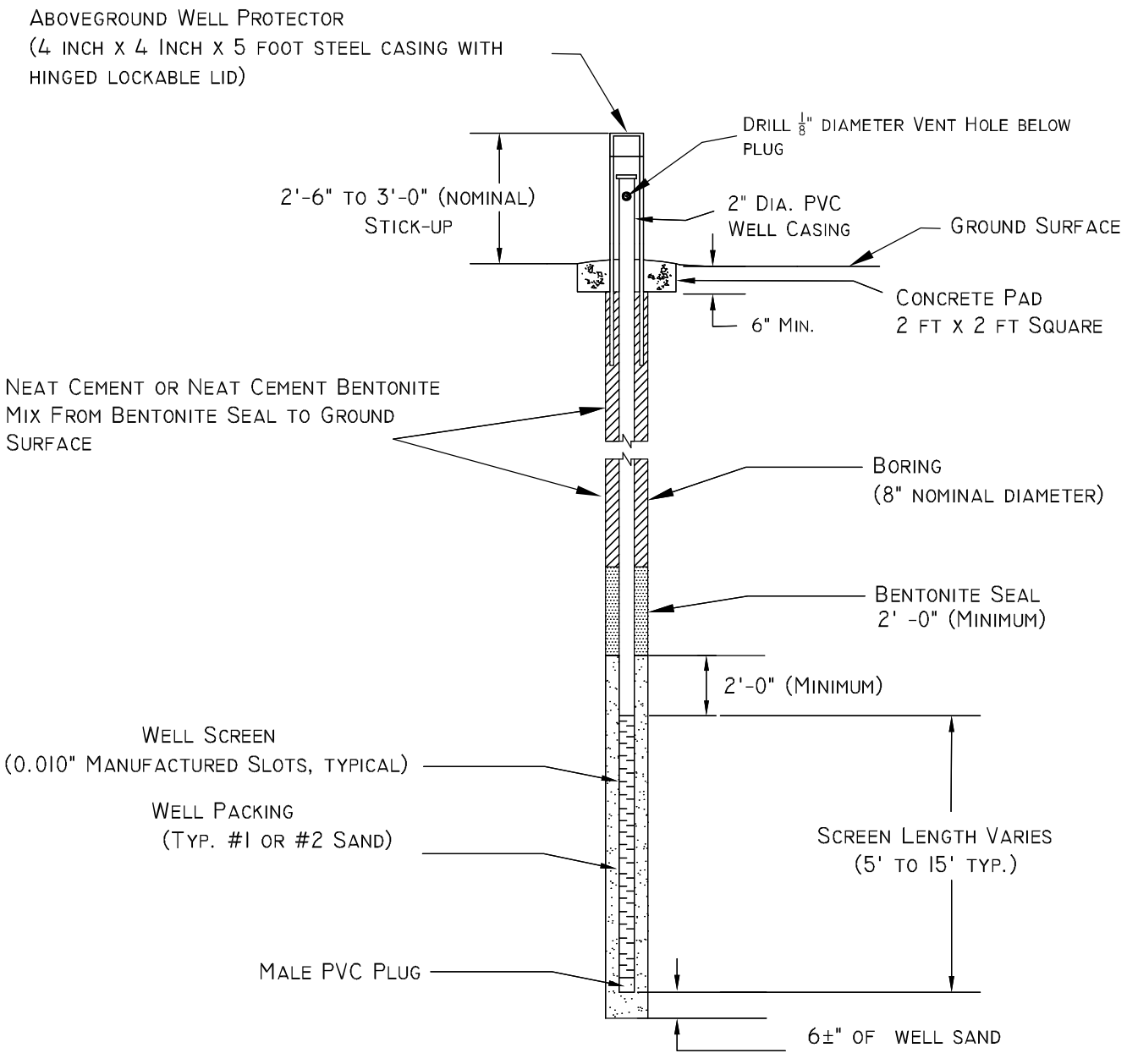
1,000' 0 500' 1,000'
SCALE

License Number: F-0116
440 South Church Street Charlotte, NC 28202

SITE LAYOUT MAP
DUKE ENERGY CAROLINAS, LLC
MARSHALL STEAM STATION ASH BASIN
NPDES PERMIT #NC0004987
CATAWBA COUNTY, NORTH CAROLINA

DATE
OCT. 10, 2014

FIGURE
2



Typical Well Construction Details
(no scale)

INFORMATION PROVIDED BY DUKE ENERGY CAROLINAS, LLC

License Number: F-0116
440 South Church Street Charlotte, NC 28202

TYPICAL MONITORING WELL CONSTRUCTION DETAILS

DATE
OCT. 10, 2014

FIGURE
3

DUKE ENERGY

GROUNDWATER MONITORING DATA SHEET FOR CONVENTIONAL SAMPLING

PROCEDURE NO	3175.1

SITE NAME	Marshall Steam Station	PERMIT #	NC0004987	SITE ID	N/A
PROJECT NAME	Ash Basin Groundwater Monitoring	FIELD CREW			
SAMPLING DATE(s)	☐ ☐ ☐ ☐	WELL/LOCATION NAME			

MONITORING WELL INFORMATION

WELL DIAMETER (in)		TOC ELEV (ft msl)		MIDDLE OF WETTED SCREEN (ft toc)			
WELL DEPTH (ft TOC)		GS ELEV (ft msl)		PUMP INTAKE DEPTH (ft TOC)			
SCREEN LENGTH (ft)		ELEV REF		SCREEN INTERVAL (ft TOC)		TO	

EQUIPMENT INFORMATION

LEVEL METER SERIAL#		SAMPLING EQUIPMENT			PURGE METHOD		
		TUBING DIAMETER (in)					
PUMP CONTROLLER SETTINGS							
PRESSURE	(psi)	RECHARGE	(sec)	DISCHARGE	(sec)		

SAMPLING INFORMATION

INITIAL DEPTH TO WATER (ft TOC)		WATER COLUMN (ft)		*Well Volume = water column X conversion factor*	
WATER ELEVATION (ft msl)		WELL VOLUME (gal)		(Conversion factor dependent on well diameter and selected well volume units)	
DETECTED ODOR	None	CONVERSION FACTOR	0.1631		
APPEARANCE	Normal				

PURGE VOLUME (gal)	WATER LEVEL AFTER PURGE * (ft)	COMPLETE EVACUATION (YES/NO)	☑ TEMP (deg C)	☑ SPECIFIC COND. (umho/cm)	☑ pH (SU)	☑ TURBIDITY (NTU)	☐ ORP (mV -NEH)	☐ DISSOLVED OXYGEN (mg/L)	☐ (gal) WELL VOL (recalculates on current water level)

TOTAL PURGE VOLUME	* Optional measurement to recalculate well volume when purging results in substantial drawdown of water column	SAMPLE COLLECTED BY	DATE	TIME	CHLORINE (mg/l)
0.00			@		NA

QC By:	

WELL CONDITION

PROTECTIVE CASING		
WELL PAD		
WELL CASING		
WELL TAG		

ADDITIONAL WELL CONDITION NOTES

SAMPLING NOTES

FIGURE 4: EXAMPLE GROUNDWATER MONITORING DATA SHEET

FIELD SAMPLING CALIBRATION FORM

STUDY: Marshall Steam Station Ash Basin Groundwater Monitoring

DATE (s): | **SURFACE UNIT READER:**

COLLECTORS: | **SURFACE UNIT SERIAL #:**

ANALYZER MODEL#: | **ANALYZER SERIAL #:**

OTHER EQUIPMENT: | **WEATHER CONDITIONS:**

PROCEDURE #: HYDROLAB 3210.3 **VALIDATED BY:**

Calibration Date / Time		DATE:			TIME:		DATE:			TIME:	
		BP (mmHg)					BP (mmHg)				
Parameter	**Calibation Standard**	**Instrument Value**		**Standard Value**	**Calibration Results**		**Instrument Value**		**Standard Value**	**Calibration Results**	
SPEC. COND. (uS/cm)	SS	0.0	—/—►	0.0	Instrument Zeroed		0.0	—/—►	0.0	Zero Pass	
	SS		—►	350				—/—►	350		
	SS		—/—►	150				—/—►	150		
pH (units)	B (7.00)		—►	7.00				—/—►			
	B (4.00)		—►	4.00				—/—►			
	B (10.00)		—/—►	10.00				—/—►			
			Buffer Temp.	25.00				Buffer Temp.			
Mid-Day Ck	B (7.00)		—►								
Time:			Buffer Temp.								
☑ ORP (mV)	SS (7.00)		—►	285				—/—►	285		
	SS (4.00)	N/A	—/—►	462			N/A	—/—►	462		
			ORP Temp.	25.00				ORP Temp.	25.00		
☐ DO (mg/L)	W										
	W										
	AW		—►					—/—►			
☐ TURB (ntu)	SS		—/—►					—/—►			
Temp Cert Device #											
TEMP (deg C)	NIST	N/A	—/—►	N/A	Adjustment Not Available		N/A	—/—►	N/A	Adjustment Not Available	
AMMONIUM (mg/L)	SS	N/A	—/—►	N/A			N/A	—/—►	N/A		
	SS	N/A	—/—►	N/A			N/A	—/—►	N/A		

INSTRUMENT MAINTENANCE	DATE / TIME

Conductance Subsystem
- ☐ Cleaned Electrodes
- ☐ Tested - OK
- ☐ See Notes

pH Subsystem
- ☐ Cleaned Electrodes
- ☐ Replaced ref Electrode KCL
- ☐ Replaced Ref. Electrode Tip
- ☐ Tested - OK ☐ See Notes

Dissolved Oxygen Subsystem
- ☐ Replaced Teflon Membrane
- ☐ Replaced DO electrolyte
- ☐ Cleaned Electrode
- ☐ See Notes

Ammonium Subsystem
- ☐ Cleaned Electrode Tip
- ☐ Installed New Electrode
- ☐ Removed Electrode / Installed Plug
- ☐ Tested - OK ☐ See Notes

Oxidation Reduction Subsystem
- ☐ Cleaned Electrode
- ☐ Tested - OK ☐ See Notes

Turbidity Subsystem
- ☐ Cleaned Electrode & Wiper
- ☐ Tested - OK ☐ See Notes

Temperature Subsystem
- ☐ Cleaned Electrode
- ☐ Tested - OK ☐ See Notes

Depth Subsystem
- ☐ Reset / Calibrated
- ☐ Tested - OK ☐ See Notes

KEY: B = Buffer; SS = Standard solution; W = Winkler; AW = Average Winkler; —► = Adjusted To; —/—► = Not Adjusted To; N/A = Not Applicable

NOTES:

FIGURE 5: EXAMPLE FIELD SAMPLING CALIBRATION FORM

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST FORM

Duke Energy SM

For Detailed Instructions, see:
http://dewww/essenv/coc/

Duke Energy Analytical Lab Services
Mail Code MGO3A2 (Building 7405)
13339 Hagers Ferry Rd
Huntersville, N. C. 28078
(704) 875-5245
Fax: (704) 875-5038

Analytical Laboratory Use Only

LIMS #

Samples Originating From NC √ SC

Logged By | Date & Time

SAMPLE PROGRAM
Groundwater √
NPDES
Drinking Water
UST
RCRA Waste

Vendor | Cooler Temp (C)

PO #

[15]Preserv.: 1=HCL 2=H_2SO_4 3=HNO_3 4=Ice 5=None

MR #

[19]Page 1 of 1
DISTRIBUTION
ORIGINAL to LAB,
COPY to CLIENT

Customer must Complete

1)Project Name		2)Phone No:
3)Client		4)Fax No:
5)Business Unit: 20036	6)Process:	7)Resp. To:
8)Project ID:	9)Activity ID:	10)Mail Code:

Customer to complete all appropriate NON-SHADED areas.

[16]Analyses Required

LAB USE ONLY [11]Lab ID	[12]Chem Desktop No.	[13]Sample Description or ID	[14]Collection Information Date	Time	Signature	[17]Comp.	[18]Grab	[20]Total # of Containers
								6

Customer to complete appropriate columns to right

Customer to sign & date below

21)Relinquished By	Date/Time	Accepted By	Date/Time
Relinquished By	Date/Time	Accepted By	Date/Time
Relinquished By	Date/Time	Accepted By	Date/Time
23)Seal/Locked By	Date/Time	Sealed/Lock Opened By	Date/Time

24)Comments

Customer, important please indicate desired turnaround

[22]Requested Turnaround

14 Days √

*7 Days

* 48 Hr

*Other
* Add. Cost Will Apply

FIGURE 6 - CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST FORM

NORTH CAROLINA GROUNDWATER SAMPLING SITE CHECKLIST

LOCATION / SITE Marshall Steam Station / Ash Basin Groundwater Monitoring PERMIT # NC0004987 **SAMPLE DATE**
SITE CONTACT **FIELD CREW**
WEATHER
PAGE 1 OF 1

		MW-4	MW-4D	MW-10S	MW-10D	MW-11S	MW-11D	MW-12S	MW-12D	MW-13S	MW-13D	MW-14S	MW-14D			
ACCESS TO WELLS																
Access cleared into well																
Access cleared around well																
Tall grass or weeds - needs mowing																
Road washing out / muddy / needs grading																
Fallen tree blocking access																
WELL SECURITY																
Well found locked																
Well found unlocked																
WELL LOCK CONDITION																
Lock in good condition																
Lock rusted, difficult to open / needs replacing																
Replaced damaged lock																
WELL CASINGS																
Casing in good condition																
Damaged casing / still functional																
Damaged casing / repair required																
CONCRETE PADS																
Pad in good condition																
Minor cracks																
Major cracks / broken / repair required																
Undermined / washing out																
Fire ants around concrete pad																
WELL PROTECTIVE CASINGS																
Casing in good condition																
Damaged casing / still functional																
Damaged casing / repair required																
Broken hinge on protective lid																
Wasp nest inside protective casing																
Ants inside protective casing																
WELL CAPS																
Well cap in good conditon																
Damaged / needs replacement																
Replaced damaged well cap																
FLUSH MOUNT WELLS																
Vault in good condition																
Water inside vault																
Vault bolt holes broken or stripped																
Bolts stripped																
Vault lid cracked or broken																
WELL ID TAGS																
Well tag in good condition																
Well tag missing																
Well tag damaged / illegible																
Lacks required information - Driller Reg #																
Lacks required information - Completion date																
Lacks required information - Total well depth																
Lacks required information - Depth to screen																
Lacks required information - Non potable tag																

NOTE:

FIGURE 7: GROUNDWATER SAMPLING SITE CHECKLIST

Tables

Table 1
Monitoring Well Information
Marshall Steam Station Ash Basin

	MW-4	MW-4D	MW-10S	MW-10D	MW-11S	MW-11D	MW-12S	MW-12D	MW-13S	MW-13D	MW-14S	MW-14D
North (ft)	686,723.33	686,715.82	681,328.43	681,327.13	682,062.41	682,060.69	683,414.08	683,409.20	685,021.83	685,017.16	683,629.12	683,626.47
East (ft)	1,414,467.78	1,414,462.36	1,418,114.26	1,418,119.07	1,411,706.21	1,411,710.71	1,410,714.04	1,410,712.50	1,410,462.33	1,410,464.23	1,416,995.37	1,416,999.23
Top of PVC Casing Elevation (ft)	866.42	866.74	772.05	772.04	884.99	884.67	871.86	871.88	847.49	847.05	811.29	811.43
Well Diameter	2"	2"	2"	2"	2"	2"	2"	2"	2"	2"	2"	2"
Well Stick-up (ft)	2.16	3.36	2.30	2.04	2.70	2.55	2.63	2.51	2.43	2.52	2.92	2.76
Type of Casing	PVC	PVC	PVC	PVC	PVC	PVC	PVC	PVC	PVC	PVC	PVC	PVC
Total Depth below TOC (ft)	50.20	64.18	29.21	87.47	54.12	93.10	25.10	98.30	20.88	48.55	46.87	62.60
Screen Length (ft)	10	5	15	5	15	5	15	5	15	5	15	5
Screen Interval (ft below TOC)	40.20 - 50.20	59.18 - 64.18	14.21 - 29.21	82.47 - 87.47	39.12 - 54.12	88.10 - 93.10	10.10 - 25.10	93.30 - 98.30	5.88 - 20.88	43.55 - 48.55	31.87 - 46.87	57.60 - 62.60

Notes:

1. ft indicates feet.
2. TOC indicates top of casing.
3. As-built well coordinates (NAD 83) and top of PVC casing elevations (NAVD 88) provided by Duke Energy.
4. Well diameter, type of casing, and screen lengths were obtained from Well Construction Records provided by Duke Energy.
5. Well total depth below TOC and well stick-up measurements provided by Duke Energy.

Table 2
Sample Parameters and Analytical Methods
Marshall Steam Station Ash Basin

PARAMETER	UNITS	ANALYTICAL METHOD
In Situ Parameters		
Field pH	pH Units	Hydrolab
Conductivity	µmhos/cm	Hydrolab
Temperature	°C	Hydrolab
Water Level	ft	Water Level Meter
Laboratory Analyses		
Antimony	µg/L	TRM / EPA 200.8
Arsenic	µg/L	TRM / EPA 200.8
Barium	mg/L	TRM / EPA 200.7
Boron	mg/L	TRM / EPA 200.7
Cadmium	µg/L	TRM / EPA 200.8
Chloride	mg/L	EPA 300.0
Chromium	mg/L	TRM / EPA 200.7
Copper	mg/L	TRM / EPA 200.7
Iron	mg/L	TRM / EPA 200.7
Lead	µg/L	TRM / EPA 200.8
Manganese	mg/L	TRM / EPA 200.7
Mercury	µg/L	EPA 245.1
Nickel	mg/L	TRM / EPA 200.7
Nitrate (as Nitrogen)	mg/L	EPA 300.0
Selenium	µg/L	TRM / EPA 200.8
Sulfate	mg/L	EPA 300.0
Thallium	µg/L	TRM / EPA 200.8
Total Dissolved Solids	µg/L	SM 2450C
Zinc	mg/L	TRM / EPA 200.7

Notes:

1. µmhos/cm indicates micro-mhos per centimeter.
2. ft indicates feet.
3. µg/L indicates micrograms per liter.
4. mg/L indicates milligrams per liter.
5. TRM indicates total recoverable metals.
6. EPA indicates Environmental Protection Agency.
7. SM indicates Standard Method.

Table 3
Sample Containers, Preservatives, and Holding Times
Marshall Steam Station Ash Basin

PARAMETER	CONTAINERS	PRESERVATIVES	HOLDING TIMES
In Situ Parameters			
Field pH	In Situ	None	Analyze Immediately
Conductivity	In Situ	None	Analyze Immediately
Temperature	In Situ	None	Analyze Immediately
Laboratory Analyses			
Antimony	500 ml HDPE	pH<2 HNO_3	6 months
Arsenic	500 ml HDPE	pH<2 HNO_3	6 months
Barium	500 ml HDPE	pH<2 HNO_3	6 months
Boron	500 ml HDPE	pH<2 HNO_3	6 months
Cadmium	500 ml HDPE	pH<2 HNO_3	6 months
Chloride	500 ml HDPE	Cool 4^{o} C	28 days
Chromium	500 ml HDPE	pH<2 HNO_3	6 months
Copper	500 ml HDPE	pH<2 HNO_3	6 months
Iron	500 ml HDPE	pH<2 HNO_3	6 months
Lead	500 ml HDPE	pH<2 HNO_3	6 months
Manganese	500 ml HDPE	pH<2 HNO_3	6 months
Mercury	500 ml HDPE	pH<2 HNO_3	6 months
Nickel	500 ml HDPE	pH<2 HNO_3	6 months
Nitrate (as Nitrogen)	500 ml HDPE	Cool 4^{o} C	48 hours
Selenium	500 ml HDPE	pH<2 HNO_3	6 months
Sulfate	500 ml HDPE	Cool 4^{o} C	28 days
Thallium	500 ml HDPE	pH<2 HNO_3	6 months
Total Dissolved Solids	500 ml HDPE	Cool 4^{o} C	7 days
Zinc	500 ml HDPE	pH<2 HNO_3	6 months

Notes:

1. ml indicates milliliter.
2. HNO_3 indicates nitric acid.
3. HDPE indicates high density polyethylene.

A

Appendix A - Boring Logs and Monitoring Well Construction Records

Form 25630 (R3-87)

FORM M-26C	REVISION 2
	PAGE 1 OF 2

DUKE POWER COMPANY
CONSTRUCTION DEPARTMENT
PROJECT B MARSHALL

SOIL TEST BORING FIELD REPORT

JOB NO. N/A
JOB NAME FLYASH LANDFILL MW's
DATE 6-29-89 WEATHER HOT

STARTING TIME N/A
GROUND SURFACE ELEV.
HRS. DRILLING N/A HRS. MOVING N/A
INSPECTOR D. DICKSON BORING NO. MW-4

	SAMPLING				SCALE	UD	SOIL CLASSIFICATION AND REMARKS
		1ST 6"	2ND 6"	3RD 6"			
					0		AD-2 DRILL RIG # 2555
1	4.5 6.0	3	4	4	5		RED MICA. SILTY FINE TO MEDIUM SAND
2	9.5 11.0	6	3	3	10		LT. BROWNISH GRAY MICA. SILTY FINE TO MEDIUM SAND.
3	14.5 16.0	4	5	6	15		LT. BROWNISH GRAY MICA. SILTY FINE TO COARSE SAND.
4	19.5 21.0	2	4	6	20		LT. BROWNISH GRAY MICA. SILTY FINE TO MEDIUM SAND.
5	24.5 26.0	6	8	9	25		LT. BROWNISH GRAY MICA. SILTY FINE TO MEDIUM SAND.
6	29.5 31.0	5	10	12	30		LT. BROWNISH GRAY MICA. SILTY FINE TO MEDIUM SAND.
7	34.5 36.0	3	5	4	35		LT. BROWNISH GRAY MICA. SILTY FINE TO MEDIUM SAND.
8	39.5 41.0	5	8	13	40		LT. BROWNISH GRAY MICA. SILTY FINE TO MEDIUM SAND.

+ STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES

BORING TERMINATED
BORING REFUSAL
WATER TOB DEPTH
WATER 24 HR: DEPTH
WATER LOSSES
CASING SIZE LENGTH

METHOD OF ADVANCING BORING	DEPTH
POWER AUGER	TO
HAND CHOP: W/MUD: W/WATER	TO
ROTARY DRILL: W/MUD: W/WATER	TO
DIAMOND CORE	TO

DRY BORING - SEE MW-4A

Form 25630 (R3-87)

FORM M–26C	REVISION 2
	PAGE 2 OF 2

DUKE POWER COMPANY
CONSTRUCTION DEPARTMENT
PROJECT MARSHALL

SOIL TEST BORING FIELD REPORT

JOB NO. N/A
STARTING TIME N/A
JOB NAME FLYASH LANDFILL MW'S
GROUND SURFACE ELEV.
DATE 6-29-89 WEATHER HOT
HRS. DRILLING N/A HRS. MOVING N/A
INSPECTOR D. DICKSON BORING NO. MW-4

SAMPLING		1ST 6"	2ND 6"	3RD 6"	SCALE	UD	SOIL CLASSIFICATION AND REMARKS
					40		
9	44.5						
	~~45.0~~		50=6"		45		LT. GRAY MICA. SICTY FINE TO MEDIUM SAND.
							FOR CLARIFICATION – 44.5 – 45.0 50=6" AUGER REFUSAL @ 47.9'
					50		DRY BORING – MOVED TO ALTERNATE BORING SITE # MW-4A
					55		
					60		
					65		
					70		
					75		
					80		

+ STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES

BORING TERMINATED
BORING REFUSAL
WATER TOB DEPTH
WATER 24 HR: DEPTH
WATER LOSSES
CASING SIZE LENGTH

METHOD OF ADVANCING BORING	DEPTH
POWER AUGER	TO
HAND CHOP: W/MUD: W/WATER	TO
ROTARY DRILL: W/MUD: W/WATER	TO
DIAMOND CORE	TO

47.9

Form 25630 (R3-87)

FORM M–26C	REVISION 2
	PAGE 1 OF 2

DUKE POWER COMPANY
CONSTRUCTION DEPARTMENT
PROJECT MARSHALL

SOIL TEST BORING FIELD REPORT

JOB NO. N/A
JOB NAME FLYASH LANDFILL MW'S
DATE 6-30-89 WEATHER HOT

STARTING TIME N/A
GROUND SURFACE ELEV.
HRS. DRILLING N/A HRS. MOVING N/A
INSPECTOR D. DICKSON BORING NO. MW-4A

SAMPLING					SCALE	UD	SOIL CLASSIFICATION AND REMARKS
		1ST 6"	2ND 6"	3RD 6"			
					0		AD-2 DRILL RIG # 2555
1	4.2 5.7	6	7	8			YELLOWISH RED MICA. SICTY FINE TO MEDIUM SAND.
					5		
2	9.2 10.7	7	6	6			WHITE MICA. FINE TO COARSE SAND
					10		
3	14.2 15.7	4	6	7			STRONG BROWN MICA. FINE TO MEDIUM SANDY SICT.
					15		
4	19.2 20.7	3	5	7			BROWNISH YELLOW MICA. SILTY FINE TO MEDIUM SAND
					20		
5	24.2 25.7	5	6	7			LT. OLIVE BROWN MICA. SILTY FINE TO MEDIUM SAND.
					25		
6	29.2 30.7	5	7	7			OLIVE MICA. SILTY FINE TO MEDIUM SAND.
					30		
7	34.2 35.7	4	6	7			OLIVE MICA. SILTY FINE TO MEDIUM SAND.
					35		
							OLIVE GRAY MICA. SILTY FINE TO COARSE SAND.
8	39.2 40.7	13	26	18	40		SPLIT SPOON SAMPLER RETURNED WET

BORING TERMINATED @ 49.6
BORING REFUSAL AUGER @ 49.6'
WATER TOB DEPTH 46.0' ON 6-30-89
WATER 24 HR: DEPTH 31.7 ON 7-6-89
WATER LOSSES N/A
CASING SIZE N/A LENGTH 0

METHOD OF ADVANCING BORING	DEPTH
POWER AUGER	0 TO 49.6
~~HAND CHOP: W/MUD: W/WATER~~	—TO—
~~ROTARY DRILL: W/MUD: W/WATER~~	—TO—
~~DIAMOND CORE~~	—TO—

+ STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES

Form 25630 (R3-87)

FORM M–26C	REVISION 2
	PAGE 2 OF 2

DUKE POWER COMPANY
CONSTRUCTION DEPARTMENT
PROJECT MARSHALL

SOIL TEST BORING FIELD REPORT

JOB NO. N/A
JOB NAME FLYASH LANDFILL MW's
DATE 6-30-89 WEATHER HOT

STARTING TIME N/A
GROUND SURFACE ELEV. _____
HRS. DRILLING N/A HRS. MOVING N/A
INSPECTOR D. DICKSON BORING NO. MW-4A

SAMPLING		1ST 6"	2ND 6"	3RD 6"	SCALE	UD	SOIL CLASSIFICATION AND REMARKS
					40		
9	44.2 45.0/2		50=4"		45		OLIVE BROWN MICA. SILTY FINE TO COARSE SAND.
10	49.2 49.5		50=3"		50		LT. OLIVE GRAY MICA. SILTY FINE TO COARSE SAND
							AUGER REFUSAL @ 49.6' BORING TERMINATED
					55		SET MONITOR WELL PER ATTACHED SKETCH.
					60		
					65		
					70		
					5		
					0		

BORING TERMINATED @ 49.6
BORING REFUSAL AUGER @ 49.6
WATER TOB DEPTH 46.0' ON 6-30-89
WATER 24 HR: DEPTH 31.7' ON 7-6-89
WATER LOSSES N/A
CASING SIZE N/A LENGTH 0

METHOD OF ADVANCING BORING	DEPTH
POWER AUGER	0 TO 49.6
~~HAND CHOP: W/MUD: W/WATER~~	— TO —
~~ROTARY DRILL: W/MUD: W/WATER~~	— TO —
~~DIAMOND CORE~~	— TO —

+ STANDARD PENETRATION RESISTANCE IS SUM OF BLOWS FOR 2ND 6" AND 3RD 6" TO DRIVE 1-3/8" I.D., 2" O.D. SPLIT BARREL SAMPLER WITH 140 POUND HAMMER FALLING 30 INCHES

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT – GROUNDWATER SECTION
P.O. BOX 27687 – RALEIGH,N.C. 27611, PHONE (919) 733-5083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR DUKE POWER CO.
DRILLER REGISTRATION NUMBER 421
STATE WELL CONSTRUCTION PERMIT NUMBER: 18-04

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: DENVER
HIGHWAY # 150
(Road, Community, or Subdivision and Lot No.)
County: CATAWBA

2. OWNER DUKE POWER CO.
ADDRESS P.O. BOX 33189 (Street or Route No.)
CHARLOTTE NC 28242
City or Town State Zip Code

3. DATE DRILLED 6-30-89 USE OF WELL MONITORING
4. TOTAL DEPTH 49.6 CUTTINGS COLLECTED ☑ Yes ☐ No
5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☑ No
6. STATIC WATER LEVEL: 34.3 FT. ☐ above ☑ below TOP OF CASING,
TOP OF CASING IS 2.6 FT. ABOVE LAND SURFACE.
7. YIELD (gpm): N/A METHOD OF TEST N/A
8. WATER ZONES (depth): N/A
9. CHLORINATION: Type N/A Amount N/A

DRILLING LOG

Depth From	Depth To	Formation Description
		SEE ATTACHED SOIL TEST BORING FIELD REPORT FOR # MW-4

If additional space is needed use back of form.

10. CASING:

	Depth From	Depth To	Diameter	Wall Thickness or Weight/Ft.	Material
	0	37.4 Ft.	2" I.D.	.154	PVC
		Ft.			
		Ft.			

11. GROUT:

	Depth From	Depth To	Material	Method
	0	32.5 Ft.	NEAT CEMENT	POURED
		Ft.		

12. SCREEN:

	Depth From	Depth To	Diameter	Slot Size	Material
	37.4	47.4 Ft.	2" I.D. in.	.010 in.	PVC
		Ft.	in.	in.	
		Ft.	in.	in.	

13. GRAVEL PACK:

	Depth From	Depth To	Size	Material
	35.5	49.6 Ft.		NC #2 SAND
		Ft.		

14. REMARKS: BENTONITE SEAL PLACED FROM 32.5 - 35.5'

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

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

Thomas L. Watson 7-15-89
SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 Revised 11/84
Submit original to Division of Environmental Management and copy to well owner.

N. C. Department of Human Resources
Division of Health Services

WELL COMPLETION RECORD

MPLETE ALL INFORMATION REQUESTED BELOW FOR EACH WELL INSTALLED, AND RETURN FORM TO THE DEPARTMENT OF HUMAN RESOURCES, SOLID AND HAZARDOUS WASTE MANAGEMENT BRAN P. O. BOX 2091, RALEIGH, N.C. 27602

NAME OF SITE:	PERMIT NO.:
MARSHALL STEAM STATION	15-04
ADDRESS:	**OWNER (print):**
HIGHWAY #150 TERRELL, NC	DUKE POWER CO
DRILLING CONTRACTOR:	**REGISTRATION NO.:**
DUKE POWER CO.	921

Casing Type: TRILOC THREADED PVC dia. 2 in. Grout Depth: from 0 to 32.5 ft. - dia. 6
Casing Depth: from 0 to 37.4 ft. - dia. 2 in. Bentonite Seal: from 32.5 to 35.5 ft. - dia. 6
Screen Type: TRILOC THREADED PVC dia. 2 in. Sand/Gravel PK: from 35.5 to 49.6 ft. - dia. 6
Screen Depth: from 37.4 to 47.4 ft. - dia. 2 in. Total Well Depth: from 0 to 49.6 ft. - dia. 6

Static Water Level: 34.3 feet from top of casing Date Measured 7/6

Yield (gpm): N/A Method of Testing: N/A Casing is 2.6 feet above land su

DRILLING LOG

DEPTH FROM	TO	FORMATION DESCRIPTION
		SEE ATTACHED
		SOIL TEST BORING
		FIELD REPORT
		FOR MW-#4.

LOCATION SKETCH

(show distance to numbered roads, or other map reference po

REMARKS: EXCEED IS RATED AS THE MOST HYDRAULICALLY CONDUCTIVE ZONE PER CONVERSATIONS WITH RALPH ROBERTS AND ED SULLIVAN.

DATE: 7-18-89 SIGNATURE: Mitzi L. Jackson

Form CI-51P	Revision 0	Page

DUKE POWER COMPANY — MARSHALL STEAM STA.

AS-BUILT INSTALLATION SKETCH

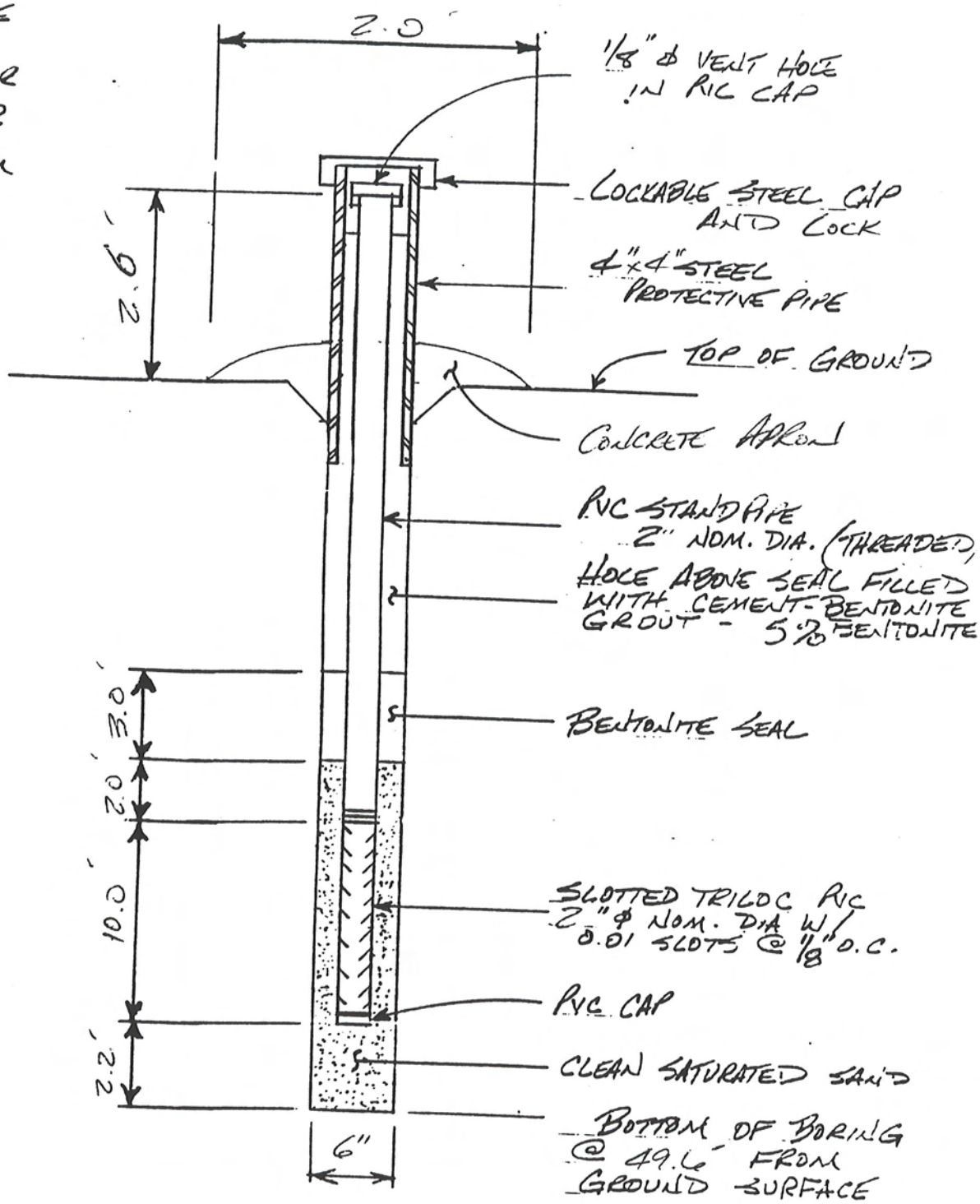
Instrument No. MW-4 Station N/A Offset N/A

By D. DICKSON Date 7-15-89

NOTE:
NOT TO SCALE

INITIAL WATER LEVEL RDG @ 34.3' FROM TOP/PIPE ON 7-6-89

T/PIPE ELEV. 15



S&ME, Inc.

ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

Telephone:
Fax:

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Duke Power-Marshall Steam Station-Ash Basin Monitor Well Installation**			**Boring No. MW-4D**
Location: **Terrell, North Carolina**		Number: **1356-06-834**	Sheet No. 1 of 2
Boring Depth (ft): **60.5**	Elevation (ft): **TBD**	Driller: **Larry Shrader, NC Cert. No. 3349**	Date Drilled: **10/12/06**
Logged By: **Courtney Withers**	Water Level: **25.5 ft bls at 24 hrs**		Drilling Method: **4¼" H.S.A.**

Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
	5		FILL: Firm, Red, Slightly Clayey, Silty, Coarse to Fine **SAND** With Rock Fragments		13
	10		SAPROLITE: Loose, White, Brown, and Orange, Micaceous, Silty, Very Fine **SAND**		10
	15		SAPROLITE: Loose, White and Orange, Micaceous, Coarse to Fine **SAND**		10
	20		SAPROLITE: Firm, Orange, Brown, and White, Micaceous, Coarse to Fine **SAND**		10
	25		SAPROLITE: Firm, Brown, White, and Red, Micaceous, Silty, Very Fine **SAND**		12
	30		SAPROLITE: Firm, White and Orange, Coarse to Fine **SAND** SAPROLITE: Stiff to Very Hard, Brown, White, and Orange, Micaceous, Very Fine Sandy **SILT** With Coarse Sand Lenses		11
					11

BORING LOG WITH WELL MARSHALL ASH BASIN.GPJ LAGWGN01.GDT 11/16/06

S&ME, Inc.

ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

Telephone:
Fax:

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
2. PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

Project: **Duke Power-Marshall Steam Station-Ash Basin Monitor Well Installation**			**Boring No. MW-4D**
Location: **Terrell, North Carolina**		Number: **1356-06-834**	Sheet No. 2 of 2
Boring Depth (ft): **60.5**	Elevation (ft): **TBD**	Driller: **Larry Shrader, NC Cert. No. 3349**	Date Drilled: **10/12/06**
Logged By: **Courtney Withers**	Water Level: **25.5 ft bls at 24 hrs**		Drilling Method: **4¼" H.S.A.**

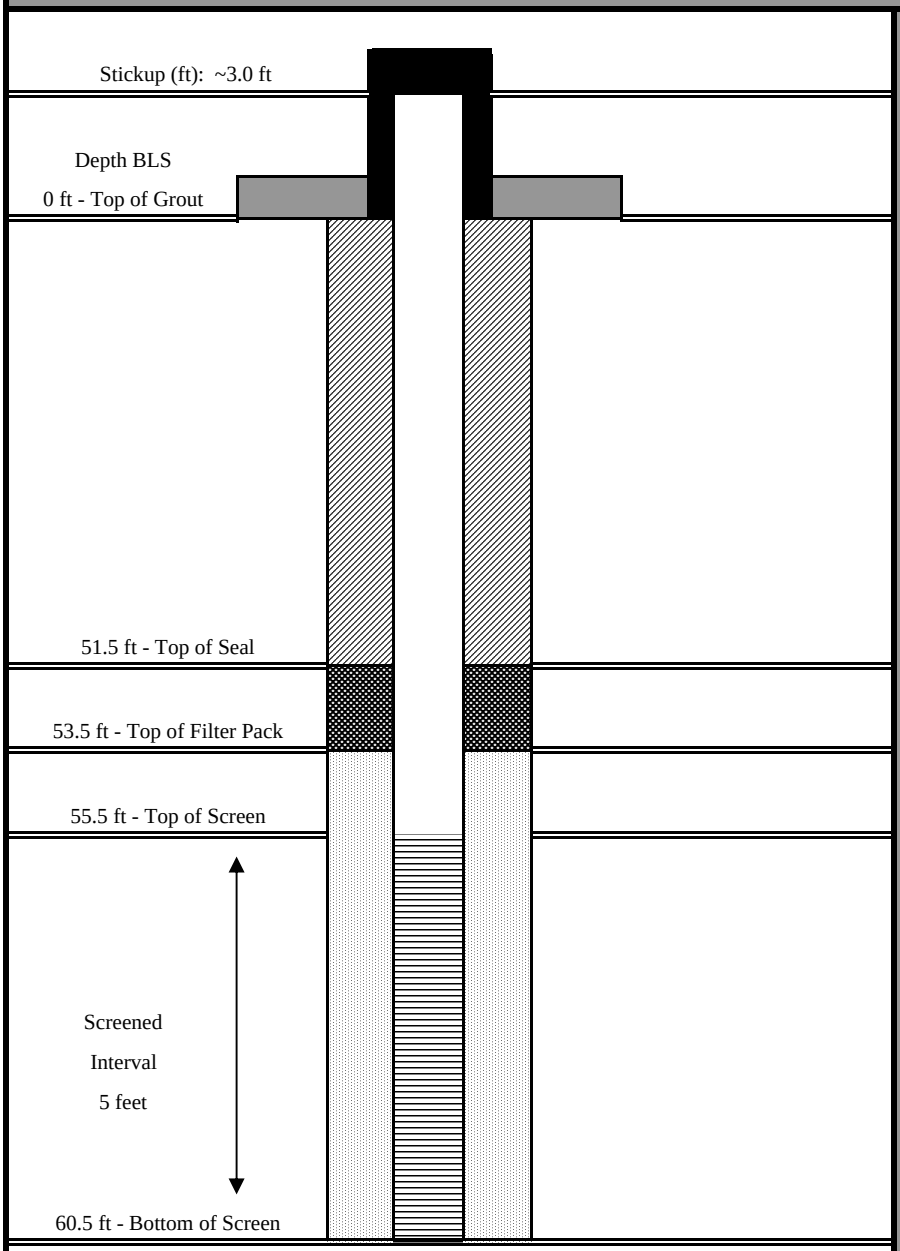
Elev. (Feet)	Depth (Feet)	Lith-ology	Material Description	Well Construction	Penetration Resistance (Blows/Foot) 0 50 100
	40				19
	45				52
	50		PARTIALLY WEATHERED ROCK: When Sampled Becomes Very Dense, Black and White, Medium to Very Fine **SAND**		50/2 >>
			Auger Refusal at 50.5 ft bls		
			BEDROCK: Fine-Grained Biotite Gneiss		
	55				
			Boring Terminated at 60.5 ft bls		
	60		**See Attached Core Picture for Recovery and RQD**		

BORING LOG WITH WELL MARSHALL ASH BASIN.GPJ LAGWGN01.GDT 11/16/06

MONITORING WELL CONSTRUCTION

WELL ID: MW-4D **TOTAL DEPTH: 60.5 ft bls**

S&ME PROJECT AND NO:			WELL USE / TYPE:	INSTALLATION DATE:
Marshall Steam Station, 1356-06-834			Monitoring	10/12/2006
DRILLING CONTRACTOR:	DRILLER AND LICENCE NO.:			DRILLING METHOD:
S&ME, Inc.	Larry Shrader, 3349			4.25 H.S.A.
24-HR WATER LEVEL:	NORTHING:	EASTING:	TOP OF CASING ELEV.:	GROUND SURFACE ELEV.:
25.5 ft bls	TBD	TBD	TBD	TBD



PAD TYPE:
2'x2' Concrete

PROTECTIVE CASING:
4"x4" Lockable Steel

CASING TYPE:
2-inch Sch. 40 PVC

CASING INTERVAL:
0 to 55.5 ft bls

SCREEN TYPE:
2-inch 0.010 Slot Sch. 40 PVC

SCREEN INTERVAL
55.5 to 60.5 ft bls

GROUT TYPE:
Neat Cement

GROUT INTERVAL
0 to 51.5 ft bls

SEAL TYPE:
Bentonite

SEAL INTERVAL:
51.5 to 53.5 ft bls

FILTER PACK:
#3 Filter Sand

FILTER PACK INTERVAL:
53.5 to 60.5 ft bls

DEVELOPMENT:
Purged ~35 Gallons

NOTES:

TBD - To Be Determined

For Lithologic Information See Attached Boring Log

WELL CONSTRUCTION RECORD

(MW-4D)

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

WELL CONTRACTOR (INDIVIDUAL) NAME (prin Larry Shrader **CERTIFICATION #** 3349

WELL CONTRACTOR COMPANY NAME S&ME, Inc. **PHONE #** 704-523-4726

STATE WELL CONSTRUCTION PERMIT# _____ **ASSOCIATED WQ PERMIT#** _____

(if applicable) (if applicable)

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

2. WELL LOCATION:
   Nearest Town: Terrell County Iredell
   Marshall Steam Station
   (Street Name, Numbers, Community, Sudivision, 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: Duke Power
   Address 526 South Church Street
   (Street or Route No.)
   Charlotte NC 28202
   City or Town State Zip Code
   (704) 373-7900
   Area code - Phone Number

4. DATE DRILLED 10/12/2006
5. TOTAL DEPTH 60.5
6. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☒
7. STATIC WATER LEVEL Below Top of Casing: 28.5 ft.
   (Use "+" if Above Top of Casing)
8. TOP OF CASING IS ~3 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 n/a
12. CASING:

	Depth		Diameter	Wall Thickness or Weight/Ft.	Material
From 0	To 55.5	Ft.	2-inch	Sch. 40	PVC
From	To	Ft.			
From	To	Ft.			

13. GROUT:

	Depth		Material	Method
From 0	To 51.5	Ft.	Neat Cement	Pour
From 51.5	To 53.5	Ft.	Bentonite	Pour

14. SCREEN:

	Depth		Diameter		Slot Size		Material
From 55.5	To 60.5	Ft.	2-inch	in.	0.01	in.	PVC
From	To	Ft.		in.		in.	

15. SAND/GRAVEL PACK:

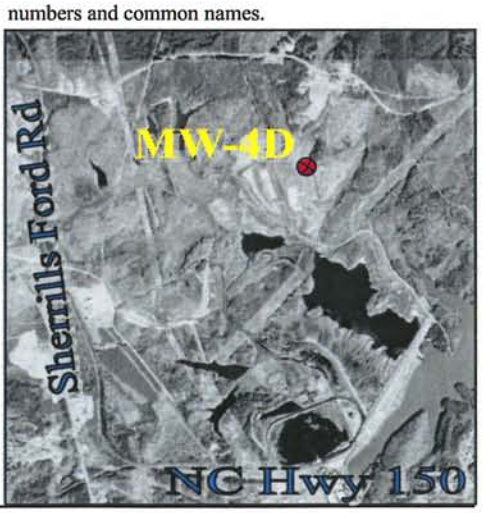
	Depth		Size	Material
From 53.5	To 60.5	Ft.	#3	Silica Sand
From	To	Ft.		

16. REMARKS: _____

DEPTH From	DEPTH To	DRILLING LOG Formation Descrpition
0	9	Fill
9	13	Silty Very Fine Sand
13	24.5	Coarse to Fine Sand
24.5	28	Silty Very Fine Sand
28	28.5	Coarse to Fine Sand
28.5	48.5	Very Fine Sandy Silt
48.5	50.5	PWR
50.5	60.5	Bedrock

LOCATION SKETCH

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



I DO HERE BY 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

Larry W. Shrader 11/20/06

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

MACTEC

engineering and constructing a better tomorrow

August 26, 2010

Mr. Jim Lindquist, Engineer
Duke Energy Corporation
Marshall Steam Station
8320 East NC Highway 150
Terrell, North Carolina 28682

Subject: **Ash Basin Monitoring Well Installation Report**
Marshall Steam Station
Terrell, Catawba County
MACTEC Project No.: 6228-10-5284

Dear Mr. Lindquist:

The purpose of this report is to present the results of monitoring well installation and evaluation activities conducted between July 26 and August 13, 2010 at the above-referenced site (Figure 1). The well installation and testing was conducted in general accordance with the requirements outlined in the Ash Basin Groundwater Monitoring Well Installation Project Work Summary (Work Summary) provided by Duke Energy (Duke) and dated May 21, 2010. The following Figures, Tables and Appendices have been included:

Figure 1: Site Location Map
Figure 2: Monitoring Well Location Map
Table 1: Summary of Well Construction Details
Table 2: Summary of Slug Test Results
Appendix A: Rock Core Photographs
Appendix B: Soil Boring Logs
Appendix C: Monitoring Well Records
Appendix D: Monitoring Well Development Records
Appendix E: Photographs of Completed Well Pairs
Appendix F: Slug Test Data

Five Type II groundwater monitoring well pairs (a total of 10 wells) were installed between July 26 and August 6, 2010 at the locations shown on Figure 2. The well locations were pre-determined by Duke and marked in the field with wooden stakes and survey flagging. Each well pair consisted of one shallow well (using the identifier "S") set into overburden soils and one deep well (using the identifier "D) set into bedrock. Standard Penetration Testing (SPT) and split-spoon sampling was performed at five-foot intervals from the surface to bedrock during installation of the deep well at each well pair. Soils observed in the split-spoon samples were logged in the field in accordance with the Unified Soil Classification System (ASTM D2487/D2488). Upon auger refusal, each deep boring was extended a minimum of 10 feet into competent bedrock using HQ-sized rock core techniques.

Rock core samples were logged in the field in accordance with the Field Guide for Rock Core Logging and Fracture Analysis established by Midwest Geosciences. As specified in the Work Summary, split-spoon sampling and rock coring were not performed during installation of the shallow wells. Photographs of rock cores obtained during installation of the five deep wells are included as Appendix A.

Shallow wells were installed using 4.25-inch ID hollow stem augers; deep wells were installed using 4.25-inch ID hollow stem augers to refusal, then HQ-sized rock core approximately 10 feet into competent bedrock. Total depths for shallow wells ranged from 18 feet below ground surface (bgs) in MW-13S to 52 feet bgs in MW-11S. Total depths for bedrock wells ranged from 46.5 feet bgs in MW-13D to 95 feet bgs in MW-12D. Shallow wells were constructed with 15 feet of 0.010-slot 2-inch diameter PVC well screen and riser with well screens set so that 10 feet of screen is below the static water table at the time of installation. Deep wells were constructed with 5-foot well screens set across low-RQD bedrock core intervals in the deep wells to facilitate maximum water flow through each well. Filter sand was placed in the annular space between the augers and the casing from the total depth of the well to approximately 2 feet above the screen. A bentonite seal was placed on top of the filter pack and the well was grouted to the surface. Please note that shallow well depths were typically adjusted after installation, but prior to placement of bentonite, to account for rise in hydraulic head observed at each location. In these instances, additional filter sand was placed between the bottom of the borehole and the bottom of the well. Each well was completed with a stand-up well cover that extends approximately 30 inches above-grade and set into a 2-foot by 2-foot concrete pad. Monitoring well ID tags were secured to the outside of the stand-up covers and well numbers were etched into the wet concrete pad. Soil boring logs and well construction records for the 10 monitoring wells installed in during this work have been included as Appendix B and C, respectively.

Subsequent to installation, each well was developed using a submersible or bladder pump to remove fine-grained material. In general, each well was purged until the development water appeared visually clear, at which time, water quality parameters (temperature, pH, conductivity and turbidity) were recorded in 5-gallon increments until turbidity readings were less than or equal to 10 NTUs. Purge water generated during well development ranged from 60 gallons to 140 gallons and was discharged to the ground surface adjacent to each well. Please note that water quality parameters were not recorded for well MW-12S. However, 140 gallons of water were purged from the well during well development. Monitoring well development records are included as Appendix D. Photographs of the completed monitoring well pairs are included as Appendix E.

Rising head slug tests were performed on each well on August 12 and 13, 2010. Prior to the tests an In-situ Level Troll pressure transducer and 2-foot long stainless steel slug were placed into the well. The water level in the well was recorded as a "Background" test until the well recharged to within 90% of the original measurement. Subsequent to normalization, the rising head test was started, the slug was removed and the change in head versus time was measured using a Rugged-reader data logger. Slug test data was analyzed using Aqtesolv software to estimate hydraulic conductivity in each well. A summary of slug test data is presented in Table 2. Copies of raw data generated during completion of the rising head slug tests are included in Appendix F.

Please contact the undersigned at (704) 357-8600, if you have questions or comments concerning this project.

Sincerely,

MACTEC ENGINEERING AND CONSULTING, INC.

Linda Campbell

Mark P. Filardi, P.G.
Senior Geologist

Robert C. Foster

Robert C. Foster, L.G.
Principal

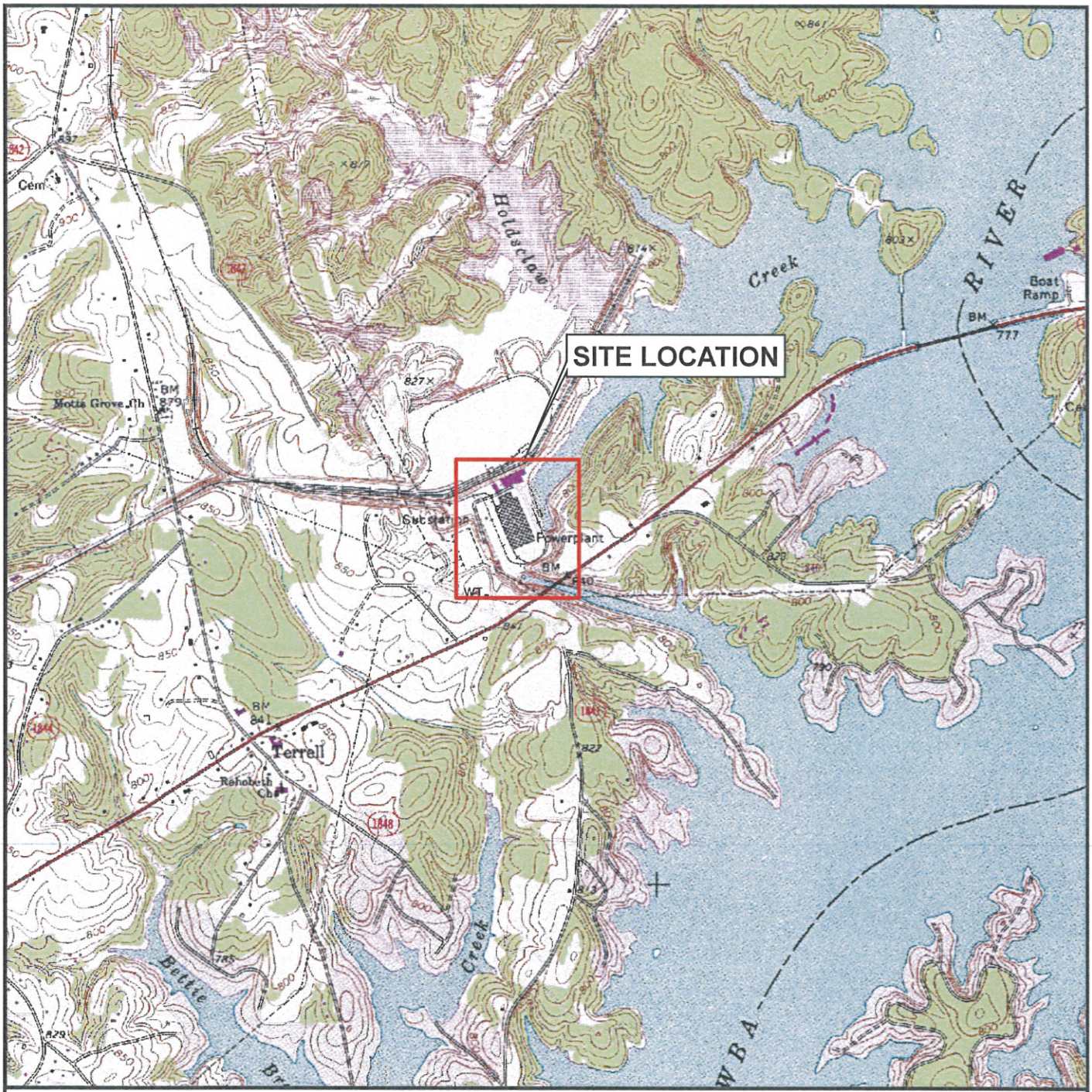
NORTH CAROLINA SEAL 1555 GEOLOGIST ROBERT C. FOSTER

Enclosures

cc: William M. Miller, PE, PLS, S&ME

For Mark P. Filardi
With Permission

FIGURES



Source: USDA-NRCS Digital Raster Graphic Mosaic for Catawba County, NC, dated 2005.

Site Location

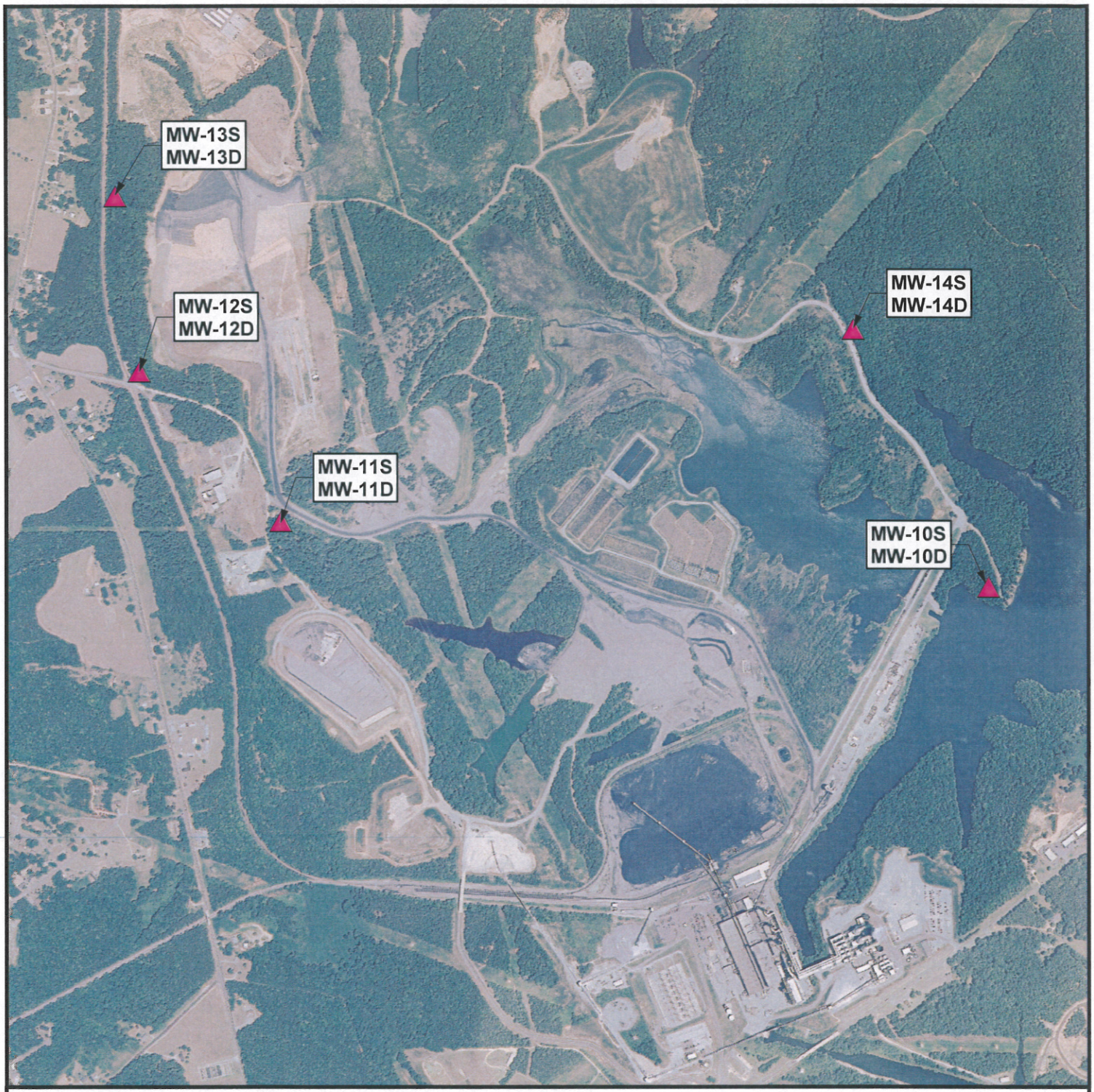
N

0 1,000 2,000 4,000 6,000 8,000 Feet

MACTEC

SITE LOCATION MAP
DUKE ENERGY
MARSHALL STEAM STATION
CATAWBA COUNTY, NORTH CAROLINA

PREPARED BY	DATE	CHECKED BY	DATE	JOB NUMBER	FIGURE
MPF	8-20	RAF	8-20-10	6228-10-5284	1



Source: Mecklenburg County Geographic Information Systems (GIS), dated 2009.

Site Location

Monitoring Well Location

N

0 625 1,250 2,500 3,750 5,000 Feet

MACTEC

MONITORING WELL LOCATIONS
DUKE ENERGY
MARSHALL STEAM STATION
CATAWBA COUNTY, NORTH CAROLINA

PREPARED BY	DATE	CHECKED BY	DATE	JOB NUMBER	FIGURE
MPF	8-20	RVF	8-20-10	6228-10-5284	2

TABLES

Table 1
Summary of Well Construction Details
Marshall Steam Station, Terrell, North Carolina

Well Number	Coordinates		Drilling Method	Construction Details				Measured Details		
	Latitude	Longitude		Well Diameter (I.D. in.)	Borehole Depth (ft bgs)	Well Depth (ft bgs)	Screen Interval (ft bgs)	Well Depth (ft below TOC)	Depth to Water (ft below TOC)	Water Column Thickness (ft)
MW-10S	35*36.36690	80*58.42864	Hollow-stem Auger	2	35.0	27.0	12 - 27	29.44	16.64	12.80
MW-10D	35*36.36670	80*58.44289	HSA/Rock Core	2	85.4	85.4	80.4 - 85.4	87.69	16.23	71.46
MW-11S	35*36.47900	80*58.76251	Hollow-stem Auger	2	55.0	52.0	37 - 52	54.38	43.77	10.61
MW-11D	35*36.47871	80*58.76130	HSA/Rock Core	2	90.5	90.5	85.5 - 90.5	93.32	43.40	49.92
MW-12S	35*36.42126	80*58.28465	Hollow-stem Auger	2	40.0	22.0	7 - 22	25.32	14.28	11.04
MW-12D	35*36.43905	80*58.31988	HSA/Rock Core	2	106.4	95.0	90 - 95	98.59	15.21	83.38
MW-13S	35*36.50564	80*58.42262	Hollow-stem Auger	2	25.5	18.0	3 - 18	21.12	5.70	15.42
MW-13D	35*36.50991	80*58.43568	HSA/Rock Core	2	46.5	46.5	41.5 - 46.5	48.61	3.59	45.02
MW-14S	35*36.39923	80*58.30479	Hollow-stem Auger	2	49.0	43.0	28 - 43	47.13	36.36	10.77
MW-14D	35*36.39410	80*58.31292	HSA/Rock Core	2	60.0	60.0	55 - 60	62.85	36.98	25.87

ft bgs = feet below ground surface

Prepared by/Date: MPF 8-19-10
Checked by/Date: RCF 8-26-10

TABLE 2
Summary of Slug Test Results
Marshall Steam Station
MACTEC Engineering and Consulting, Inc.
MACTEC Project No. 6228-10-5284

Slug Test ID	Test Type	Test Date	Well Diameter (I.D. in.)	Borehole Depth (ft bgs)	Well Depth (ft bgs)	Screen Interval (ft bgs)	Well Depth (ft below TOC)	Depth to Water (ft below TOC)	Water Column Thickness (ft)	TOP of Screen (ft below TOC)	Rising Head Test Results in cm/sec			Average K cm/sec
											Bouwer & Rice	Dagan[1]	Hvorslev	
MW-10S	Rising Head	8/16/2010	2	35.0	27.0	12 - 27	29.44	16.64	12.80	14.44	7.49E-04	9.22E-04	1.36E-03	1.01E-03
MW-10D	Rising Head	8/16/2010	2	85.4	85.4	80.4 - 85.4	87.69	16.23	71.46	82.69	1.13E-04	-	1.19E-04	1.16E-04
MW-11S	Rising Head	8/16/2010	2	55.0	52.0	37 - 52	54.38	43.77	10.61	39.38	1.54E-03	1.29E-03	2.05E-03	1.62E-03
MW-11D	Rising Head	8/16/2010	2	90.5	90.5	85.5 - 90.5	93.32	43.40	49.92	88.32	3.43E-05	-	3.45E-05	3.44E-05
MW-12S	Rising Head	8/16/2010	2	40.0	22.0	7 - 22	25.32	14.28	11.04	10.32	1.56E-03	1.79E-03	1.45E-03	1.60E-03
MW-12D	Rising Head	8/16/2010	2	106.4	95.0	90 - 95	98.59	15.21	83.38	93.59	1.34E-04	-	1.30E-04	1.32E-04
MW-13S	Rising Head	8/16/2010	2	25.5	18.0	3 - 18	21.12	5.70	15.42	6.12	2.40E-04	-	2.73E-04	2.56E-04
MW-13D	Rising Head	8/16/2010	2	46.5	46.5	41.5 - 46.5	48.61	3.59	45.02	43.61	7.92E-04	-	7.05E-04	7.48E-04
MW-14S	Rising Head	8/16/2010	2	49.0	43.0	28 - 43	47.13	36.36	10.77	32.13	9.57E-04	8.91E-04	1.01E-03	9.52E-04
MW-14D	Rising Head	8/16/2010	2	60.0	60.0	55 - 60	62.85	36.98	25.87	57.85	6.02E-04		6.48E-04	6.25E-04

Notes:
1 - Dagan method applicable to wells screened across the water table.
2 - Barker-Black is a fractured rock method and was not used on saprolite wells.
ft bgs = feet below ground surface
TOC - Top of casing

Prepared by: CHB Date: 8/24/10
Checked by: RCF Date: 8-24-10

APPENDICES

APPENDIX A
ROCK CORE PHOTOGRAPHS

Photo 1: Well MW-10D – Core Run #1 (74.7 – 75.2 ft.)

Photo 2: MW-10D, Core Run #2 (75.2 – 80.4 ft.)

Photo 3: MW-10D, Core Run #2 (75.2 – 80.4 ft.)

Photo 4: MW-10D, Entire Core including Core Run #3 (80.4 – 85.4 ft.)

Photo 5: MW-14D, Core Run #1 (50.0 – 51.3 ft.)

Photo 6: MW-14D, Core Run #2 (51.3 – 56.2 ft.)

Photo 7: MW-14D, Core and Run #3 (56.2 – 60.1 ft.)

Photo 8: MW-11D, Core Run #1 (80.5 – 80.8 ft.)

Photo 9: MW-11D, Core #2 (80.8 – 85.6 ft.)

Photo 10: MW-11D, Core Run #3 (85.6 – 90.6 ft.)

Photo 11: MW-12D, Top of Core Runs #1 (94.0 – 96.2 ft.) and #2 (96.2 – 101.5 ft.)


Photo 12: MW-12D, Bottom of Core Runs #1 (94.0 – 96.2 ft.) and #2 (96.2 – 101.5 ft.)

Photo 13: Top of core Run #3 (101.5 – 106.4 ft.)

Photo 14: Bottom of Core Run #3 (101.5 – 106.4 ft.)

Photo 15: MW-12D, Entire Core

Photo 16: MW-13D, Core Run #1 (36.0 – 40.2 ft.)

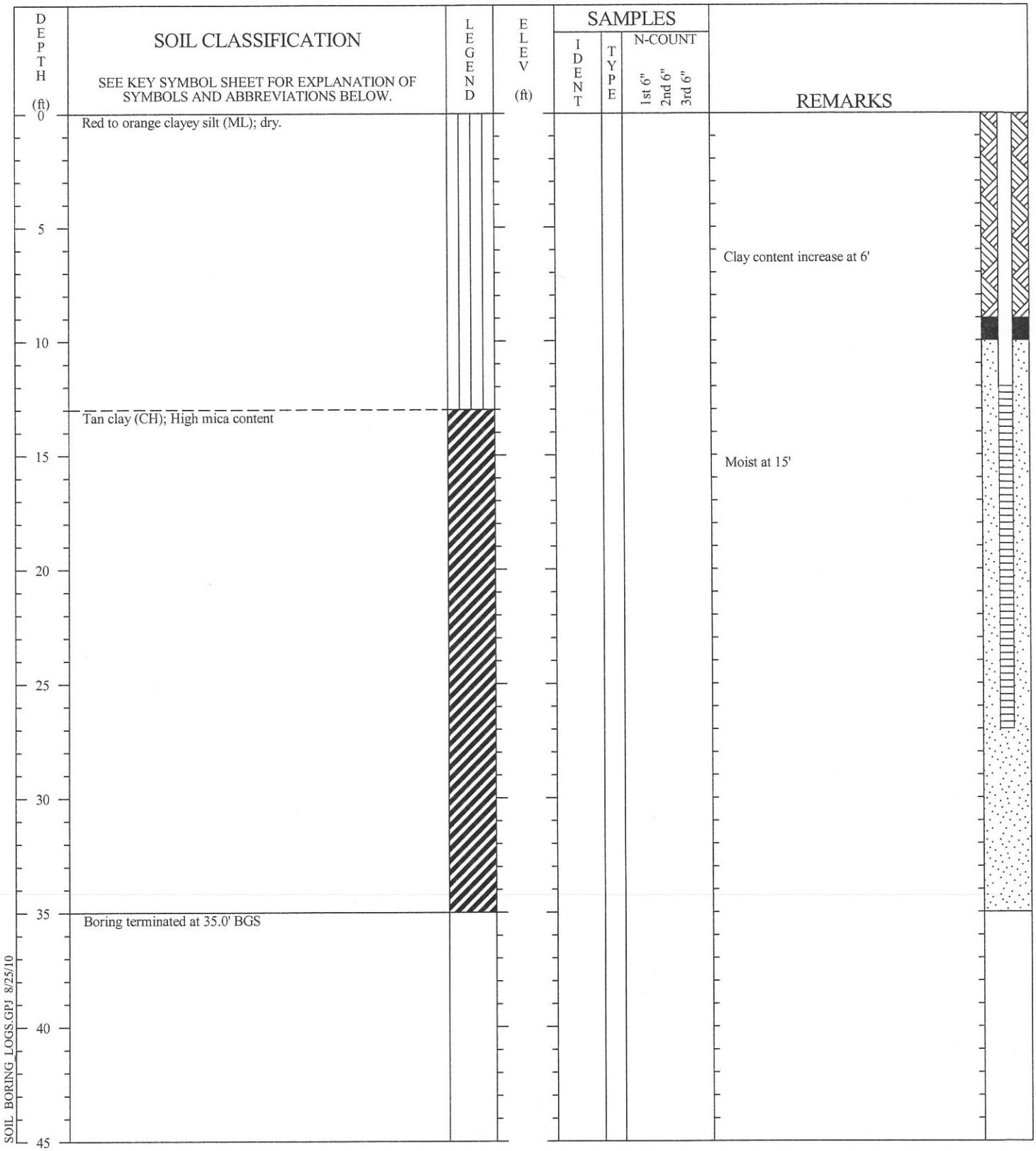
Photo 17: MW-13D, Core Run #1 (36.0 – 40.2 ft.) and Top of Core Run #2 (40.2 – 45.1 ft.)

Photo 18: MW-13D, Core Run #2 (40.2 – 45.1 ft.) and top of Core Run #3 (45.1 – 46.4 ft.)

Photo 19: MW-13D, Bottom of Core Run #2 (40.2 – 45.1 ft.)

Photo 20: MW-13D, Entire Core including Run #1 (36.0 – 40.2 ft.),
Run #2 (40.2 – 45.1 ft.) and Run #3 (45.1 – 46.4 ft.)

APPENDIX B
SOIL BORING LOGS



SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA
HOLE DIA.:
REMARKS: RVF 8-20-10

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-10S

July 26, 2010
PROJ. NO.: 6228-10-5284

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
0	Red to tan (2.5YR 5/8) silty fine sand (SM)						
				SS-1		3-3-5	
5							
	Strong brown (7.5YR 4/6) silty fine sand (SM)						
				SS-2		2-4-4	Micaceous Quartz mineral banding (9.5'-10.0')
10							
	Strong brown (7.5YR 4/6) silty clay (CL)						
				SS-3		3-2-2	Micaceous; Mafic mineral banding (14'-15')
15							
	Pale brown (10YR 6/3) silty fine sand (SM)						
				SS-4		2-3-4	Micaceous; Coarse quartz sand (19'-20')
20							Flowing sand (22'-23')
	Grayish brown (10YR 5/2) silty fine sand (SM)						
				SS-5		2-2-4	Quartz banding with trace Fe stained gravel
25							
				SS-6		1-2-3	Vertical quartz band with Fe staining from 29.5'-30.0'
30							
				SS-7		2-2-4	
35							
	Yellow (10YR 7/6) clayey sand (SC)						
				SS-8		2-4-6	Coarse quartz sand (39.5'-40.0') - possible top of PWR
40							
				SS-9		2-3-4	
45							

SOIL BORING LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.:
REMARKS: RAF 8-20-10

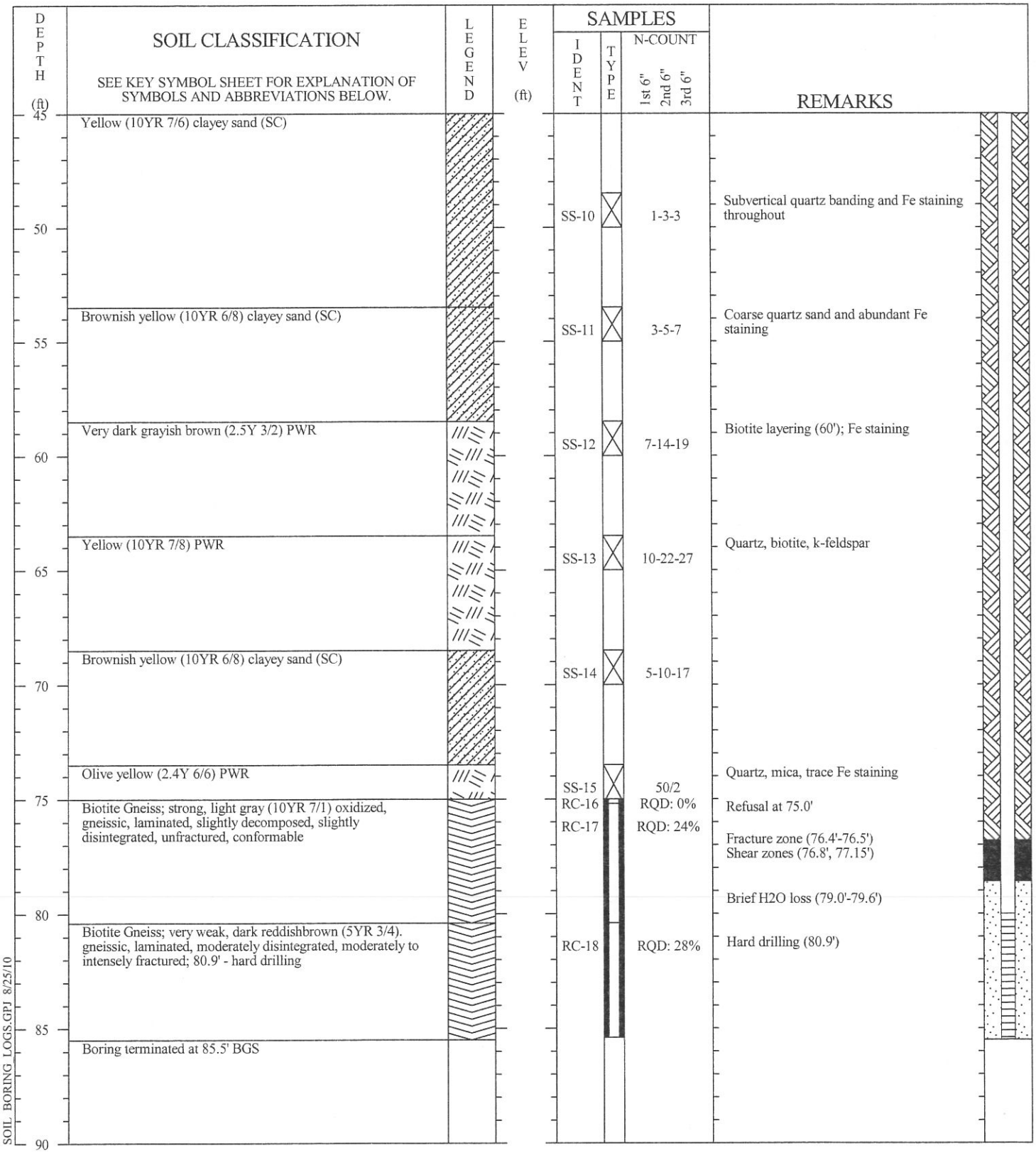
THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-10D

July 27, 2010
PROJ. NO.: 6228-10-5284

MACTEC



SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.:
REMARKS: RQF 8/20/10

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SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-10D

July 27, 2010
PROJ. NO.: 6228-10-5284

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
0	Red (2.5YR 5/8) clayey silt (ML)						Dry
5	Yellow (2.5YR 8/6) to light yellowish brown (2.5Y 6/3) silty fine sand (SM)						Dry
40	Yellow (10YR 5/8) to light gray (10YR 7/2) clayey fine sand (SW)						Increasing mica content Moist at 45' BGW
45							

SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA
HOLE DIA.:
REMARKS: RQF 8/20/10

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-11S

July 30, 2010
PROJ. NO.: 6228-10-5284

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES: IDENT	SAMPLES: TYPE	SAMPLES: N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
45	Yellow (10YR 5/8) to light gray (10YR 7/2) clayey fine sand (SW)						
50							
55	Boring terminated at 55.0' BGS						
60							
65							
70							
75							
80							
85							
90							

SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA
HOLE DIA.:
REMARKS: RCF 8/20/10

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-11S

July 30, 2010
PROJ. NO.: 6228-10-5284 **PAGE 2 OF 2**

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
0	Red (2.5YR 5/8) clayey silt (ML)						Some mica; dry
				SS-1		5-8-11	
5							
	Yellow (2.5YR 8/6) fine sand (SW)			SS-2		2-3-3	Dry; thinly laminated with quartz and Fe stained bands
10							
	Light yellowish brown (2.5Y 6/3) silty fine sand (SM)			SS-3		2-3-4	Micaceous
15							
				SS-4		2-2-4	Some gravel sized white clay (19.5'-20.0')
20							
				SS-5		3-3-5	Increasing secondary mineralization (white clay)
25							
				SS-6		3-3-5	
30							
				SS-7		3-3-4	Increasing Fe staining
35							
	Yellow (10YR 7/8) clayey fine sand (SC)						Micaceous
				SS-8		4-5-4	Moist at 40.0'
40							
				SS-9		3-3-4	
45							

SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.:
REMARKS: RVF 8/20/10

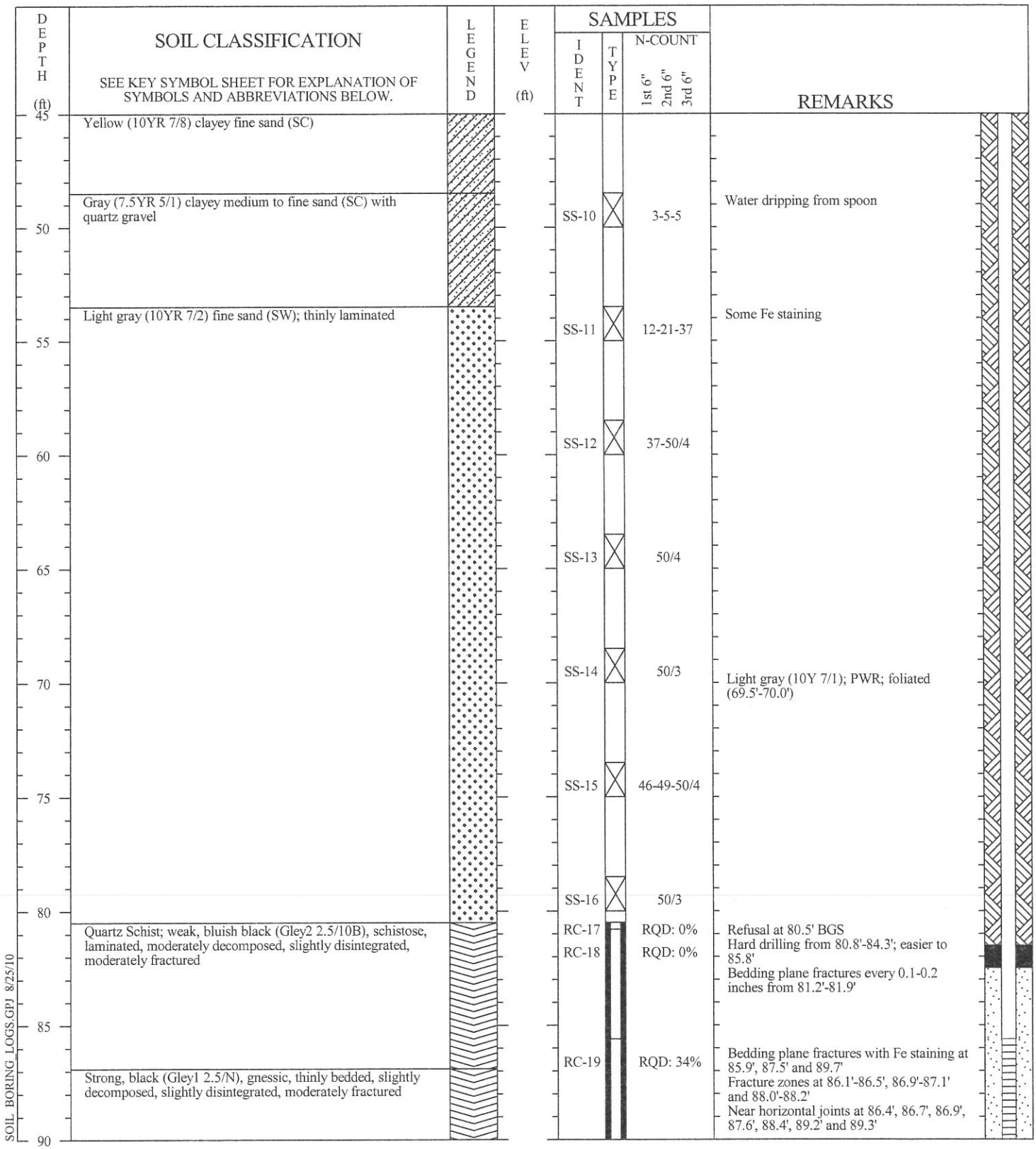
THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-11D

July 29, 2010
PROJ. NO.: 6228-10-5284

MACTEC



SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.:
REMARKS: RCF 8/20/10

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-11D

July 29, 2010
PROJ. NO.: 6228-10-5284

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
90	Boring terminated at 90.6' BGS						
95							
100							
105							
110							
115							
120							
125							
130							
135							

SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.:
REMARKS: RUF 8/20/10

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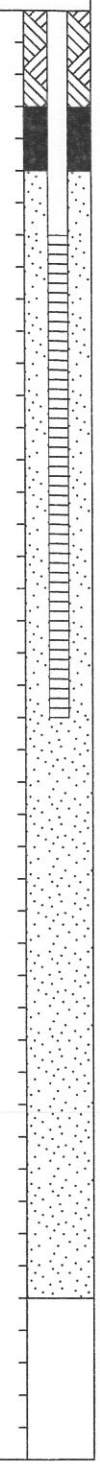
SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-11D

July 29, 2010
PROJ. NO.: 6228-10-5284 **PAGE 3 OF 3**

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
0	Light red (2.5YR 6/6) clayey silt (ML)						Dry
5	Yellow (10YR 7/8) clay silt (ML)						Dry; trace gravel
10							
15							
20							
25							Water on augers at 26'
30	Yellowish brown (10YR 5/6) silty clay (CL)						Moist
35							
40	Boring terminated at 40.0' BGS						Wet at 38'
45							



SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA
HOLE DIA.:
REMARKS: RCF 8/20/10

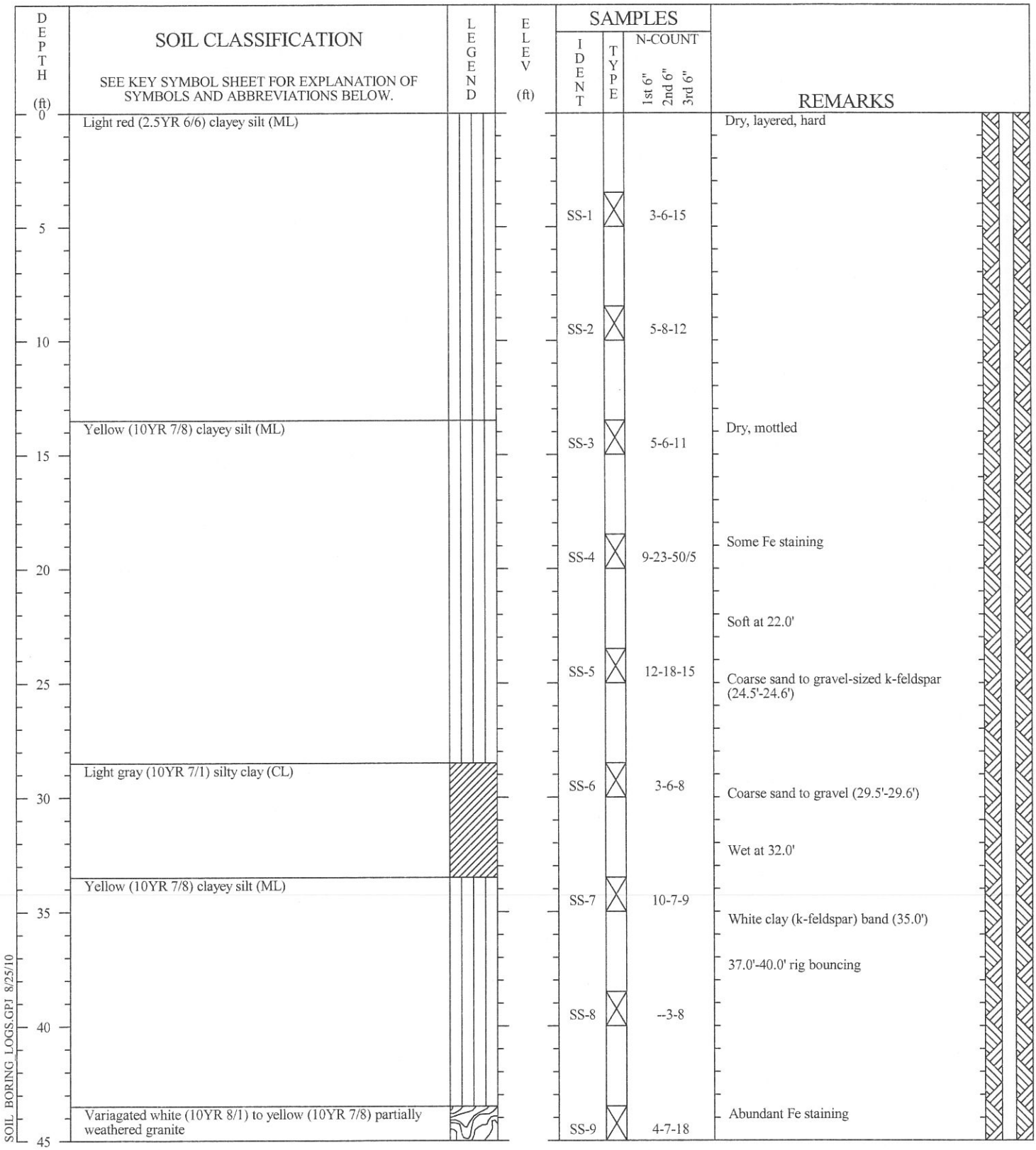
THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-12S

August 3, 2010
PROJ. NO.: 6228-10-5284 **PAGE 1 OF 1**

MACTEC



SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.:
REMARKS: RCF 8/20/10

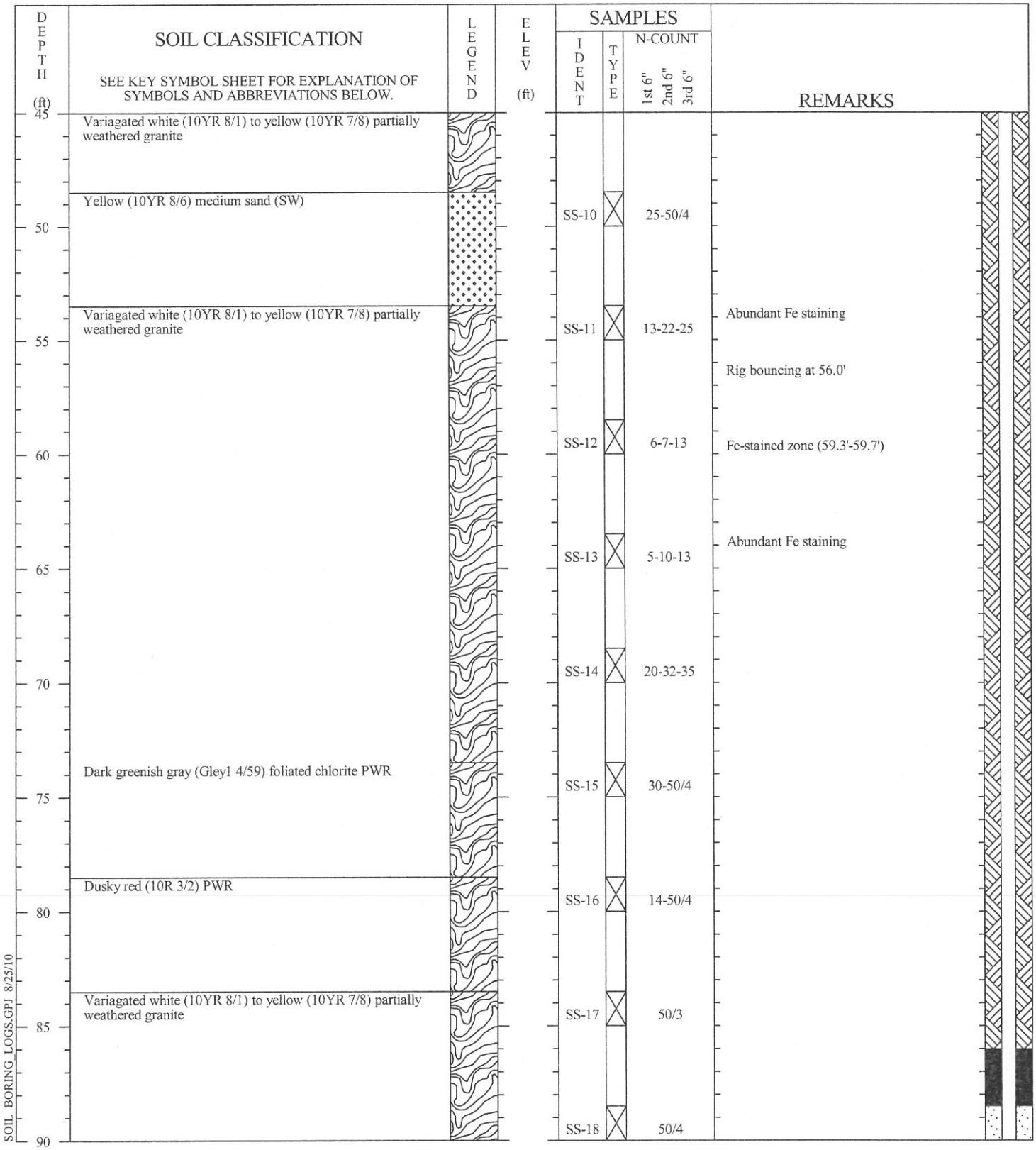
THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-12D

August 3, 2010
PROJ. NO.: 6228-10-5284

MACTEC



SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.:
REMARKS: ROF 8/20/10

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-12D

August 3, 2010
PROJ. NO.: 6228-10-5284

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
90	Variagated white (10YR 8/1) to yellow (10YR 7/8) partially weathered granite						
				SS-19		50/2	Refusal at 94.0' BGS
95	Granite, strong, dark gray (Gley1 4/N) phaneritic, massive, slightly foliated, slightly decomposed (94.0'-95.6') to fresh (95.6' to 96.2'), competent, slightly fractured			RC-20		RQD: 59%	Bedding plane fracture with Fe staining (95.1')
				RC-21		RQD: 77%	
100							
				RC-22		RQD: 69%	
	Foliated Granite: weak, dark gray (Gley1 4/N), Gneissic, foliated, moderately decomposed, disintegrated, unfractures						
105	Chlorite Mica Shist; strong, very dark gray (Gley1 3/N), shistose, laminated, fresh, competent, unfractured						
	Boring terminated at 106.4' BGS						
110							
115							
120							
125							
130							
135							

SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.:
REMARKS: RAF 8/20/10

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SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-12D

August 3, 2010
PROJ. NO.: 6228-10-5284 **PAGE 3 OF 3**

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
0	Red (2.5YR 5/8) silt (ML)						Dry
5							
7	Brownish yellow (10YR 6/6) silty clay (CL)						Dry
8	Very pale brown (10YR 7/3) medium sand (SP) with gravel						Moist
10	Light olive brown (2.5Y 5/3) clayey sand (SC)						Dry
15							
20							
25	Light olive brown (2.5Y 5/3) sandy clay (CL)						Wet, flowing
	Boring terminated at 25.5' BGS						
30							
35							
40							
45							

SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA
HOLE DIA.:
REMARKS: RCF 8/20/10

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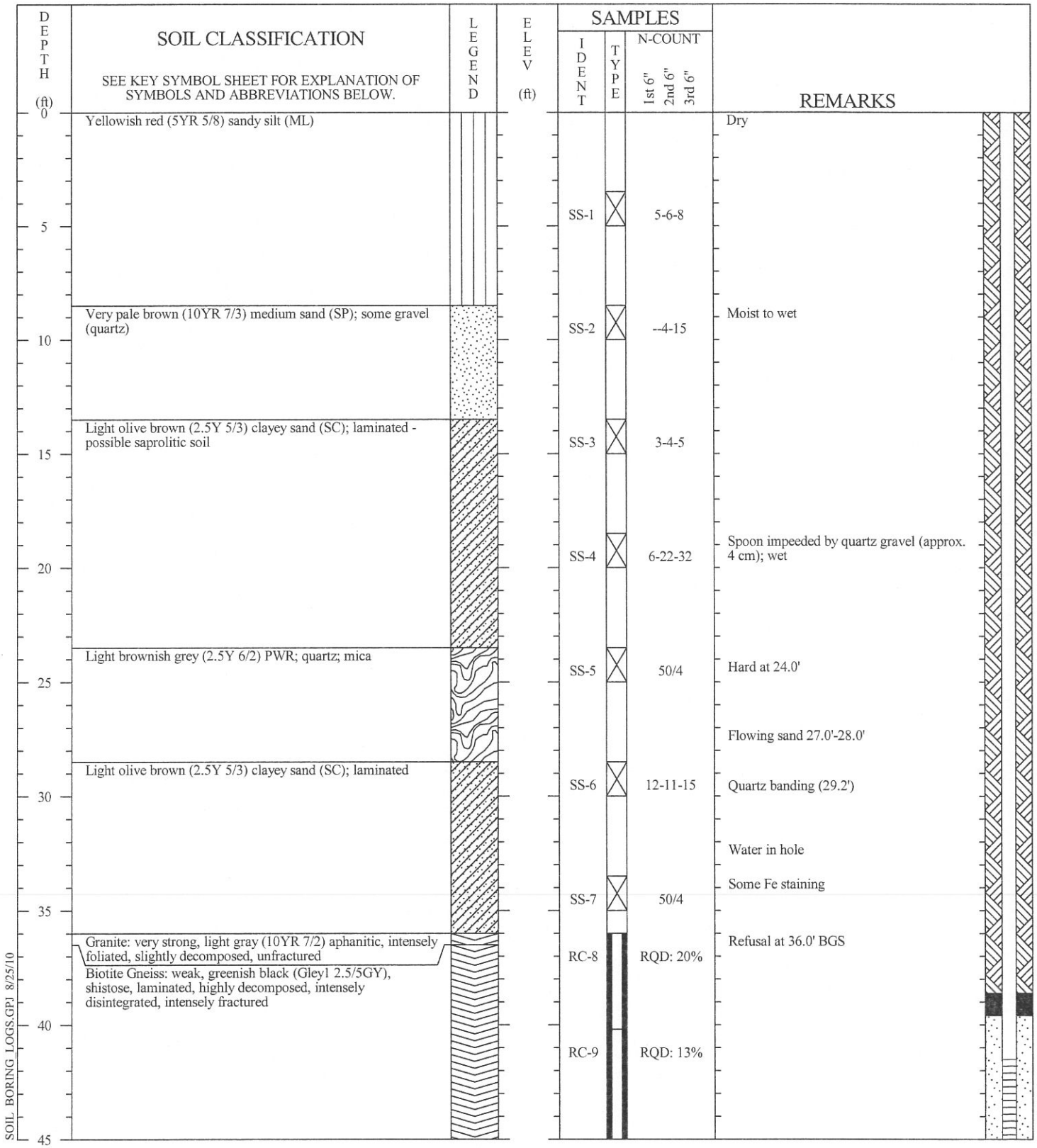
SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-13S

August 6, 2010
PROJ. NO.: 6228-10-5284 **PAGE** 1 **OF** 1

MACTEC



SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.:
REMARKS:

RCF 8/20/10

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SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-13D

August 4, 2010
PROJ. NO.: 6228-10-5284

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
45				RC-10		RQD: 0%	
	Boring terminated at 46.6' BGS						
50							
55							
60							
65							
70							
75							
80							
85							
90							

SOIL BORING LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.:
REMARKS: PGF 8/20/10

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-13D

August 4, 2010
PROJ. NO.: 6228-10-5284

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
0	Red (2.5YR 5/8) silty sand (SM)						Dry
5	Light brownish yellow (10YR 6/4) silty sand (SM)						Dry; micaceous
30							Trace clay at 33.0'
35							Some gravel at 37.0'
45							

SOIL BORING LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA
HOLE DIA.:
REMARKS: RJF 8/20/10

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SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-14S

July 30, 2010
PROJ. NO.: 6228-10-5284

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
45	Light brownish yellow (10YR 6/4) silty sand (SM)						
	Boring terminated at 49.0' BGS						
50							
55							
60							
65							
70							
75							
80							
85							
90							

SOIL BORING LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA
HOLE DIA.:
REMARKS: RCF 8/20/10

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-14S

July 30, 2010
PROJ. NO.: 6228-10-5284 **PAGE 2 OF 2**

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
0	Red (2.5YR 5/8) silty sand (SM)						Dry
				SS-1		4-5-6	
5							
	Light brownish yellow (10YR 6/4) silty sand (SM)			SS-2		2-3-4	Micaceous, dry
10							
				SS-3		2-4-4	Trace coarse-grained quartz banding and Fe-staining; dry
15							
				SS-4		4-5-6	
20							
				SS-5		6-11-12	
25							
				SS-6		9-16-20	Quartz and mafic min banding from 29.8'-30.0'
30							
				SS-7		11-20-27	Coarse-grained to gravel sized quartz and mafic banding (34.5'-35.0')
35							
	Light yellowish brown (2.5Y 6/4) sand with quartz gravel (SP)			SS-8		11-26-36	
40							
	Gray (Gley1 5/N) granite rock (RK)	+ + + +		SS-9		50/4	Fe-stained, weathered
45							

SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.:
REMARKS: RCK 8/20/10

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-14D

July 28, 2010
PROJ. NO.: 6228-10-5284

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	SAMPLES N-COUNT 1st 6" 2nd 6" 3rd 6"	REMARKS
45	Gray (Gley1 5/N) granite rock (RK)						
				SS-10		29-50/3	Chlorite vein at 48.7'
50	Biotite gneiss: bluish gray (Gley2 5/1), strong, gneissic, laminated, slightly decomposed, slightly disintegrated, moderately fractured			RC-11			Refusal at 50.0' BGS Bedding plan joint at 50.25', 50.45', 50.9', 51.15' (45°)
				RC-12			Shear at 50.35' with Fe-staining Fracture zone at 52.0'-52.4' Bedding plane foliation infilled with quartz Joints with Fe-staining at 52.8'-52.9' Fe-stained joint at 53.6' Joint at 53.75'
55	Granite, white (5YR 8/1) moderate strength, Fe-staining, coarse grained, laminated, moderately decomposed, moderately disintegrated, unfractured			RC-13			Healed bedding plane joint at 57.6' infilled with quartz Joint with Fe-staining at 58.6' Joint with Fe-staining at 58.8'
	White (5YR 8/1), weak, abundant Fe-staining, gneissic, intensely foliated, intensely disintegrated, intensely fractured						
60	Boring terminated at 60.1' BGS						
65							
70							
75							
80							
85							
90							

SOIL_BORING_LOGS.GPJ 8/25/10

DRILLER: Abel McGuire - AE Drilling
EQUIPMENT: CME-750
METHOD: HSA/NQ Rock Core
HOLE DIA.:
REMARKS: RCF 8/20/10

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: Duke Energy Marshall Steam Station
WELL ID: MW-14D

July 28, 2010
PROJ. NO.: 6228-10-5284

MACTEC

APPENDIX C
MONITORING WELL RECORDS

NON RESIDENTIAL WELL CONSTRUCTION RECORD

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

WELL CONTRACTOR CERTIFICATION # 3571

1. WELL CONTRACTOR:
Abel McGuire
Well Contractor (Individual) Name
A E DRILLING SERVICES, LLC
Well Contractor Company Name
Two United Way
Street Address
Greenville SC 29607
City or Town State Zip Code
(864) 288-1986
Area code Phone number

2. WELL INFORMATION:
WELL CONSTRUCTION PERMIT#
OTHER ASSOCIATED PERMIT#(if applicable)
SITE WELL ID #(if applicable)

3. WELL USE (Check One Box) Monitoring ☒ Municipal/Public ☐
Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐
Irrigation ☐ Other ☐ (list use)
DATE DRILLED 7-26-10

4. WELL LOCATION:
Marshall Stn
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)
CITY: Terrell COUNTY Catawba
TOPOGRAPHIC / LAND SETTING: (check appropriate box)
☒ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
LATITUDE 35 ° 36 ' 36690 " DMS OR 3x.xxxxxxxx DD
LONGITUDE 80 ° 58 ' 42864 " DMS OR 7x.xxxxxxxx DD
Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map andattached to this form if not using GPS)

5. FACILITY (Name of the business where the well is located.)
Marshall Steam Station
Facility Name Facility ID# (if applicable)
8320 East NC Highway 150
Street Address
Terrell, N.C. 28682
City or Town State Zip Code
Jim Lindquist
Contact Name
Mailing Address
City or Town State Zip Code
(828) 478 7622
Area code Phone number

6. WELL DETAILS: MW-10S
a. TOTAL DEPTH: 27'
b. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☐
c. WATER LEVEL Below Top of Casing: 16.64 FT.
(Use "+" if Above Top of Casing)

d. TOP OF CASING IS 3' 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 N/A
g. WATER ZONES (depth):
Top Bottom Top Bottom
Top Bottom Top Bottom
Top Bottom Top Bottom

7. CASING:

	Depth		Diameter	Thickness/ Weight	Material
Top 0	Bottom 12	Ft.	2"	.010	PVC
Top	Bottom	Ft.			
Top	Bottom	Ft.			

8. GROUT:

	Depth		Material	Method
Top 0'	Bottom 9'	Ft.	Cement	Tremie
Top 10	Bottom 9	Ft.	Bentonite	Tremie
Top	Bottom	Ft.		

9. SCREEN:

	Depth		Diameter	Slot Size	Material
Top 12'	Bottom 27'	Ft.	2" in.	.10 in.	PVC.
Top	Bottom	Ft.	in.	in.	
Top	Bottom	Ft.	in.	in.	

10. SAND/GRAVEL PACK:

	Depth		Size	Material
Top 10'	Bottom 27'	Ft.	#1	Sand
Top	Bottom	Ft.		
Top	Bottom	Ft.		

11. DRILLING LOG

Top	Bottom	Formation Description
0	27	SAPROLITE OVERBURDEN

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.

Abel McGuire 8-4-10
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

ABEL McGUIRE
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) 807-6300

Form GW-1b
Rev. 11/08

NON RESIDENTIAL WELL CONSTRUCTION RECORD

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

WELL CONTRACTOR CERTIFICATION # 3571

1. WELL CONTRACTOR:
Abel McGuire
Well Contractor (Individual) Name
A E DRILLING SERVICES, LLC
Well Contractor Company Name
Two United Way
Street Address
Greenville SC 29607
City or Town State Zip Code
(864) 288-1986
Area code Phone number

2. WELL INFORMATION:
WELL CONSTRUCTION PERMIT#
OTHER ASSOCIATED PERMIT#(if applicable)
SITE WELL ID #(if applicable)

3. WELL USE (Check One Box) Monitoring ☒ Municipal/Public ☐
Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐
Irrigation ☐ Other ☐ (list use)
DATE DRILLED 7-27-10

4. WELL LOCATION:
Marshall Stn
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)
CITY: Terrell COUNTY Catawba
TOPOGRAPHIC / LAND SETTING: (check appropriate box)
☐Slope ☐Valley ☐Flat ☐Ridge ☐Other
LATITUDE 35 °36 ' 36670 " DMS **OR** 3x.xxxxxxxxx DD
LONGITUDE 80 °58 ' 44289 " DMS **OR** 7x.xxxxxxxxx DD
Latitude/longitude source: ☐GPS ☐Topographic map
(location of well must be shown on a USGS topo map andattached to this form if not using GPS)

5. FACILITY (Name of the business where the well is located.)
Marshall Steam Station
Facility Name Facility ID# (if applicable)
8320 East NC Highway 150
Street Address
Terrell N.C. 28682
City or Town State Zip Code
Jim Lindquist
Contact Name
Mailing Address
City or Town State Zip Code
(828) 478 7622
Area code Phone number

6. WELL DETAILS: MW-10 D
a. **TOTAL DEPTH:** 85.5'
b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒
c. **WATER LEVEL** Below Top of Casing: 16.23 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3' 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** N/A
g. **WATER ZONES** (depth):
Top Bottom Top Bottom
Top Bottom Top Bottom
Top Bottom Top Bottom

7. CASING:	Depth	Diameter	Thickness/ Weight	Material
Top 0	Bottom 80.5 Ft.	2"	.010	PVC
Top	Bottom Ft.			
Top	Bottom Ft.			

8. GROUT:	Depth	Material	Method
Top 0'	Bottom 77' Ft.	Cement	[illegible] Tremie
Top 78.5	Bottom 77 Ft.	Bentonite	Tremie
Top	Bottom Ft.		

9. SCREEN:	Depth	Diameter	Slot Size	Material
Top 80.5'	Bottom 85.5' Ft.	2" in.	.10 in.	Sch. 40 PVC
Top	Bottom Ft.	in.	in.	
Top	Bottom Ft.	in.	in.	

10. SAND/GRAVEL PACK:

	Depth	Size	Material
Top 78.5	Bottom 85.5 Ft.	#2	Sand
Top	Bottom Ft.		
Top	Bottom Ft.		

11. DRILLING LOG

Top	Bottom	Formation Description
0	75	Saprolite overburden
75	85.5	Rock

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.

Abel McGuire 7/27/10
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Abel McGuire
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) 807-6300

Form GW-1b
Rev. 11/08

NON RESIDENTIAL WELL CONSTRUCTION RECORD

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

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1. WELL CONTRACTOR:
Abel McGuire
Well Contractor (Individual) Name
A E DRILLING SERVICES, LLC
Well Contractor Company Name
Two United Way
Street Address
Greenville SC 29607
City or Town State Zip Code
(864) 288-1986
Area code Phone number

2. WELL INFORMATION:
WELL CONSTRUCTION PERMIT#
OTHER ASSOCIATED PERMIT#(if applicable)
SITE WELL ID #(if applicable)

3. WELL USE (Check One Box) Monitoring ☒ Municipal/Public ☐
Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐
Irrigation ☐ Other ☐ (list use)
DATE DRILLED 7-30-10

4. WELL LOCATION:
Marshall Station
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)
CITY: Terrell COUNTY Catawba
TOPOGRAPHIC / LAND SETTING: (check appropriate box)
☐Slope ☐Valley ☐Flat ☐Ridge ☐Other
LATITUDE 35 °36'47900" DMS OR 3x.xxxxxxxxx DD
LONGITUDE 80 °58'76251" DMS OR 7x.xxxxxxxxx DD
Latitude/longitude source: ☐GPS ☐Topographic map
(location of well must be shown on a USGS topo map andattached to this form if not using GPS)

5. FACILITY (Name of the business where the well is located.)
Marshall Steam Station
Facility Name Facility ID# (if applicable)
8320 E Hwy 150
Street Address
Terrell, NC 28682
City or Town State Zip Code
Jim Lindquist
Contact Name
Mailing Address
City or Town State Zip Code
( ) Phone number
Area code

6. WELL DETAILS: MW-11S
a. **TOTAL DEPTH:** 55'
b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒
c. **WATER LEVEL** Below Top of Casing: 43.77 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3' 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** N/A
g. **WATER ZONES** (depth):
Top Bottom Top Bottom
Top Bottom Top Bottom
Top Bottom Top Bottom

7. CASING:	Depth		Diameter	Thickness/ Weight	Material
Top 0	Bottom 37	Ft.	2"	.010	PVC
Top	Bottom	Ft.			
Top	Bottom	Ft.			

8. GROUT:	Depth		Material	Method
Top 0'	Bottom 32'	Ft.	Cement	Tremie
Top 35	Bottom 32	Ft.	Bentonite	Tremie
Top	Bottom	Ft.		

9. SCREEN:	Depth		Diameter	Slot Size	Material
Top 37'	Bottom 52'	Ft.	2' in.	.10 in.	P.V.C.
Top	Bottom	Ft. in.	in.	in.	
Top	Bottom	Ft. in.	in.	in.	

10. SAND/GRAVEL PACK:	Depth		Size	Material
Top 38'	Bottom 55'	Ft.	#1	Sand
Top	Bottom	Ft.		
Top	Bottom	Ft.		

11. DRILLING LOG

Top	Bottom	Formation Description
0	35	SAPROLITE OVERBURDEN
35	55	BEDROCK

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.

Abel McGuire 8-7-10
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Abel McGuire
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) 807-6300

Form GW-1b
Rev. 11/08

NON RESIDENTIAL WELL CONSTRUCTION RECORD

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

WELL CONTRACTOR CERTIFICATION # 3571

1. WELL CONTRACTOR:
Abel McGuire
Well Contractor (Individual) Name
A E DRILLING SERVICES, LLC
Well Contractor Company Name
Two United Way
Street Address
Greenville SC 29607
City or Town State Zip Code
(864) 288-1986
Area code Phone number

2. WELL INFORMATION: MW-110
WELL CONSTRUCTION PERMIT#
OTHER ASSOCIATED PERMIT#(if applicable)
SITE WELL ID #(if applicable)

3. WELL USE (Check One Box) Monitoring ☒ Municipal/Public ☐
Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐
Irrigation ☐ Other ☐ (list use)
DATE DRILLED 7-30-10

4. WELL LOCATION:
Marshall Stn
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)
CITY: Terrell COUNTY Catawba
TOPOGRAPHIC / LAND SETTING: (check appropriate box)
☐Slope ☐Valley ☐Flat ☐Ridge ☐Other
LATITUDE 35 °36 ·47871 " DMS **OR** 3x.xxxxxxxx DD
LONGITUDE 80 °58 ·76130 " DMS **OR** 7x.xxxxxxxx DD
Latitude/longitude source: ☒GPS ☐Topographic map
(location of well must be shown on a USGS topo map andattached to this form if not using GPS)

5. FACILITY (Name of the business where the well is located.)
Marshal Steam Station
Facility Name Facility ID# (if applicable)
8320 East NC Highway 150
Street Address
Terrell, NC. 28682
City or Town State Zip Code
Jim Linquist
Contact Name
Mailing Address
City or Town State Zip Code
(828) 478 7622
Area code Phone number

6. WELL DETAILS: MW-110
a. **TOTAL DEPTH:** 90.6'
b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒
c. **WATER LEVEL** Below Top of Casing: 43.40 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3' 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** N/A
g. **WATER ZONES** (depth):
Top____ Bottom____ Top____ Bottom____
Top____ Bottom____ Top____ Bottom____
Top____ Bottom____ Top____ Bottom____

7. CASING:

Depth	Diameter	Thickness/ Weight	Material
Top 0 Bottom 85.6 Ft.	2"	.010	PVC
Top____ Bottom____ Ft.			
Top____ Bottom____ Ft.			

8. GROUT:

Depth	Material	Method
Top 0' Bottom 81.5' Ft.	Portland Cement	Trimied
Top 82.5 Bottom 81.5 Ft.	Bentonite	Tremie
Top____ Bottom____ Ft.		

9. SCREEN:

Depth	Diameter	Slot Size	Material
Top 85.6 Bottom 90.6 Ft.	2" in.	.10 in.	Sch. 40 PVC
Top____ Bottom____ Ft.	____ in.	____ in.	
Top____ Bottom____ Ft.	____ in.	____ in.	

10. SAND/GRAVEL PACK:

Depth	Size	Material
Top 82.5 Bottom 90.6' Ft.	#2	Sand
Top____ Bottom____ Ft.		
Top____ Bottom____ Ft.		

11. DRILLING LOG

Top	Bottom	Formation Description
0	81	Saprolite Overburden
81	90.6	Bedrock

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.

Abel McGuire 8-4-10
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

ABEL McGUIRE
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) 807-6300

Form GW-1b
Rev. 11/08

NON RESIDENTIAL WELL CONSTRUCTION RECORD

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

WELL CONTRACTOR CERTIFICATION # 3571

1. WELL CONTRACTOR:
Abel McGuire
Well Contractor (Individual) Name
A E DRILLING SERVICES, LLC
Well Contractor Company Name
Two United Way
Street Address
Greenville SC 29607
City or Town State Zip Code
(864) 288-1986
Area code Phone number

2. WELL INFORMATION:
WELL CONSTRUCTION PERMIT#
OTHER ASSOCIATED PERMIT#(if applicable)
SITE WELL ID #(if applicable)

3. WELL USE (Check One Box) Monitoring ☒ Municipal/Public ☐
Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐
Irrigation ☐ Other ☐ (list use)
DATE DRILLED 8-4-10

4. WELL LOCATION:
Marshall Steam Station
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)
CITY: Terrell COUNTY Catawba
TOPOGRAPHIC / LAND SETTING: (check appropriate box)
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
LATITUDE 35 ° 36 · 42126 " DMS **OR** 3x.xxxxxxxx DD
LONGITUDE 80 ° 58 · 28465 " DMS **OR** 7x.xxxxxxxx DD
Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map andattached to this form if not using GPS)

5. FACILITY (Name of the business where the well is located.)
Marshall Steam Station
Facility Name Facility ID# (if applicable)
8320 East N.C. Highway 150
Street Address
Terrell, N.C. 28682
City or Town State Zip Code
Jim Lindquist
Contact Name
Mailing Address
City or Town State Zip Code
(828) 478 7622
Area code Phone number

6. WELL DETAILS: MW-12S
a. **TOTAL DEPTH:** 40'
b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒
c. **WATER LEVEL** Below Top of Casing: 14.28 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3' 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** N/A
g. **WATER ZONES** (depth):
Top___ Bottom___ Top___ Bottom___
Top___ Bottom___ Top___ Bottom___
Top___ Bottom___ Top___ Bottom___

7. CASING:	Depth	Diameter	Thickness/ Weight	Material
Top 0	Bottom 7 Ft.	2"	.010	PVC
Top	Bottom Ft.			
Top	Bottom Ft.			

8. GROUT:	Depth	Material	Method
Top 0'	Bottom 3' Ft.	Cement	Trimied
Top 5'	Bottom 3 Ft.	Bentonite	Tremie
Top	Bottom Ft.		

9. SCREEN:	Depth	Diameter	Slot Size	Material
Top 7'	Bottom 22' Ft.	2" in.	.10 in.	PVC.
Top	Bottom Ft.	in.	in.	
Top	Bottom Ft.	In.	in.	

10. SAND/GRAVEL PACK:	Depth	Size	Material
Top 5'	Bottom 40' Ft.	#1	Sand
Top	Bottom Ft.		
Top	Bottom Ft.		

11. DRILLING LOG

Top	Bottom	Formation Description
0	40	SAPROLITE OVERBURDEN

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.

Abel McGuire 8-4-10
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Abel McGuire
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) 807-6300

Form GW-1b
Rev. 11/08

NON RESIDENTIAL WELL CONSTRUCTION RECORD

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

WELL CONTRACTOR CERTIFICATION # 3571

1. WELL CONTRACTOR:
Abel McGuire
Well Contractor (Individual) Name
A E DRILLING SERVICES, LLC
Well Contractor Company Name
Two United Way
Street Address
Greenville SC 29607
City or Town State Zip Code
(864) 288-1986
Area code Phone number

2. WELL INFORMATION:
WELL CONSTRUCTION PERMIT#
OTHER ASSOCIATED PERMIT#(if applicable)
SITE WELL ID #(if applicable)

3. WELL USE (Check One Box) Monitoring ☒ Municipal/Public ☐
Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐
Irrigation ☐ Other ☐ (list use)
DATE DRILLED 8-3-10

4. WELL LOCATION:
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)
CITY: COUNTY
TOPOGRAPHIC / LAND SETTING: (check appropriate box)
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
LATITUDE 35 ° 36 · 43905 " DMS OR 3x.xxxxxxxx DD
LONGITUDE 80 ° 58 · 31988 " DMS OR 7x.xxxxxxxx DD
Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map andattached to this form if not using GPS)

5. FACILITY (Name of the business where the well is located.)
Marshal Steam Station
Facility Name Facility ID# (if applicable)
8320 East N.C. Highway 150
Street Address
Terrel, N.C. 28682
City or Town State Zip Code
Jim Lindquist
Contact Name
Mailing Address
City or Town State Zip Code
(828) 478 7622
Area code Phone number

6. WELL DETAILS: MW-12D
a. **TOTAL DEPTH:** 106'
b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒
c. **WATER LEVEL** Below Top of Casing: 15.21 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3' 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** N/A
g. **WATER ZONES** (depth):
Top Bottom Top Bottom
Top Bottom Top Bottom
Top Bottom Top Bottom

7. CASING:	Depth		Diameter	Thickness/ Weight	Material
Top 0	Bottom 90	Ft.	2"	.010	PVC
Top	Bottom	Ft.			
Top	Bottom	Ft.			

8. GROUT:	Depth		Material	Method
Top 0'	Bottom 86'	Ft.	Cement	Tremie
Top 88.5	Bottom 86	Ft.	Bentonite	Tremie
Top	Bottom	Ft.		

9. SCREEN:	Depth		Diameter	Slot Size	Material
Top 90'	Bottom 95'	Ft.	2" in.	.10 in.	PVC.
Top	Bottom	Ft.	in.	in.	
Top	Bottom	Ft.	in.	in.	

10. SAND/GRAVEL PACK:

	Depth		Size	Material
Top 88.5	Bottom 106'	Ft.	#1	Sand
Top	Bottom	Ft.		
Top	Bottom	Ft.		

11. DRILLING LOG

Top	Bottom	Formation Description
0	90	SAPROLITE OVERBURDEN
90	106	BEDROCK

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.

Abel McGuire 8-4-10
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Abel McGuire
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) 807-6300

Form GW-1b
Rev. 11/08

NON RESIDENTIAL WELL CONSTRUCTION RECORD

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

WELL CONTRACTOR CERTIFICATION # 3571

1. WELL CONTRACTOR:
Abel McGuire
Well Contractor (Individual) Name
A E DRILLING SERVICES, LLC
Well Contractor Company Name
Two United Way
Street Address
Greenville SC 29607
City or Town State Zip Code
(864) 288-1986
Area code Phone number

2. WELL INFORMATION:
WELL CONSTRUCTION PERMIT#
OTHER ASSOCIATED PERMIT#(if applicable)
SITE WELL ID #(if applicable)

3. WELL USE (Check One Box) Monitoring ☒ Municipal/Public ☐
Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐
Irrigation ☐ Other ☐ (list use)
DATE DRILLED 8-6-10

4. WELL LOCATION:
Marshall Steam Station
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)
CITY: Terrell COUNTY Catawba
TOPOGRAPHIC / LAND SETTING: (check appropriate box)
☒ Slope ☐ Valley ☐ Flat ☒ Ridge ☐ Other
LATITUDE 35 ° 36' 50564 " DMS OR 3x.xxxxxxxx DD
LONGITUDE 80 ° 58' 42262" DMS OR 7x.xxxxxxxx DD
Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map andattached to this form if not using GPS)

5. FACILITY (Name of the business where the well is located.)
Marshall Steam Station
Facility Name Facility ID# (if applicable)
8320 East N.C. Highway 150
Street Address
Terrell, N.C. 28682
City or Town State Zip Code
Jim Lindquist
Contact Name
Mailing Address
City or Town State Zip Code
(828) 478 7622
Area code Phone number

6. WELL DETAILS: MW-13S
a. **TOTAL DEPTH:** 25'
b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒
c. **WATER LEVEL** Below Top of Casing: 5.70 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3' 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** N/A
g. **WATER ZONES** (depth):
Top____ Bottom____ Top____ Bottom____
Top____ Bottom____ Top____ Bottom____
Top____ Bottom____ Top____ Bottom____

7. CASING:

Depth	Diameter	Thickness/ Weight	Material
Top 0 Bottom 3 Ft.	2"	.010	PVC
Top____ Bottom____ Ft.			
Top____ Bottom____ Ft.			

8. GROUT:

Depth	Material	Method
Top 0' Bottom 1' Ft.	Cement	Pour
Top 2 Bottom 1 Ft.	Bentonite	Tremie
Top____ Bottom____ Ft.		

9. SCREEN:

Depth	Diameter	Slot Size	Material
Top 3' Bottom 18' Ft.	2' in.	.10 in.	PVC
Top____ Bottom____ Ft.____ in.	____ in.	____ in.	
Top____ Bottom____ Ft.____ in.	____ in.	____ in.	

10. SAND/GRAVEL PACK:

Depth	Size	Material
Top 2' Bottom 25.5 Ft.	#1	Sand
Top____ Bottom____ Ft.		
Top____ Bottom____ Ft.		

11. DRILLING LOG

Top	Bottom	Formation Description
0	18	SAPROLITE OVERBURDEN

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.

Abel McGuire 8-7-10
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Abel McGuire
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) 807-6300

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NON RESIDENTIAL WELL CONSTRUCTION RECORD

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

WELL CONTRACTOR CERTIFICATION # 3571

1. WELL CONTRACTOR:
Abel McGuire
Well Contractor (Individual) Name
A E DRILLING SERVICES, LLC
Well Contractor Company Name
Two United Way
Street Address
Greenville SC 29607
City or Town State Zip Code
(864) 288-1986
Area code Phone number

2. WELL INFORMATION:
WELL CONSTRUCTION PERMIT#
OTHER ASSOCIATED PERMIT#(if applicable)
SITE WELL ID #(if applicable)

3. WELL USE (Check One Box) Monitoring ☐ Municipal/Public ☐
Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐
Irrigation ☐ Other ☐ (list use)
DATE DRILLED 8-6-10

4. WELL LOCATION:
Marshall Stn.
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)
CITY: Terrell COUNTY Catawba
TOPOGRAPHIC / LAND SETTING: (check appropriate box)
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
LATITUDE 35 ° 36 ' 50.91 " DMS OR 3x.xxxxxxxx DD
LONGITUDE 80 ° 58 ' 43.68 " DMS OR 7x.xxxxxxxx DD
Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map andattached to this form if not using GPS)

5. FACILITY (Name of the business where the well is located.)
Marshal Steam Station
Facility Name Facility ID# (if applicable)
8320 East N.C. Highway 150
Street Address
Terrel, N.C. 28682
City or Town State Zip Code
Jim Lindquist
Contact Name
Mailing Address
City or Town State Zip Code
(828) 478 7622
Area code Phone number

6. WELL DETAILS: MW-130
a. **TOTAL DEPTH:** 46.6'
b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒
c. **WATER LEVEL** Below Top of Casing: 3.59 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3' 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** N/A
g. **WATER ZONES** (depth):
Top___ Bottom___ Top___ Bottom___
Top___ Bottom___ Top___ Bottom___
Top___ Bottom___ Top___ Bottom___

7. CASING:	Depth	Diameter	Thickness/ Weight	Material
Top 0	Bottom 41.6 Ft.	2"	.010	PVC
Top	Bottom Ft.			
Top	Bottom Ft.			

8. GROUT:	Depth	Material	Method
Top 0'	Bottom 38.6 Ft.	Cement	Tremie
Top 39.6	Bottom 38.6 Ft.	Bentonite	Tremie
Top	Bottom Ft.		

9. SCREEN:	Depth	Diameter	Slot Size	Material
Top 41.6'	Bottom 46.6' Ft.	2' in.	.10 in.	Sch. 40 PVC
Top	Bottom Ft. in.	in.	in.	
Top	Bottom Ft. in.	in.	in.	

10. SAND/GRAVEL PACK:	Depth	Size	Material
Top 39.6'	Bottom 46.6' Ft.	#1	Sand
Top	Bottom Ft.		
Top	Bottom Ft.		

11. DRILLING LOG

Top	Bottom	Formation Description
0	41	SAPROLITE OVERBURDEN
41	46.6	BEDROCK

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.

Abel McGuire 8-7-10
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

Abel McGuire
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) 807-6300

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NON RESIDENTIAL WELL CONSTRUCTION RECORD

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

WELL CONTRACTOR CERTIFICATION # 3571

1. WELL CONTRACTOR:

Abel McGuire
Well Contractor (Individual) Name

A E DRILLING SERVICES, LLC
Well Contractor Company Name

Two United Way
Street Address

Greenville SC 29607
City or Town State Zip Code

(864) 288-1986
Area code Phone number

2. WELL INFORMATION: ~~APPL-NEW~~

WELL CONSTRUCTION PERMIT#

OTHER ASSOCIATED PERMIT#(if applicable)

SITE WELL ID #(if applicable)

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

DATE DRILLED 7-29-10

4. WELL LOCATION:

Marshall Steam
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)

CITY: Terrell COUNTY Catawba

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

LATITUDE 35 ° 36 ' 39410 " DMS OR 3x.xxxxxxxx DD

LONGITUDE 80 ° 58 ' 31292 " DMS OR 7x.xxxxxxxx DD

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

5. FACILITY (Name of the business where the well is located.)

Marshall Steam Station
Facility Name Facility ID# (if applicable)

8320 East N.C. Highway 150
Street Address

Terrell, N.C. 28682
City or Town State Zip Code

Jim Linquist
Contact Name

Mailing Address

City or Town State Zip Code

(828) 478 7622
Area code Phone number

6. WELL DETAILS: MW-14D

a. **TOTAL DEPTH:** 60.1'

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

c. **WATER LEVEL** Below Top of Casing: 36.98 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3' 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** N/A

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

7. CASING:

Depth	Diameter	Thickness/ Weight	Material
Top 0' Bottom 55.1' Ft.	2'	Sch. 40	PVC
Top___ Bottom___ Ft.			
Top___ Bottom___ Ft.			

8. GROUT:

Depth	Material	Method
Top 0' Bottom 51' Ft.	Cement	Trimied
Top 53.5 Bottom 51 Ft.	Bentonite	Tremie
Top___ Bottom___ Ft.		

9. SCREEN:

Depth	Diameter	Slot Size	Material
Top 55.1' Bottom 60.1' Ft.	2' in.	.10 in.	PVC.
Top___ Bottom___ Ft.	in.	in.	
Top___ Bottom___ Ft.	in.	in.	

10. SAND/GRAVEL PACK:

Depth	Size	Material
Top 53.5 Bottom 60.1' Ft.	#2	Sand
Top___ Bottom___ Ft.		
Top___ Bottom___ Ft.		

11. DRILLING LOG

Top	Bottom	Formation Description
0	55	SAPROLITE OVERBURDEN
55	60	BEDROCK

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.

Abel McGuire 8-4-10
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

ABEL McGUIRE
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) 807-6300

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NON RESIDENTIAL WELL CONSTRUCTION RECORD

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

WELL CONTRACTOR CERTIFICATION # 3571

1. WELL CONTRACTOR:
Abel McGuire
Well Contractor (Individual) Name
A E DRILLING SERVICES, LLC
Well Contractor Company Name
Two United Way
Street Address
Greenville SC 29607
City or Town State Zip Code
(864) 288-1986
Area code Phone number

2. WELL INFORMATION:
WELL CONSTRUCTION PERMIT#
OTHER ASSOCIATED PERMIT#(if applicable)
SITE WELL ID #(if applicable)

3. WELL USE (Check One Box) Monitoring ☒ Municipal/Public ☐
Industrial/Commercial ☐ Agricultural ☐ Recovery ☐ Injection ☐
Irrigation ☐ Other ☐ (list use)
DATE DRILLED 7-28-10

4. WELL LOCATION:
MARSHALL SPA
(Street Name, Numbers, Community, Subdivision, Lot No., Parcel, Zip Code)
CITY: TERRELL COUNTY CATAWBA
TOPOGRAPHIC / LAND SETTING: (check appropriate box)
☐ Slope ☐ Valley ☐ Flat ☐ Ridge ☐ Other
LATITUDE 35 ° 36 ' 39923 " DMS OR 3x.xxxxxxxx DD
LONGITUDE 80 ° 58 ' 30479 " DMS OR 7x.xxxxxxxx DD
Latitude/longitude source: ☒ GPS ☐ Topographic map
(location of well must be shown on a USGS topo map andattached to this form if not using GPS)

5. FACILITY (Name of the business where the well is located.)
Marshall Steam Station
Facility Name Facility ID# (if applicable)
8320 East NC Highway 150
Street Address
Terrel, N.C. 28682
City or Town State Zip Code
Jim Lundquist
Contact Name
Mailing Address
City or Town State Zip Code
(828) 478 7622
Area code Phone number

6. WELL DETAILS: MW-14S
a. **TOTAL DEPTH:** 49'
b. **DOES WELL REPLACE EXISTING WELL?** YES ☐ NO ☒
c. **WATER LEVEL** Below Top of Casing: 36.36 FT.
(Use "+" if Above Top of Casing)

d. **TOP OF CASING IS** 3' 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** N/A
g. **WATER ZONES** (depth):
Top Bottom Top Bottom
Top Bottom Top Bottom
Top Bottom Top Bottom

7. CASING:	Depth		Diameter	Thickness/ Weight	Material
Top 0	Bottom 28	Ft.	2"	.010	PVC
Top	Bottom	Ft.			
Top	Bottom	Ft.			

8. GROUT:	Depth		Material	Method
Top 0'	Bottom 25	Ft.	Cement	Trimied
Top 26'	Bottom 25'	Ft.	Bentonite	Tremie
Top	Bottom	Ft.		

9. SCREEN:	Depth		Diameter	Slot Size	Material
Top 28'	Bottom 43'	Ft.	2' in.	.10 in.	PVC
Top	Bottom	Ft.	in.	in.	
Top	Bottom	Ft.	in.	in.	

10. SAND/GRAVEL PACK:

	Depth		Size	Material
Top 26'	Bottom 49	Ft.	#1	Sand
Top	Bottom	Ft.		
Top	Bottom	Ft.		

11. DRILLING LOG

Top	Bottom	Formation Description
0	49	SAPROLITE OVERBURDEN

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.

Abel McGuire 8-4-10
SIGNATURE OF CERTIFIED WELL CONTRACTOR DATE

ABEL McGUIRE
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) 807-6300

Form GW-1b
Rev. 11/08

APPENDIX D
MONITORING WELL DEVELOPMENT RECORDS

MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.

MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-14D

SITE NAME Duke Marshall Steam Station DATE _____ TIME OF SAMPLE N/A

FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS _____

TOTAL WELL DEPTH (TWD) 62.85 FT (measured / well tag / drillers log – **circle one**)

SCREENED INTERVAL 55-60 bgs MEASURING POINT FOR DEPTH Top of casing

DEPTH TO GROUNDWATER (DGW) 36.98

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 25.87

CASING DIAMETER 2 IN.

ONE STANDING WELL VOLUME = 4.22 gal.

(NOTE ½" = 0.0102G/FT: ¾" = 0.023 G/FT: 1"= 0.041G/FT: 2" = 0.163 G/FT: 4" = 0.653 G/FT: 6" = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 12.65 FIVE STANDING WELL VOLUMES = 21.10

METHOD OF WELL EVACUATION: BAILER / PUMP / OTHER: TYPE _____

TOTAL VOLUME OF WATER REMOVED: 70 GAL.

WELL TYPE: FLUSH MOUNT / ABOVE GRADE COMMENTS _____

LOCKING CAP YES X NO _____ No sample collected/purged for

PROTECTIVE POST/ABUTMENT YES _____ NO X development only

NONPOTABLE LABEL YES X NO _____

ID PLATE YES X NO _____

WELL INTEGRITY SATISFACTORY YES X NO _____

WELL YIELD LOW _____ MODERATE _____ HIGH X

Time	Volume	pH	Temp (°C)	Cond. (µS/cm)	Dis. O_2 (mg/L)	Turbidity (NTU)	ORP (mV)	Notes
	30	5.68	18.00	.682	0.10	234		
	35	5.66	18.10	.685	0.03	115		
	40	5.65	18.10	.687	0.03	90		
	45	5.65	18.50	.688	0.02	90		
	50	5.65	18.50	.690	0.02	87		
	55	5.59	18.20	--	--	55		Meter Malfunction
	60	5.57	16.30	.709	0.02	44		
	65	5.58	17.10	.727	0.01	21		
	70	5.62	17.20	.734	0.01	14		

MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.

MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-13S

SITE NAME Duke Marshall Steam Station DATE _____ TIME OF SAMPLE N/A

FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS _____

TOTAL WELL DEPTH (TWD) 21.12 FT. (measured / well tag / drillers log – **circle one**)

SCREENED INTERVAL 3-18 bgs. MEASURING POINT FOR DEPTH Top of casing

DEPTH TO GROUNDWATER (DGW) 5.70

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 15.42

CASING DIAMETER 2 IN.

ONE STANDING WELL VOLUME = 2.51 gal.

(NOTE ½" = 0.0102G/FT: ¾" = 0.023 G/FT: 1"= 0.041G/FT: 2" = 0.163 G/FT: 4" = 0.653 G/FT: 6" = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 7.54 FIVE STANDING WELL VOLUMES = 12.55

METHOD OF WELL EVACUATION: BAILER / PUMP / OTHER: TYPE _____

TOTAL VOLUME OF WATER REMOVED: 60 GAL.

WELL TYPE: FLUSH MOUNT / ABOVE GRADE COMMENTS _____

LOCKING CAP YES X NO _____ No sample collected/purged for

PROTECTIVE POST/ABUTMENT YES _____ NO X development only

NONPOTABLE LABEL YES X NO _____

ID PLATE YES X NO _____

WELL INTEGRITY SATISFACTORY YES X NO _____

WELL YIELD LOW _____ MODERATE _____ HIGH X

Time	Volume	pH	Temp (°C)	Cond. (µS/cm)	Dis. O_2 (mg/L)	Turbidity (NTU)	ORP (mV)	Notes
	35	5.96	19.70	.200	10.56	-10		Turbidity meter
	45	6.27	19.00	.098	10.89	-10		Malfunction
	50	6.49	18.60	.091	10.91	-10		
	55	6.52	18.40	.090	10.77	-10		
	60	6.54	18.30	.089	10.83	-10		

MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.

MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-13D

SITE NAME Duke Marshall Steam Station DATE _____ TIME OF SAMPLE N/A

FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS _____

TOTAL WELL DEPTH (TWD) 48.61 FT. (measured / well tag / drillers log – **circle one**)

SCREENED INTERVAL 41.5-46.5 bgs MEASURING POINT FOR DEPTH Top of Casing

DEPTH TO GROUNDWATER (DGW) 3.59

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 45.02

CASING DIAMETER 2 IN.

ONE STANDING WELL VOLUME = 7.34 gal.

(NOTE ½" = 0.0102G/FT: ¾" = 0.023 G/FT: 1"= 0.041G/FT: 2" = 0.163 G/FT: 4" = 0.653 G/FT: 6" = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 22.01 FIVE STANDING WELL VOLUMES = 36.70

METHOD OF WELL EVACUATION: BAILER / PUMP / OTHER: TYPE _____

TOTAL VOLUME OF WATER REMOVED: 85 GAL.

WELL TYPE: FLUSH MOUNT / ABOVE GRADE

COMMENTS _____

LOCKING CAP YES X NO _____

PROTECTIVE POST/ABUTMENT YES _____ NO X

NONPOTABLE LABEL YES X NO _____

ID PLATE YES X NO _____

WELL INTEGRITY SATISFACTORY YES X NO _____

No sample collected/purged for development only

WELL YIELD LOW _____ MODERATE _____ HIGH X

Time	Volume	pH	Temp (°C)	Cond. (µS/cm)	Dis. O_2 (mg/L)	Turbidity (NTU)	ORP (mV)	Notes
	45	6.76	18.60	.098	--	182		
	50	6.72	17.60	.098	12.03	202		
	55	6.61	17.40	.093	--	140		
	60	6.60	17.60	.093	11.65	272		
	65	--	--	--	--	--		
	70	6.51	17.10	.092	11.81	30		
	75	6.54	17.10	.092	11.58	77		
	80	6.55	17.20	.091	11.29	68		
	85	6.55	17.00	.091	11.52	9		

MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.

MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-12S

SITE NAME Duke Marshall Steam Station DATE _____ TIME OF SAMPLE N/A

FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS _____

TOTAL WELL DEPTH (TWD) 25.32 FT. (measured / well tag / drillers log – **circle one**)

SCREENED INTERVAL 7-22 MEASURING POINT FOR DEPTH Top of casing

DEPTH TO GROUNDWATER (DGW) 14.28

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 11.04

CASING DIAMETER 2 IN.

ONE STANDING WELL VOLUME = 1.80 gal.

(NOTE ½" = 0.0102G/FT: ¾" = 0.023 G/FT: 1"= 0.041G/FT: 2" = 0.163 G/FT: 4" = 0.653 G/FT: 6" = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 5.40 FIVE STANDING WELL VOLUMES = 9.00

METHOD OF WELL EVACUATION: BAILER / PUMP / OTHER: TYPE _____

TOTAL VOLUME OF WATER REMOVED: _____ GAL.

WELL TYPE: FLUSH MOUNT / ABOVE GRADE

COMMENTS _____

LOCKING CAP YES X NO _____ No sample collected/purged for

PROTECTIVE POST/ABUTMENT YES _____ NO X development only

NONPOTABLE LABEL YES X NO _____

ID PLATE YES X NO _____

WELL INTEGRITY SATISFACTORY YES X NO _____

WELL YIELD LOW _____ MODERATE _____ HIGH X

Time	Volume	pH	Temp (°C)	Cond. (µS/cm)	Dis. O_2 (mg/L)	Turbidity (NTU)	ORP (mV)	Notes
	140							

MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.

MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-12D

SITE NAME Duke Marshall Steam Station DATE _____ TIME OF SAMPLE N/A

FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS _____

TOTAL WELL DEPTH (TWD) 98.59 FT (measured / well tag / drillers log – **circle one**)

SCREENED INTERVAL 90-95 bgs MEASURING POINT FOR DEPTH Top of casing

DEPTH TO GROUNDWATER (DGW) 15.21

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 83.38

CASING DIAMETER 2 IN.

ONE STANDING WELL VOLUME = 13.59 gal.

(NOTE ½" = 0.0102G/FT: ¾" = 0.023 G/FT: 1"= 0.041G/FT: 2" = 0.163 G/FT: 4" = 0.653 G/FT: 6" = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 40.77 FIVE STANDING WELL VOLUMES = 67.95

METHOD OF WELL EVACUATION: BAILER / PUMP / OTHER: TYPE _____

TOTAL VOLUME OF WATER REMOVED: 85 GAL.

WELL TYPE: FLUSH MOUNT / ABOVE GRADE COMMENTS _____

LOCKING CAP YES X NO _____ No sample collected/purged for

PROTECTIVE POST/ABUTMENT YES _____ NO X development only

NONPOTABLE LABEL YES X NO _____

ID PLATE YES X NO _____

WELL INTEGRITY SATISFACTORY YES X NO _____

WELL YIELD LOW _____ MODERATE _____ HIGH X

Time	Volume	pH	Temp (°C)	Cond. (µS/cm)	Dis. O_2 (mg/L)	Turbidity (NTU)	ORP (mV)	Notes
	25	5.97	19.60	.090	12.84	123		Pumped Dry
	30	5.88	18.70	.052	12.81	848		Pumped Dry Before 35-gal
	35	5.84	18.90	.043	11.64	121		Pumped Dry
	40	5.81	17.60	.038	12.35	179		
	45	5.74	17.30	.037	12.35	232		
	50	5.69	17.60	.033	0.00	83		
	55	5.65	18.60	.032	0.00	114		
	60	5.67	20.00	.032	0.00	14		
	65	5.69	18.00	.031	0.00	70		
	70	5.58	19.30	.029	0.00	28		
	75	5.61	19.20	.029	0.01	49		
	80	5.67	18.10	.029	0.01	23		
	85	5.58	17.80	.028	0.00	10		

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MACTEC ENGINEERING AND CONSULTING, INC.

MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-11S

SITE NAME Duke Marshall Steam Station DATE _____ TIME OF SAMPLE N/A

FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS _____

TOTAL WELL DEPTH (TWD) 54.38 FT (measured / well tag / drillers log – **circle one**)

SCREENED INTERVAL 37-52 bgs MEASURING POINT FOR DEPTH Top of casing

DEPTH TO GROUNDWATER (DGW) 43.77

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 10.61

CASING DIAMETER 2 IN.

ONE STANDING WELL VOLUME = 1.73 gal.

(NOTE ½" = 0.0102G/FT: ¾" = 0.023 G/FT: 1"= 0.041G/FT: 2" = 0.163 G/FT: 4" = 0.653 G/FT: 6" = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 5.19 FIVE STANDING WELL VOLUMES = 8.65

METHOD OF WELL EVACUATION: BAILER / PUMP / OTHER: TYPE _____

TOTAL VOLUME OF WATER REMOVED: 60 GAL.

WELL TYPE: FLUSH MOUNT / ABOVE GRADE COMMENTS _____

LOCKING CAP YES X NO _____ No sample collected/purged for

PROTECTIVE POST/ABUTMENT YES X NO _____ development only

NONPOTABLE LABEL YES X NO _____

ID PLATE YES X NO _____

WELL INTEGRITY SATISFACTORY YES X NO _____

WELL YIELD LOW _____ MODERATE _____ HIGH X

Time	Volume	pH	Temp (°C)	Cond. (µS/cm)	Dis. O_2 (mg/L)	Turbidity (NTU)	ORP (mV)	Notes
	25	7.11	19.21	.087	.02	230		
	30	6.77	18.50	.068	.04	63		
	35	6.60	17.90	.060	.04	20		
	40	6.66	18.30	.058	.04	10		
	45	6.57	17.90	.055	.04	9		
	50	6.54	18.00	.053	.04	4		
	55	6.41	18.00	.050	.03	2		
	60	6.40	17.30	.048	.04	2		

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MACTEC ENGINEERING AND CONSULTING, INC.

MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-11D

SITE NAME Duke Marshall Steam Station DATE _____ TIME OF SAMPLE N/A

FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS _____

TOTAL WELL DEPTH (TWD) 93.32 FT. (measured / well tag / drillers log – **circle one**)

SCREENED INTERVAL 85.5-90.5 bgs MEASURING POINT FOR DEPTH Top of casing

DEPTH TO GROUNDWATER (DGW) 43.40'

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 49.92'

CASING DIAMETER 2 IN.

ONE STANDING WELL VOLUME = 8.14 gal.

(NOTE ½" = 0.0102G/FT: ¾" = 0.023 G/FT: 1"= 0.041G/FT: 2" = 0.163 G/FT: 4" = 0.653 G/FT: 6" = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 24.41 FIVE STANDING WELL VOLUMES = 40.70

METHOD OF WELL EVACUATION: BAILER / (PUMP) / OTHER: TYPE _____

TOTAL VOLUME OF WATER REMOVED: 60 GAL.

WELL TYPE: FLUSH MOUNT / (ABOVE GRADE)

COMMENTS _____

LOCKING CAP YES X NO _____

PROTECTIVE POST/ABUTMENT YES X NO _____

NONPOTABLE LABEL YES X NO _____

ID PLATE YES X NO _____

WELL INTEGRITY SATISFACTORY YES X NO _____

No sample collected/purged for development only

WELL YIELD LOW _____ MODERATE X HIGH _____

Time	Volume	pH	Temp (°C)	Cond. (µS/cm)	Dis. O_2 (mg/L)	Turbidity (NTU)	ORP (mV)	Notes
	60	7.84	18.90	.071	.04	4.80		

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MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-10S

SITE NAME Duke Marshall Steam Station DATE _____ TIME OF SAMPLE N/A

FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS _____

TOTAL WELL DEPTH (TWD) 29.44 FT. (measured / well tag / drillers log – **circle one**)

SCREENED INTERVAL 12-27 bgs MEASURING POINT FOR DEPTH top of casing

DEPTH TO GROUNDWATER (DGW) 16.64 below TOC

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 12.80

CASING DIAMETER 2 IN.

ONE STANDING WELL VOLUME = 2.09 gal.

(NOTE ½" = 0.0102G/FT: ¾" = 0.023 G/FT: 1"= 0.041G/FT: 2" = 0.163 G/FT: 4" = 0.653 G/FT: 6" = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 6.26 FIVE STANDING WELL VOLUMES = 10.45

METHOD OF WELL EVACUATION: BAILER / (PUMP) / OTHER: TYPE _____

TOTAL VOLUME OF WATER REMOVED: 60 GAL.

WELL TYPE: FLUSH MOUNT / (ABOVE GRADE)

COMMENTS _____

LOCKING CAP YES X NO _____ No sample collected/purged for

PROTECTIVE POST/ABUTMENT YES _____ NO X development only

NONPOTABLE LABEL YES X NO _____

ID PLATE YES X NO _____

WELL INTEGRITY SATISFACTORY YES X NO _____

WELL YIELD LOW _____ MODERATE _____ HIGH X

Time	Volume	pH	Temp (°C)	Cond. (µS/cm)	Dis. O_2 (mg/L)	Turbidity (NTU)	ORP (mV)	Notes
	40	6.13	19.40	0.163	0.01	14		
	45	6.09	18.20	.067	0.01	3		
	50	6.11	18.00	.057	0.01	1		
	55	5.96	17.20	.051	0.01	1		
	60	5.97	17.50	.048	0.01	1		

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MACTEC ENGINEERING AND CONSULTING, INC.

MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-10D

SITE NAME Duke Marshall Steam Station DATE _____ TIME OF SAMPLE N/A

FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS _____

TOTAL WELL DEPTH (TWD) 87.69 FT (measured / well tag / drillers log – **circle one**)

SCREENED INTERVAL 80.4 – 85.4 bgs MEASURING POINT FOR DEPTH Top of casing

DEPTH TO GROUNDWATER (DGW) 16.23

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 71.46

CASING DIAMETER 2 IN.

ONE STANDING WELL VOLUME = 11.65 gal.

(NOTE ½" = 0.0102G/FT: ¾" = 0.023 G/FT: 1"= 0.041G/FT: 2" = 0.163 G/FT: 4" = 0.653 G/FT: 6" = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 39.94 FIVE STANDING WELL VOLUMES = 58.25

METHOD OF WELL EVACUATION: BAILER / PUMP / OTHER: TYPE _____

TOTAL VOLUME OF WATER REMOVED: 80 GAL.

WELL TYPE: FLUSH MOUNT / ABOVE GRADE COMMENTS _____

LOCKING CAP YES X NO _____ No sample collected/purged for

PROTECTIVE POST/ABUTMENT YES _____ NO X development only

NONPOTABLE LABEL YES X NO _____

ID PLATE YES X NO _____

WELL INTEGRITY SATISFACTORY YES X NO _____

WELL YIELD LOW _____ MODERATE _____ HIGH X

Time	Volume	pH	Temp (°C)	Cond. (µS/cm)	Dis. O_2 (mg/L)	Turbidity (NTU)	ORP (mV)	Notes
	30	6.82	20.10	.090	11.38	320		
	35	6.80	19.70	.082	11.38	183		
	40	6.73	19.60	.077	11.38	172		
	45	6.63	18.70	.073	0.03	144		
	50	6.63	19.00	.071	0.02	124		
	55	6.63	18.70	.070	0.05	140		
	60	6.98	18.30	.107	11.28	90		
	65	6.78	17.80	.078	.003	58		
	70	6.62	17.70	.068	11.96	5		
	75	6.65	18.00	.065	0.04	2		
	80	6.62	17.60	.065	11.59	5		

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MACTEC ENGINEERING AND CONSULTING, INC.

MONITORING WELL SAMPLING FIELD DATA WORKSHEET

MACTEC PROJECT NUMBER 6228-10-5284 MONITORING WELL NUMBER MW-14S

SITE NAME Duke Marshall Steam Station DATE _____ TIME OF SAMPLE N/A

FIELD PERSONNEL Mark Filardi WEATHER CONDITIONS _____

TOTAL WELL DEPTH (TWD) 47.13 FT (measured / well tag / drillers log – **circle one**)

SCREENED INTERVAL 28-43 bgs MEASURING POINT FOR DEPTH Top of casing

DEPTH TO GROUNDWATER (DGW) 36.36

LENGTH OF WATER COLUMN (LWC) = TWD – DGW = 10.77

CASING DIAMETER 2 IN.

ONE STANDING WELL VOLUME = 1.76 gal.

(NOTE ½" = 0.0102G/FT: ¾" = 0.023 G/FT: 1"= 0.041G/FT: 2" = 0.163 G/FT: 4" = 0.653 G/FT: 6" = 1.46 G/FT)

THREE STANDING WELL VOLUMES = 5.27 FIVE STANDING WELL VOLUMES = 8.80

METHOD OF WELL EVACUATION: BAILER (PUMP) OTHER: TYPE _____

TOTAL VOLUME OF WATER REMOVED: 90 GAL.

WELL TYPE: FLUSH MOUNT (ABOVE GRADE)

COMMENTS _____

LOCKING CAP	YES X	NO _____	No sample collected/purged for
PROTECTIVE POST/ABUTMENT	YES _____	NO X	development only
NONPOTABLE LABEL	YES X	NO _____	
ID PLATE	YES X	NO _____	
WELL INTEGRITY SATISFACTORY	YES X	NO _____	

WELL YIELD LOW _____ MODERATE _____ HIGH X

Time	Volume	pH	Temp (°C)	Cond. (µS/cm)	Dis. O_2 (mg/L)	Turbidity (NTU)	ORP (mV)	Notes
	40	5.96	18.50	.839	13.17	538		
	45	5.64	17.70	.857	12.55	138		
	50	5.59	17.60	.855	.03	100		
	55	5.60	17.50	.866	.01	117		
	60	5.55	17.50	.870	.00	27		
	65	5.56	17.50	0.91	12.35	27		DO malfunction
	70	5.60	17.50	0.92	11.50	20		
	75	5.50	16.60	0.92	.02	20		
	80	5.49	17.00	0.93	.02	250		
	85	5.52	17.60	0.92	15.97	10		
	90	5.47	17.60	0.93	12.30	23		

APPENDIX E
PHOTOGRAPHS OF COMPLETED WELL PAIRS

Photo 1: Well pair MW-13S (Right) and MW-13D (Left)

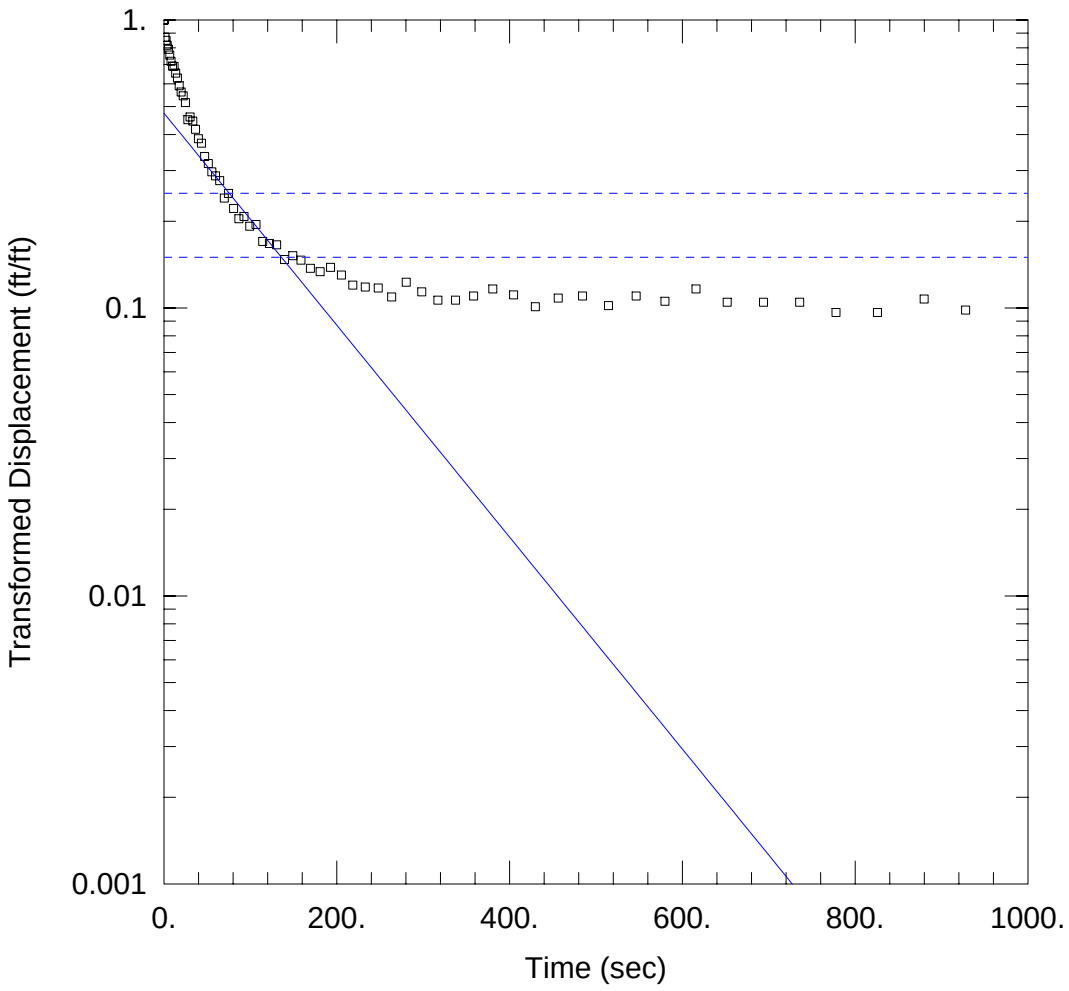
Photo 2: Well pair MW-12S (Right) and MW-12D (Left)

Photo 3: Well pair MW-14S (Left) and MW-14D (Right)

Photo 4: Well pair MW-11S (Left) and MW-11D (Right)

Photo 5: Well pair MW-10S (Right) and MW-10D (Left)

APPENDIX F
SLUG TEST DATA



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-14S
Test Date: 8/16/2010

AQUIFER DATA

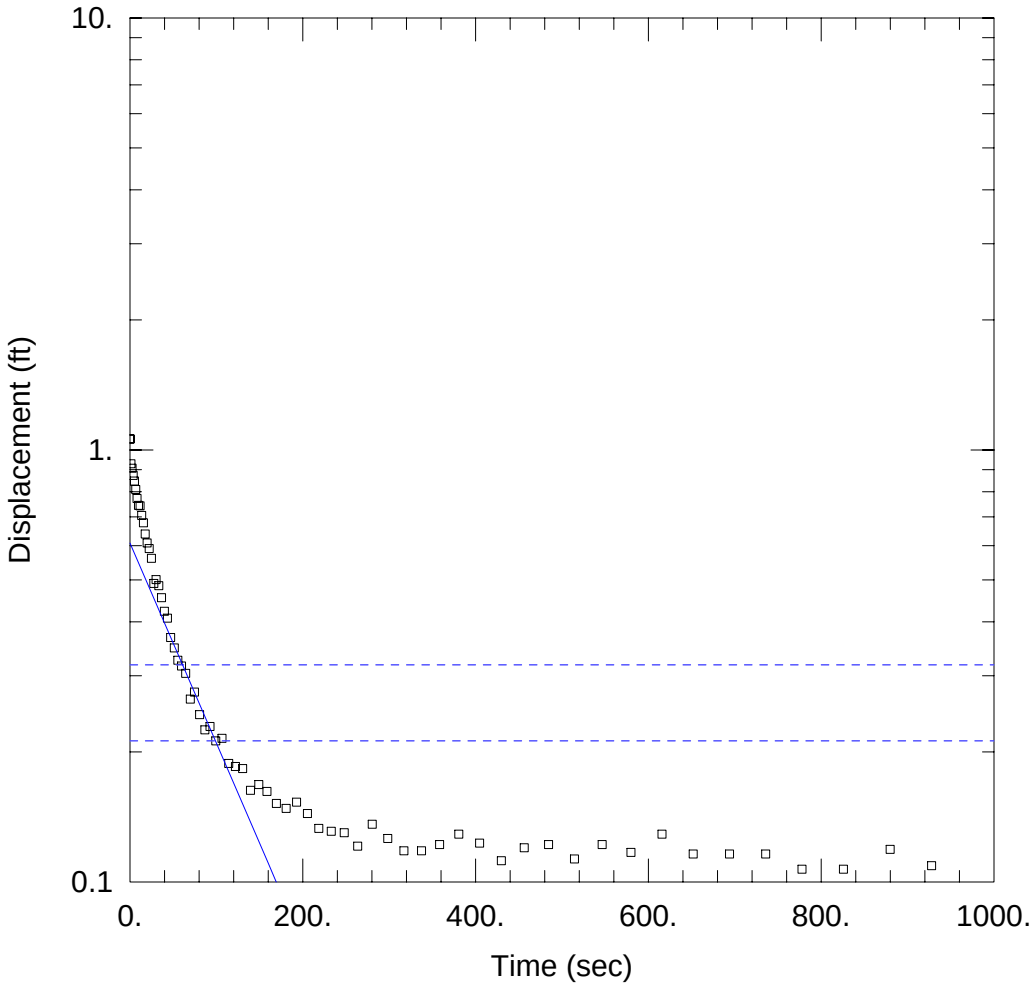
Saturated Thickness: 10.77 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-14S)

Initial Displacement: 1.06 ft
Total Well Penetration Depth: 10.77 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 10.77 ft
Screen Length: 10.77 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Dagan
K = 0.0008911 cm/sec
y0 = 0.5161 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-14S
Test Date: 8/16/2010

AQUIFER DATA

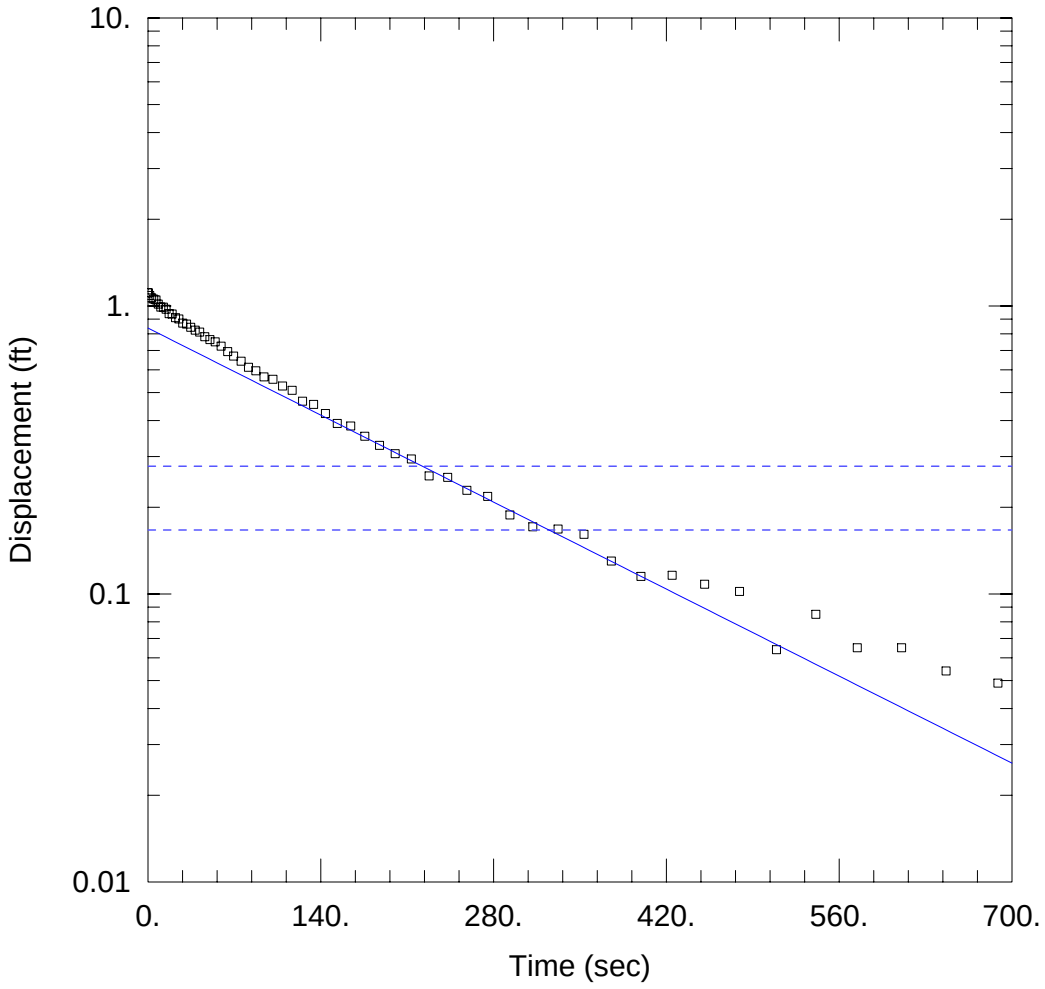
Saturated Thickness: 10.77 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-14S)

Initial Displacement: 1.06 ft
Total Well Penetration Depth: 10.77 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 10.77 ft
Screen Length: 10.77 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0009566 cm/sec
y0 = 0.6086 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-14D
Test Date: 8/16/2010

AQUIFER DATA

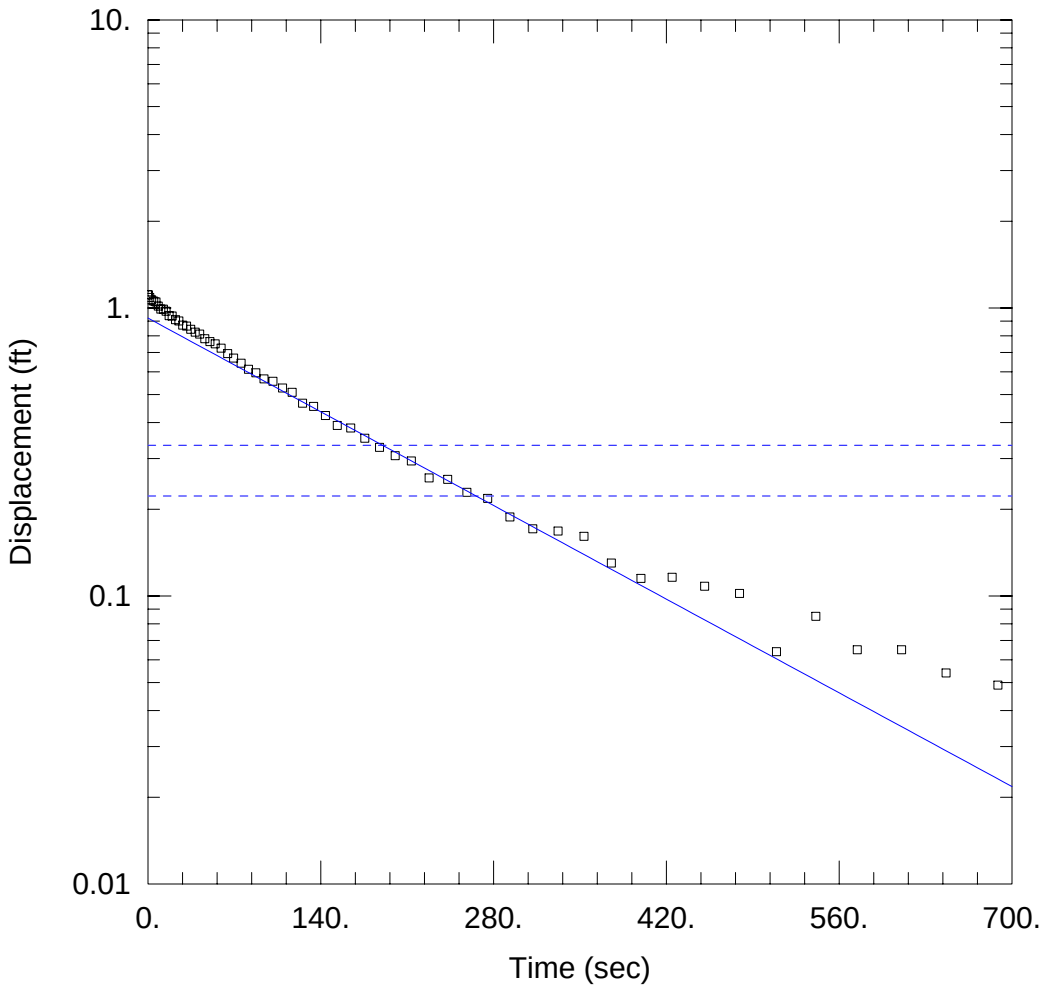
Saturated Thickness: 25.87 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-14D)

Initial Displacement: 1.111 ft
Total Well Penetration Depth: 25.87 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 25.87 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0006479 cm/sec
y0 = 0.8376 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-14D
Test Date: 8/16/2010

AQUIFER DATA

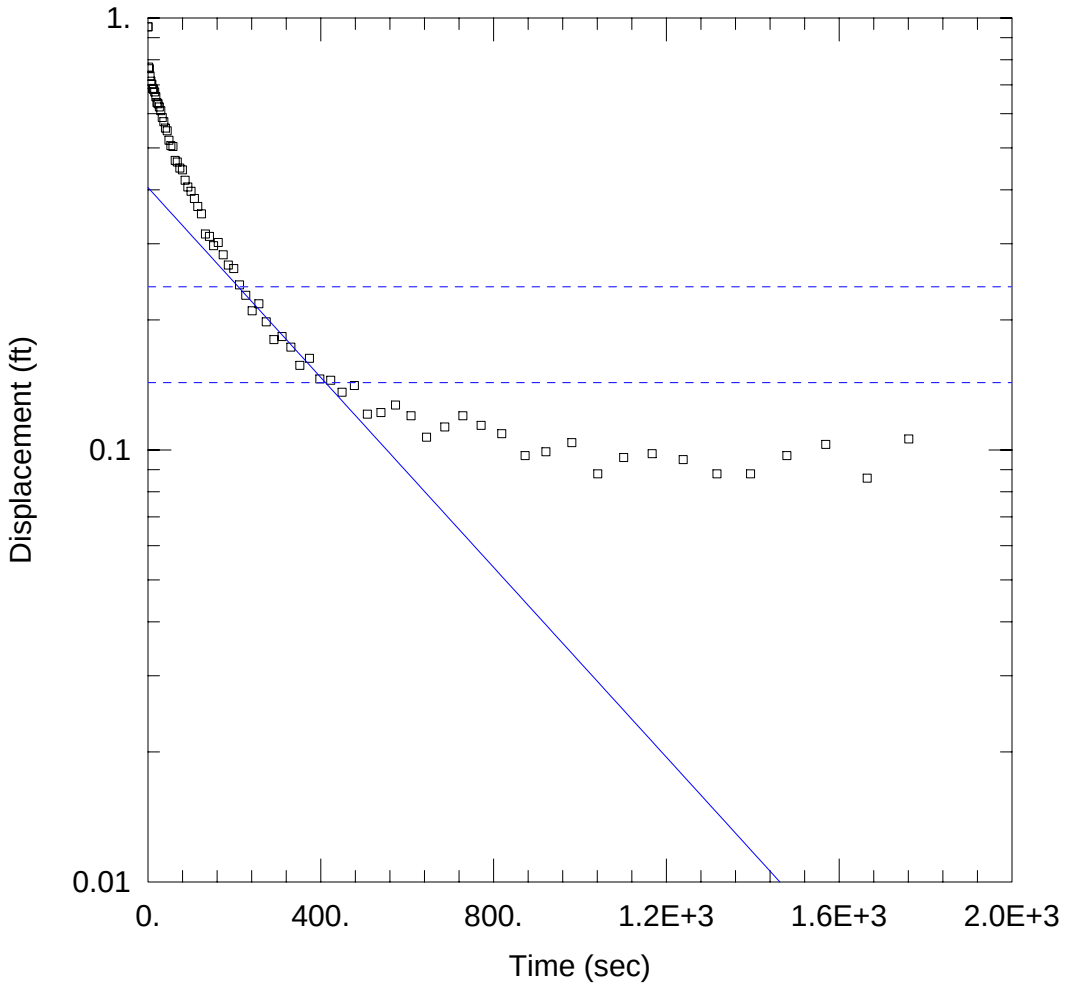
Saturated Thickness: 25.87 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-14D)

Initial Displacement: 1.111 ft
Total Well Penetration Depth: 25.87 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 25.87 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0006015 cm/sec
y0 = 0.9218 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-13S
Test Date: 8/16/2010

AQUIFER DATA

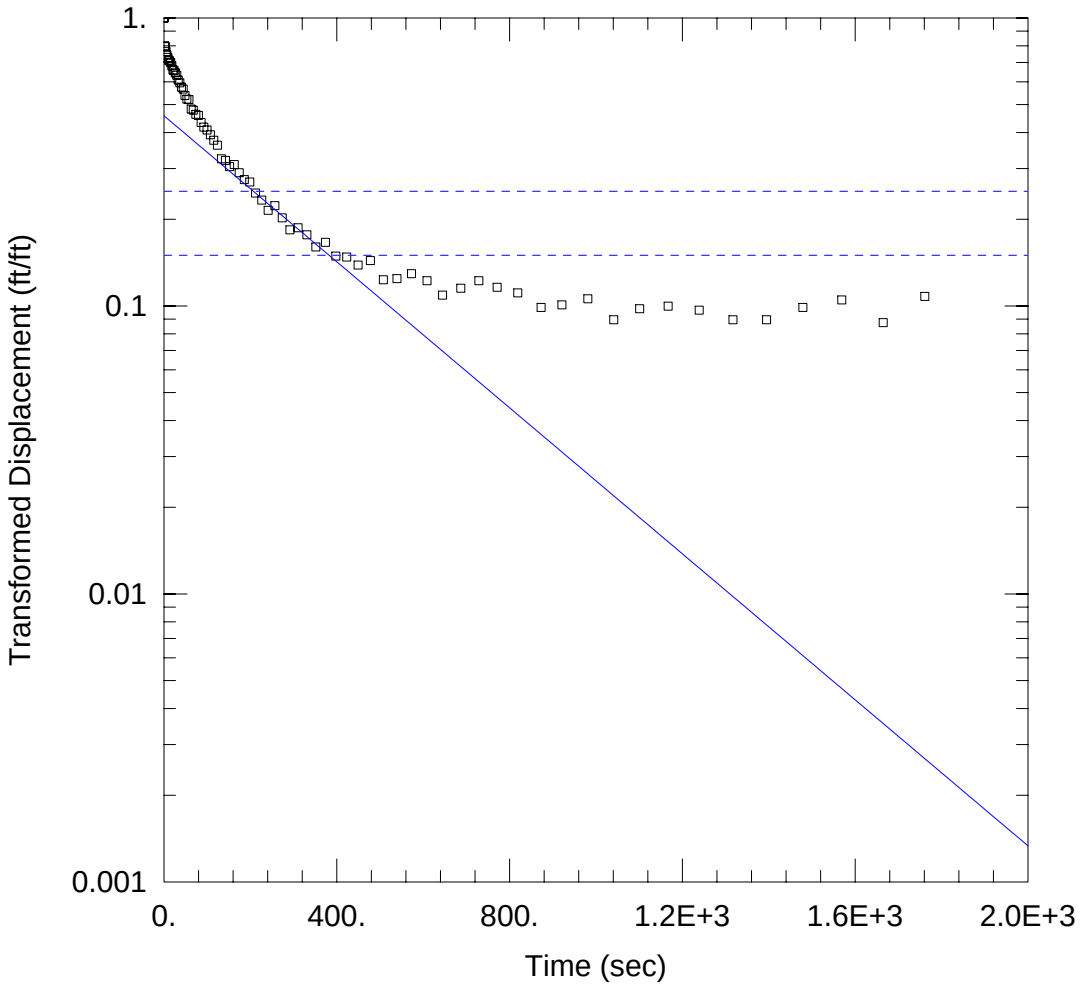
Saturated Thickness: 15.42 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-13S)

Initial Displacement: 0.954 ft
Total Well Penetration Depth: 15.42 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 15.42 ft
Screen Length: 15. ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0002725 cm/sec
y0 = 0.4048 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-09-5100
Location: Marshall Steam Station
Test Well: MW-13S
Test Date: 8/16/2010

AQUIFER DATA

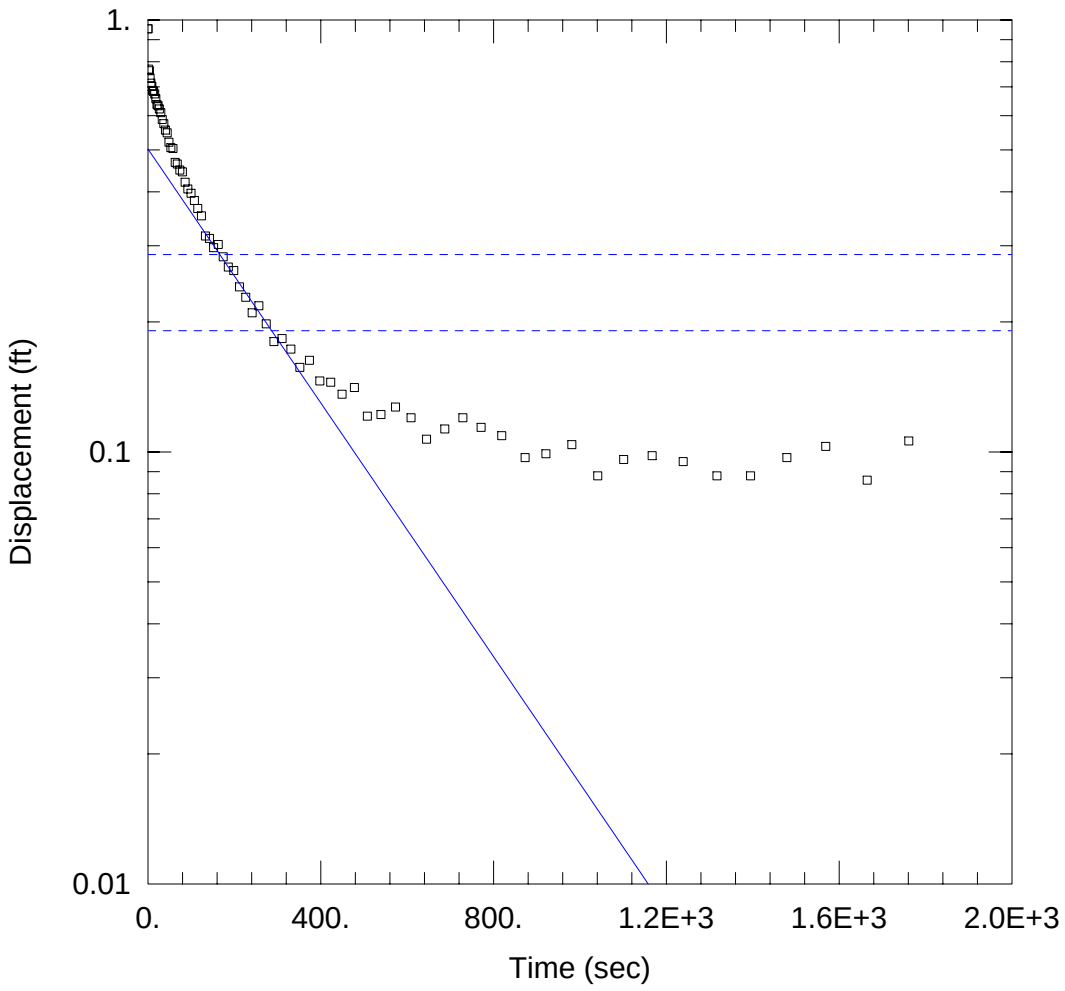
Saturated Thickness: 15.42 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-13S)

Initial Displacement: 0.954 ft
Total Well Penetration Depth: 15.42 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 15.42 ft
Screen Length: 15. ft
Well Radius: 0.0833 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Dagan
K = 7.376E-5 cm/sec
y0 = 0.4439 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-13S
Test Date: 8/16/2010

AQUIFER DATA

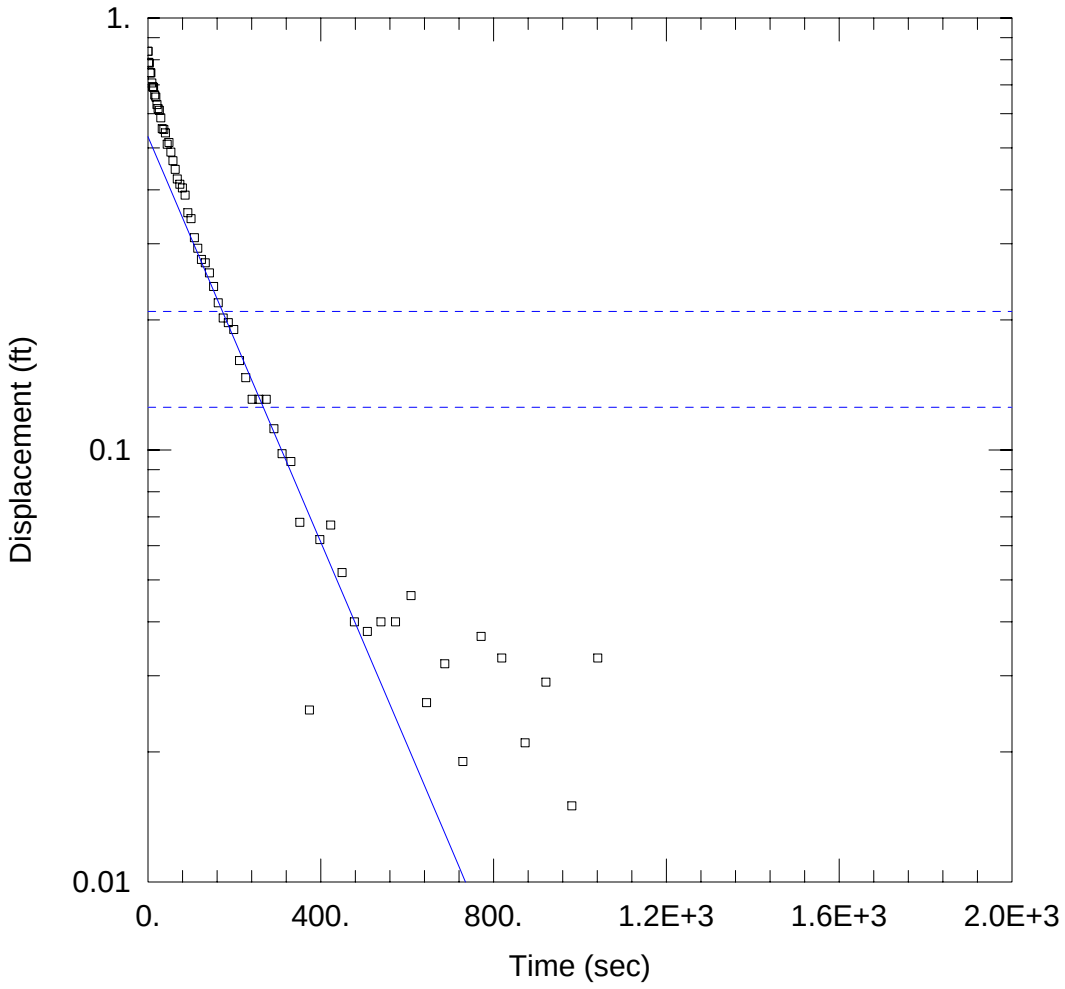
Saturated Thickness: 15.42 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-13S)

Initial Displacement: 0.954 ft
Total Well Penetration Depth: 15.42 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 15.42 ft
Screen Length: 15. ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0002399 cm/sec
y0 = 0.5024 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-13D
Test Date: 8/16/2010

AQUIFER DATA

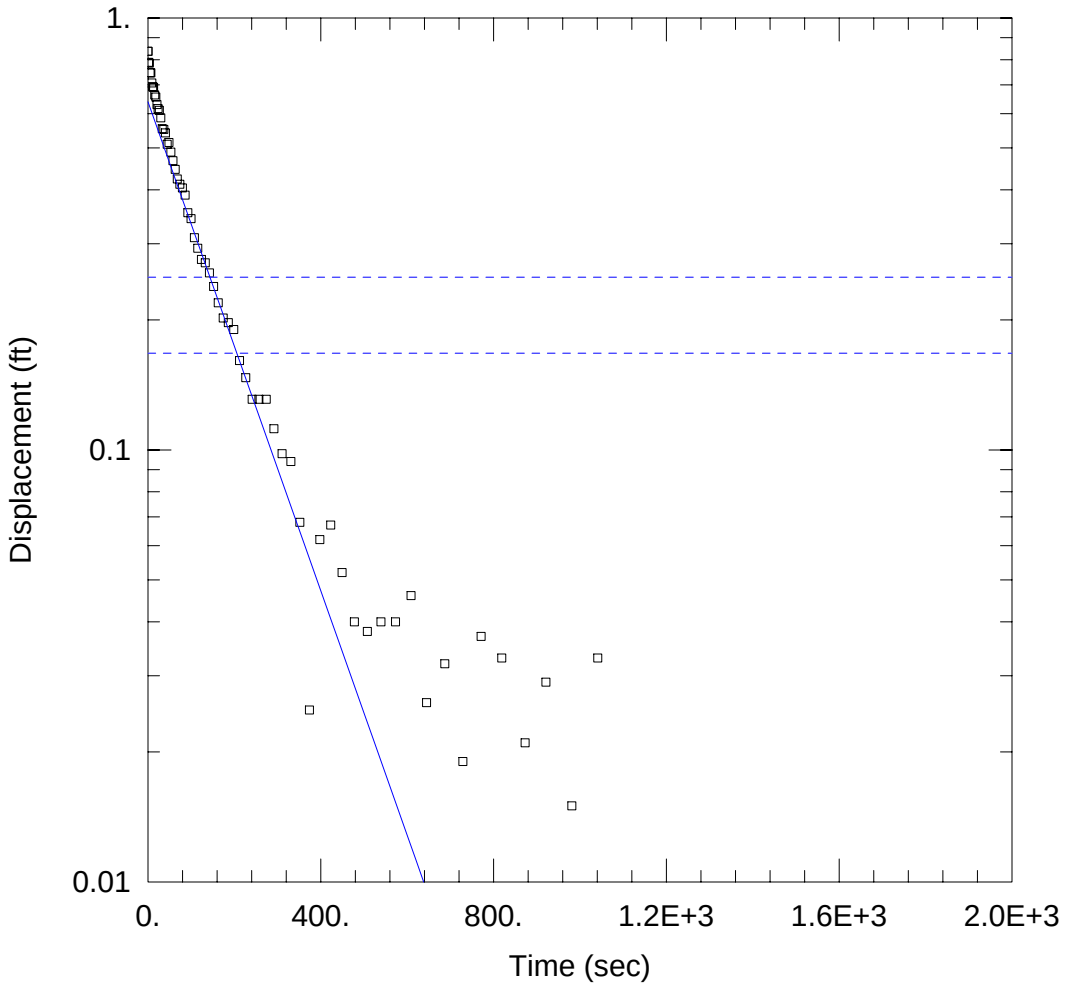
Saturated Thickness: 45.02 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-13D)

Initial Displacement: 0.837 ft
Total Well Penetration Depth: 45.02 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 45.02 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0007045 cm/sec
y0 = 0.5309 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-13D
Test Date: 8/16/2010

AQUIFER DATA

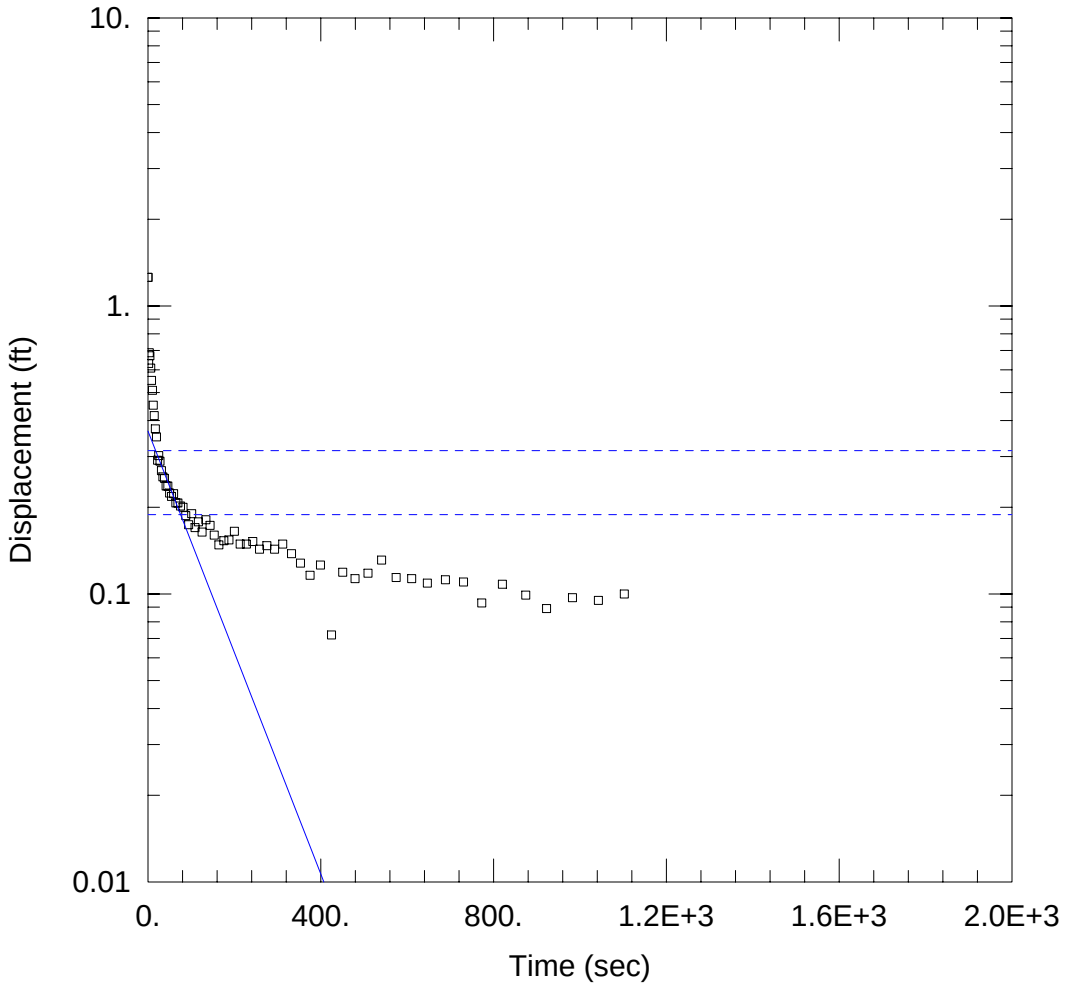
Saturated Thickness: 45.02 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-13D)

Initial Displacement: 0.837 ft
Total Well Penetration Depth: 45.02 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 45.02 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0007923 cm/sec
y0 = 0.6391 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-12S
Test Date: 8/16/2010

AQUIFER DATA

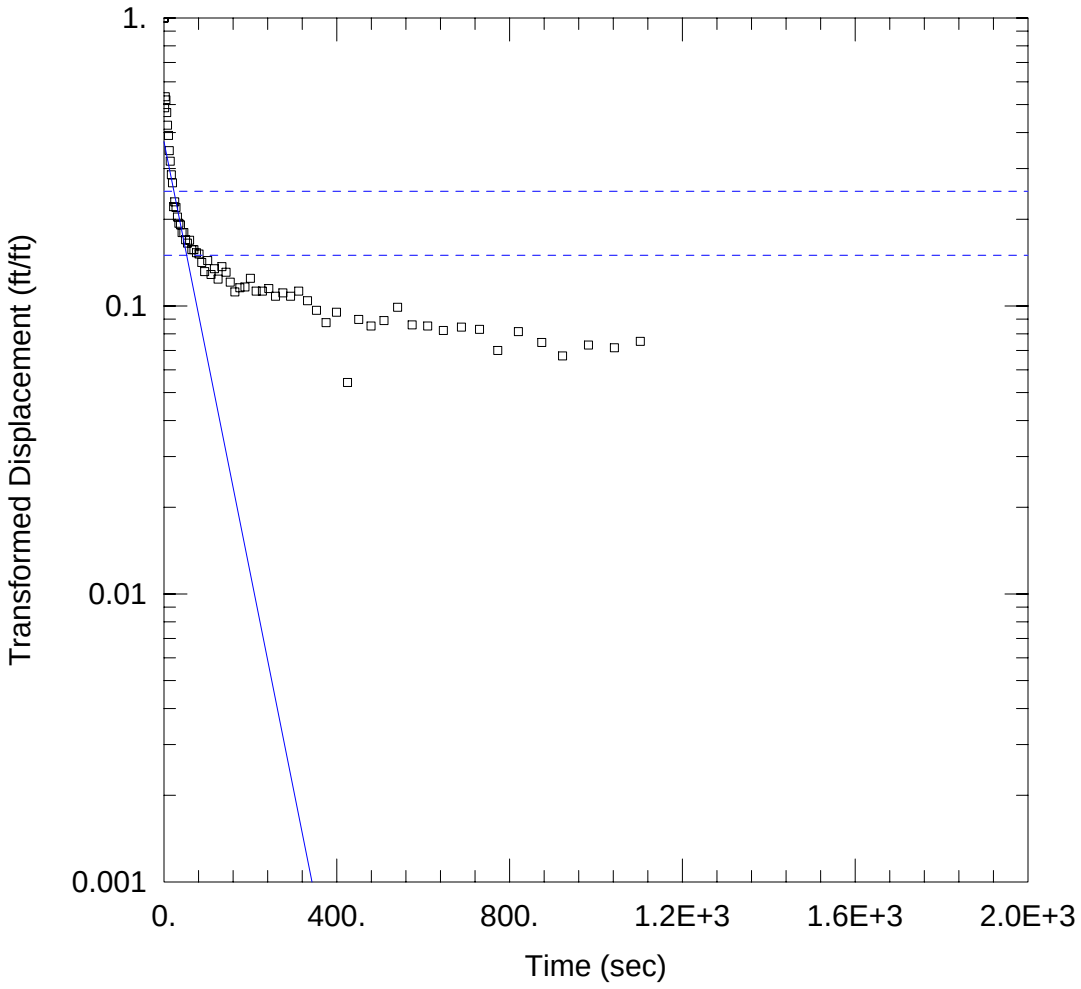
Saturated Thickness: 11.04 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-12S)

Initial Displacement: 1.257 ft
Total Well Penetration Depth: 11.04 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 11.04 ft
Screen Length: 11.04 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.001445 cm/sec
y0 = 0.3676 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-12S
Test Date: 8/16/2010

AQUIFER DATA

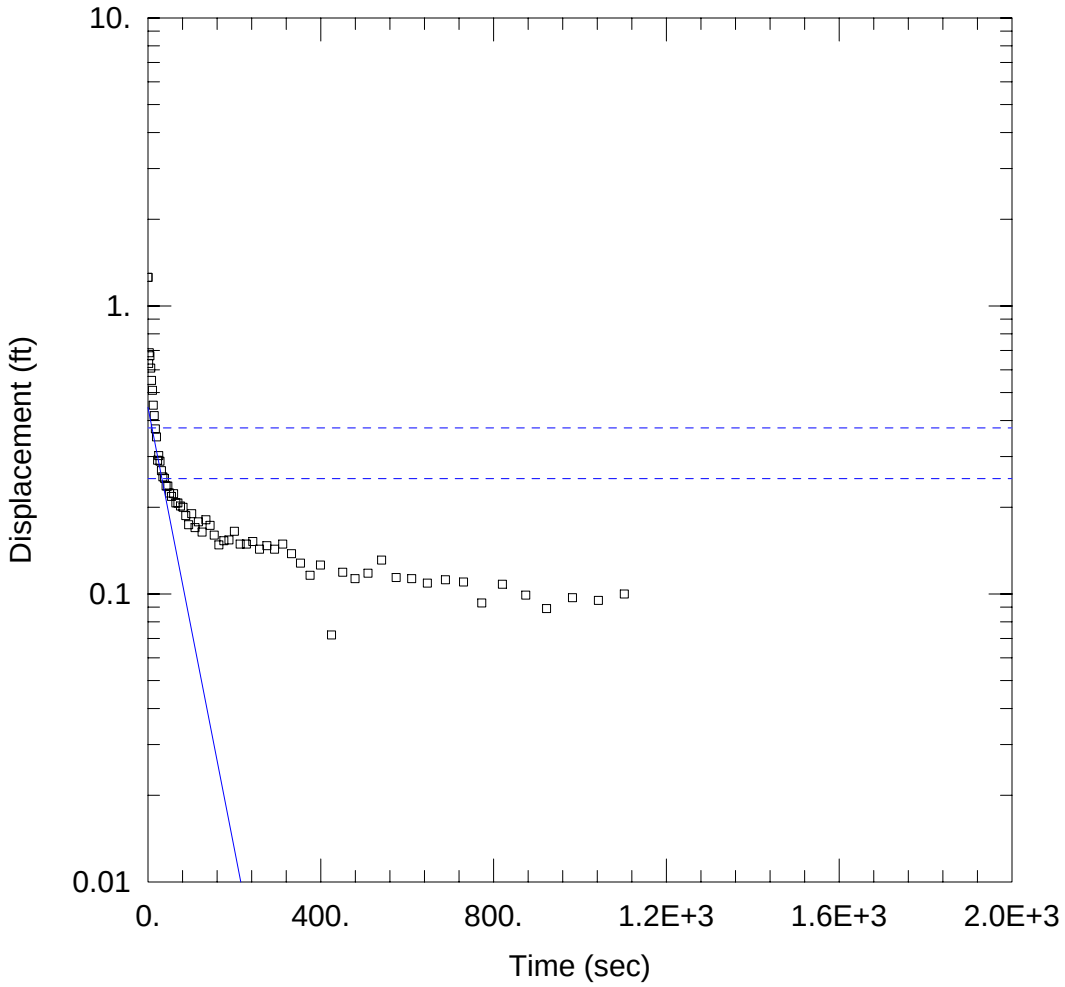
Saturated Thickness: 11.04 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-12S)

Initial Displacement: 1.257 ft
Total Well Penetration Depth: 11.04 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 11.04 ft
Screen Length: 11.04 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Dagan
K = 0.001787 cm/sec
y0 = 0.4844 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-12S
Test Date: 8/16/2010

AQUIFER DATA

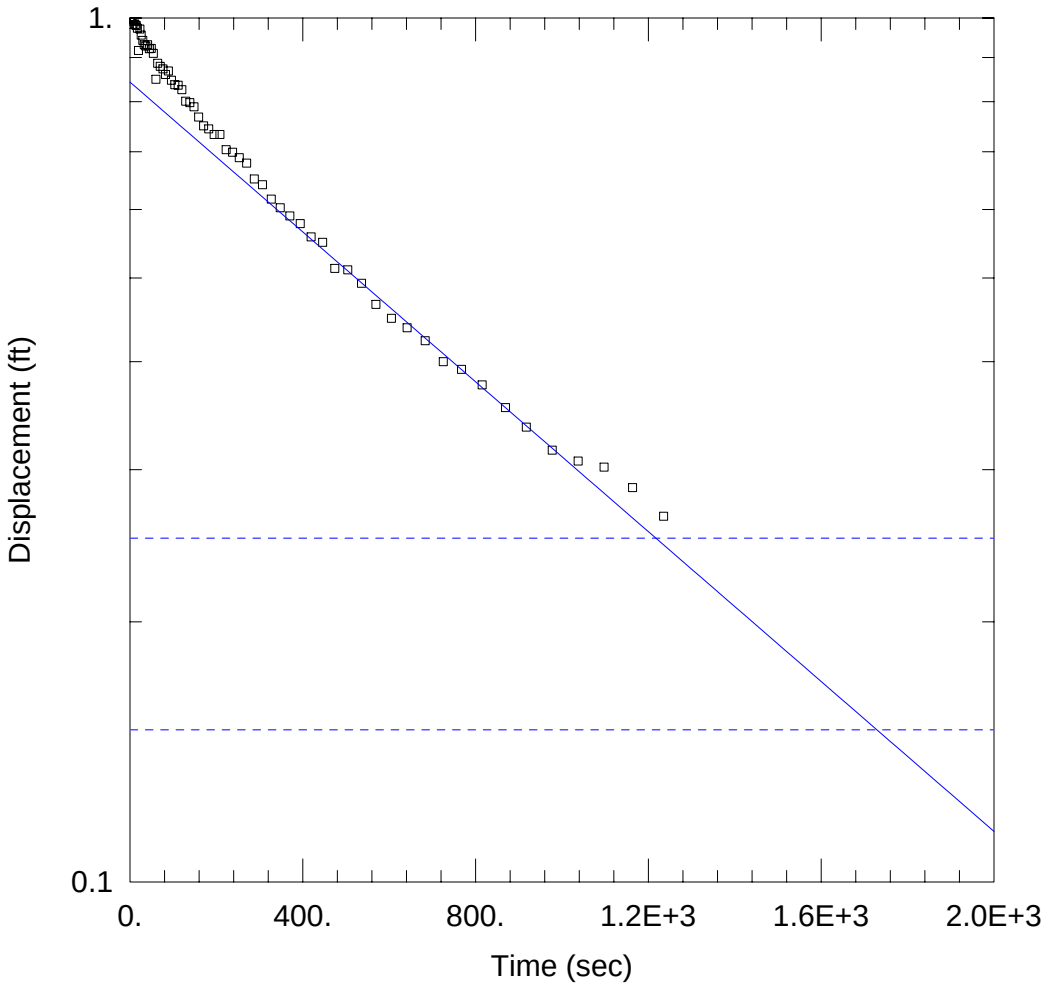
Saturated Thickness: 11.04 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-12S)

Initial Displacement: 1.257 ft
Total Well Penetration Depth: 11.04 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 11.04 ft
Screen Length: 11.04 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.001557 cm/sec
y0 = 0.4443 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-12D
Test Date: 8/16/2010

AQUIFER DATA

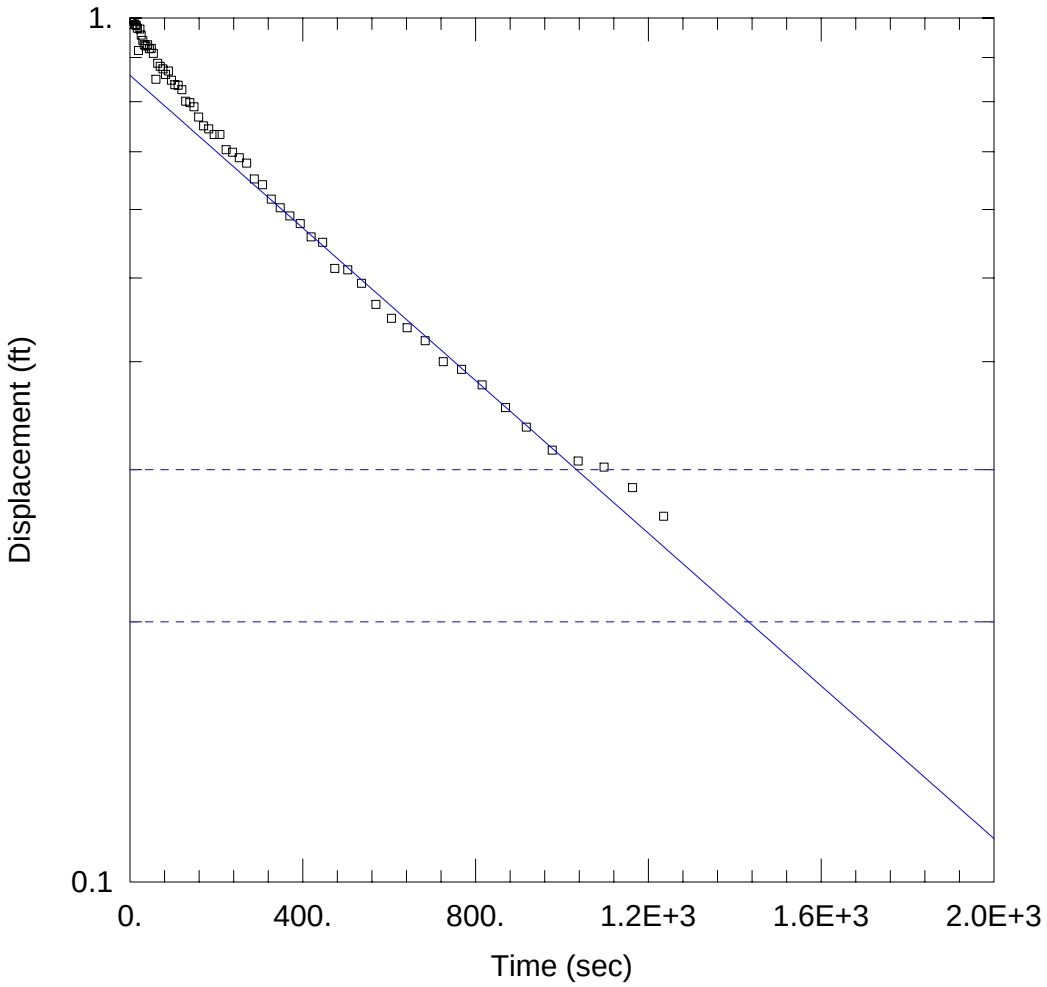
Saturated Thickness: 83.38 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-12D)

Initial Displacement: 1. ft
Total Well Penetration Depth: 83.38 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 83.38 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0001302 cm/sec
y0 = 0.8428 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-12D
Test Date: 8/16/2010

AQUIFER DATA

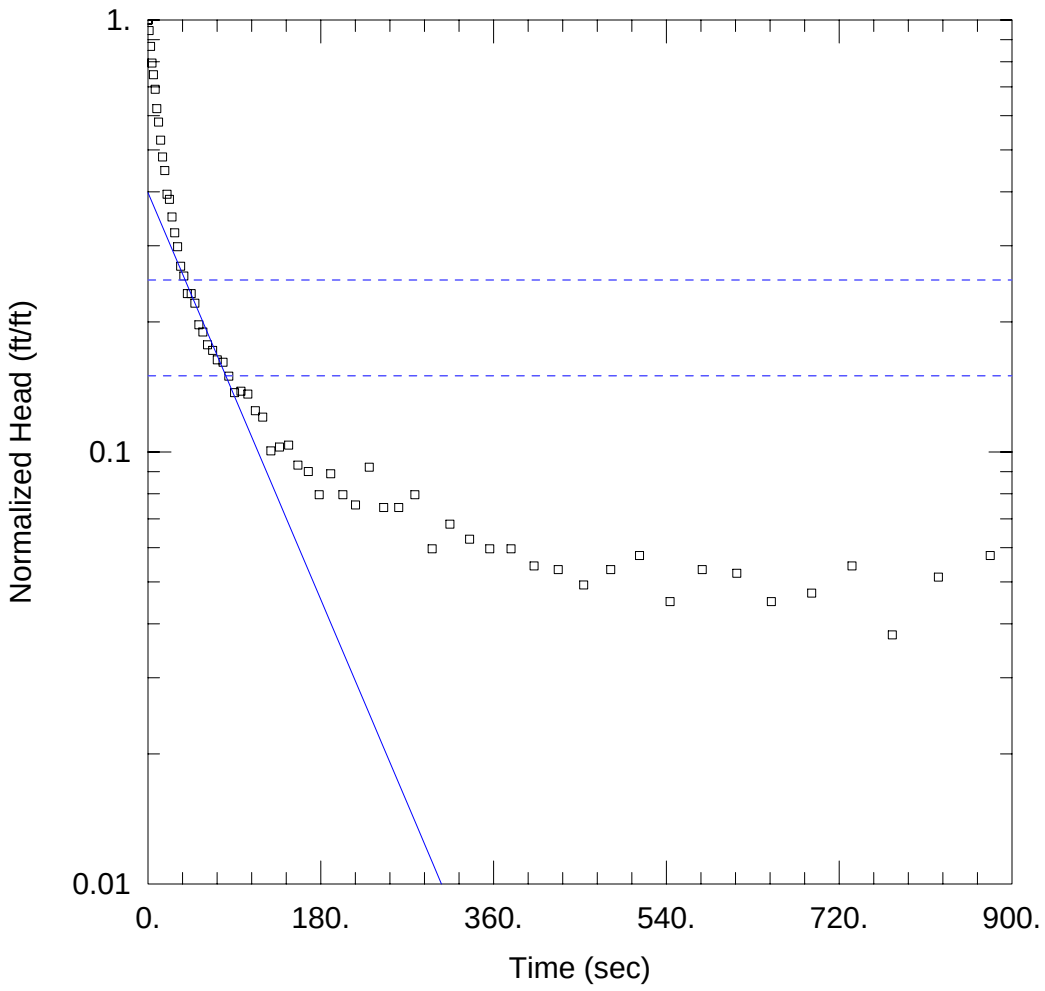
Saturated Thickness: 83.38 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-12D)

Initial Displacement: 1. ft
Total Well Penetration Depth: 83.38 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 83.38 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0001336 cm/sec
y0 = 0.8583 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-11S
Test Date: 8/16/2010

AQUIFER DATA

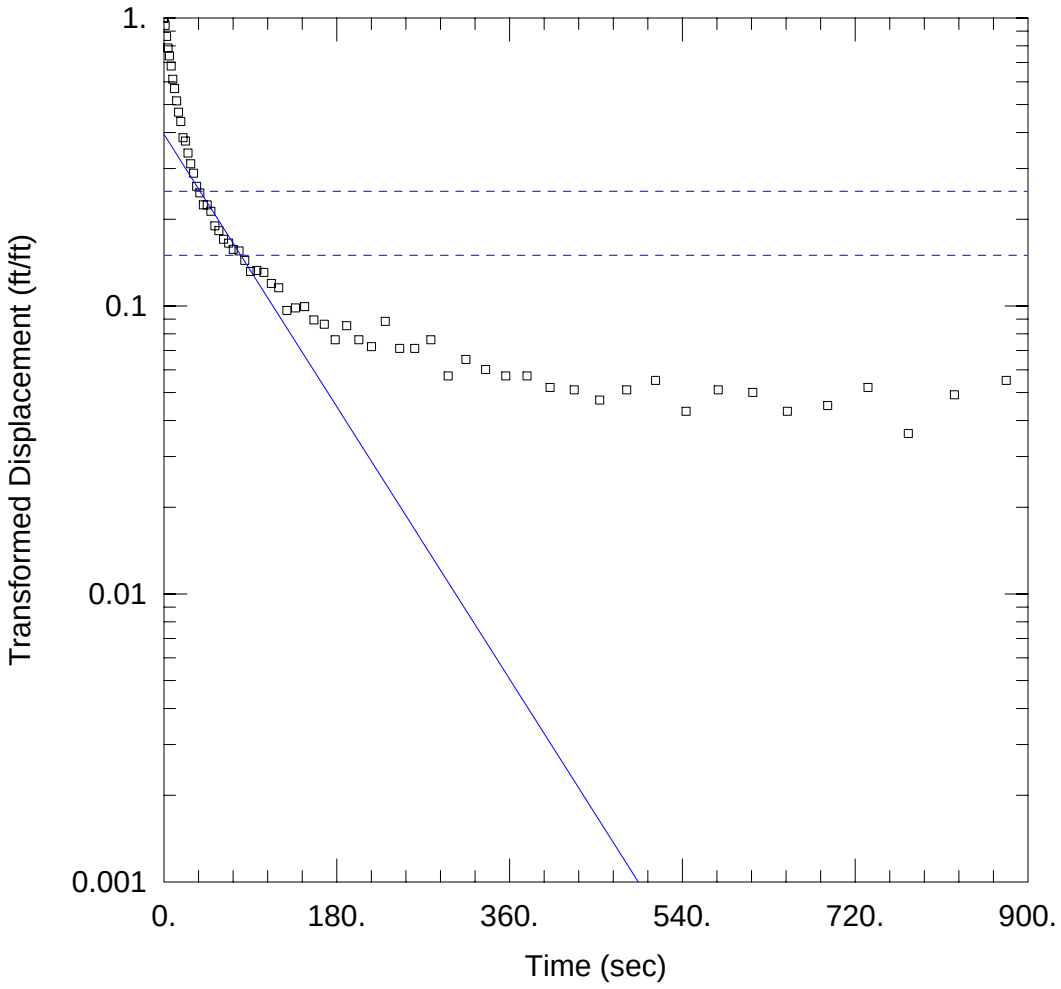
Saturated Thickness: 10.61 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-11S)

Initial Displacement: 0.955 ft
Total Well Penetration Depth: 10.61 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 10.61 ft
Screen Length: 10.61 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.002047 cm/sec
y0 = 0.3804 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-11S
Test Date: 8/16/2010

AQUIFER DATA

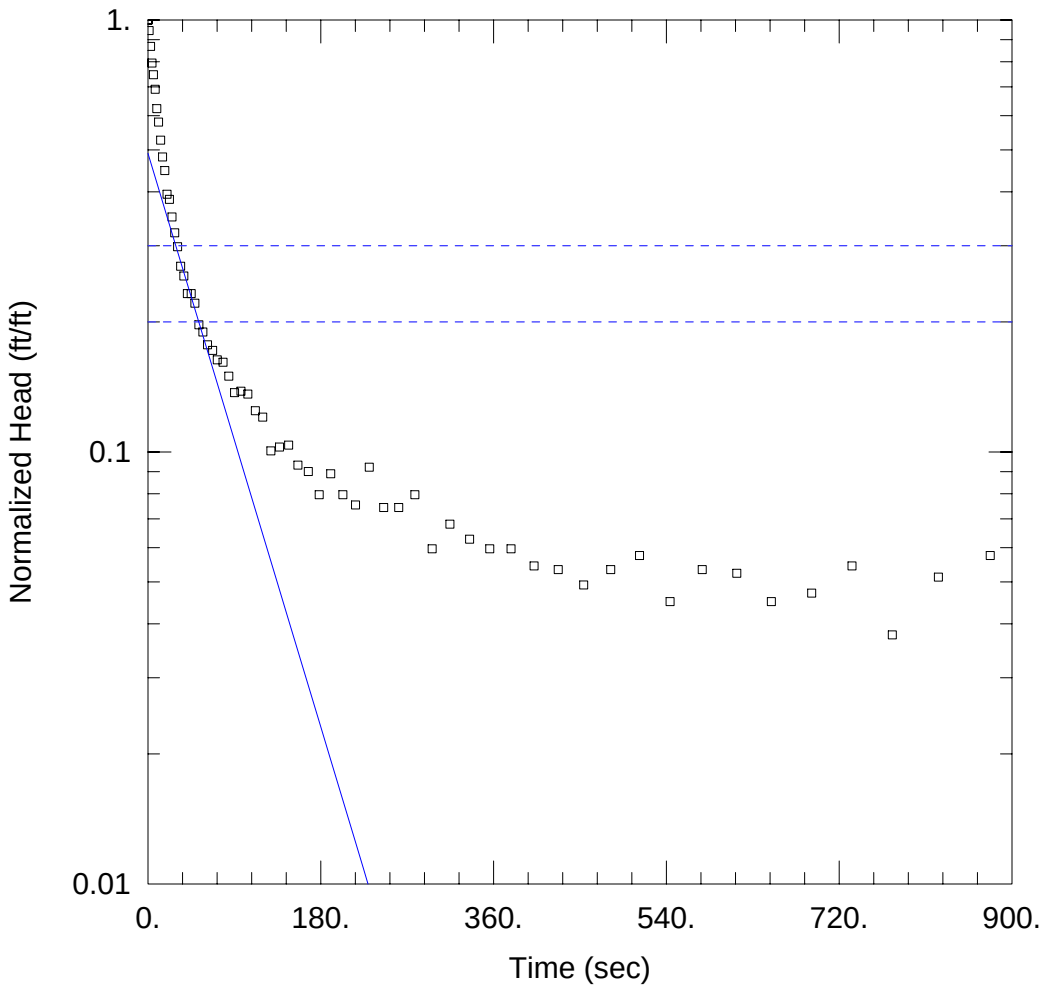
Saturated Thickness: 10.61 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-11S)

Initial Displacement: 0.955 ft
Total Well Penetration Depth: 10.61 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 10.61 ft
Screen Length: 10.61 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Dagan
K = 0.001285 cm/sec
y0 = 0.387 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-11S
Test Date: 8/16/2010

AQUIFER DATA

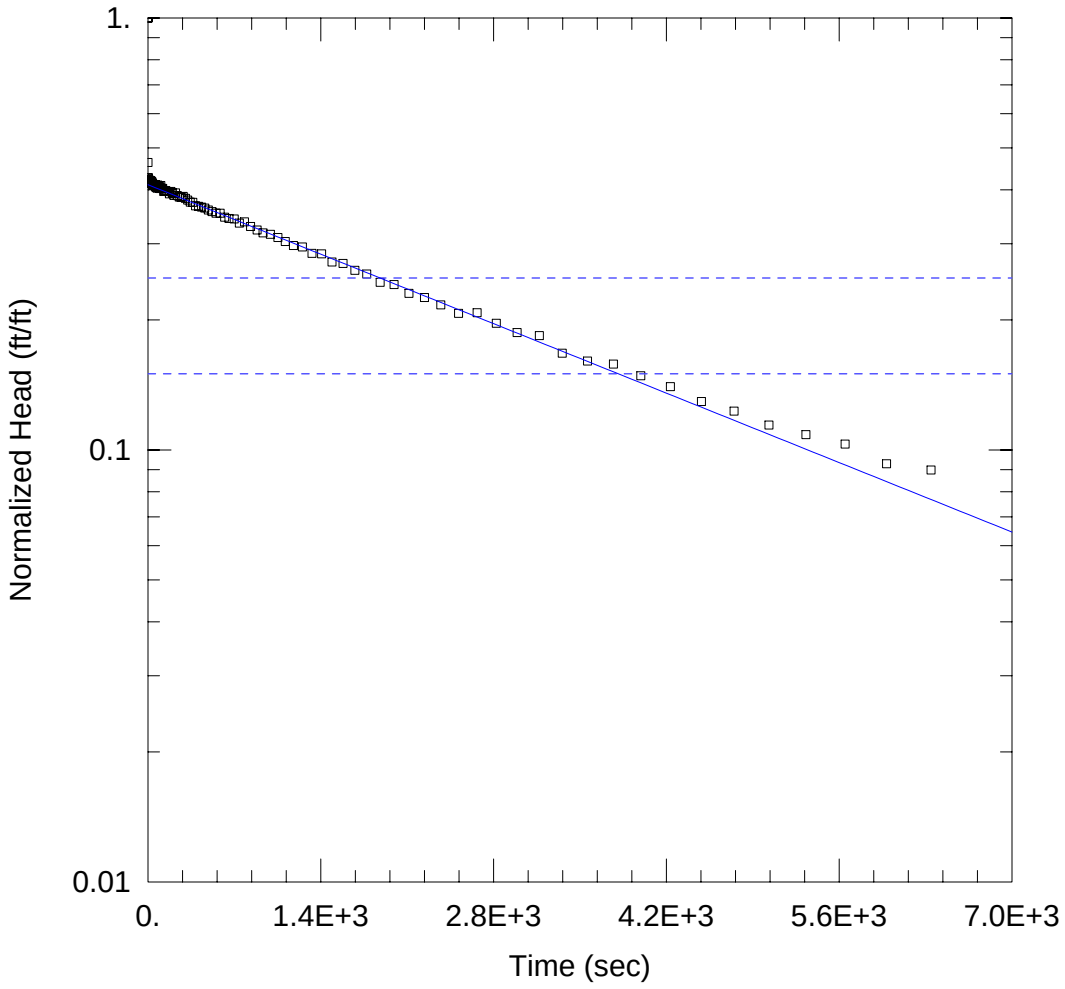
Saturated Thickness: 10.61 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-11S)

Initial Displacement: 0.955 ft
Total Well Penetration Depth: 10.61 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 10.61 ft
Screen Length: 10.61 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.00154 cm/sec
y0 = 0.4687 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-11D
Test Date: 8/16/2010

AQUIFER DATA

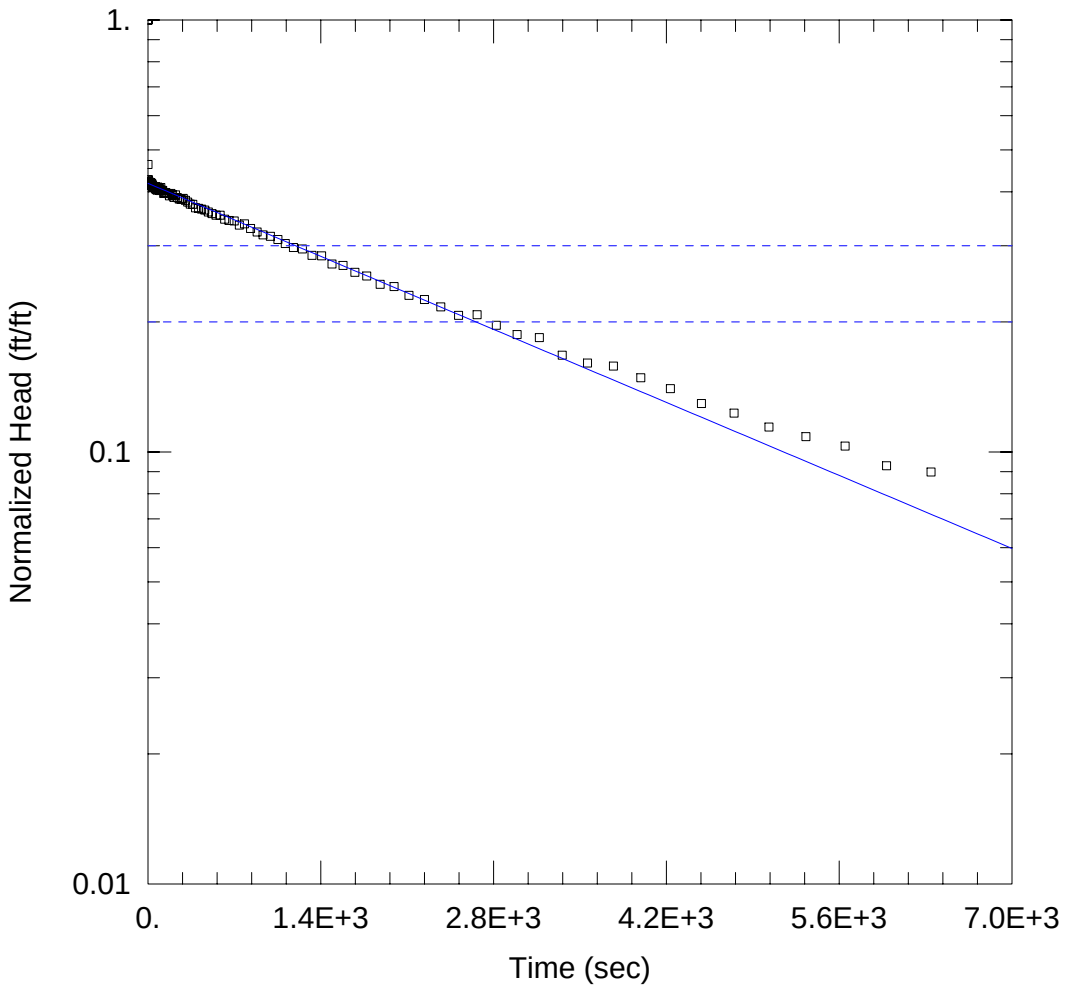
Saturated Thickness: 49.92 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-11D)

Initial Displacement: 2.627 ft
Total Well Penetration Depth: 49.92 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 49.92 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 3.448E-5 cm/sec
y0 = 1.08 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-11D
Test Date: 8/16/2010

AQUIFER DATA

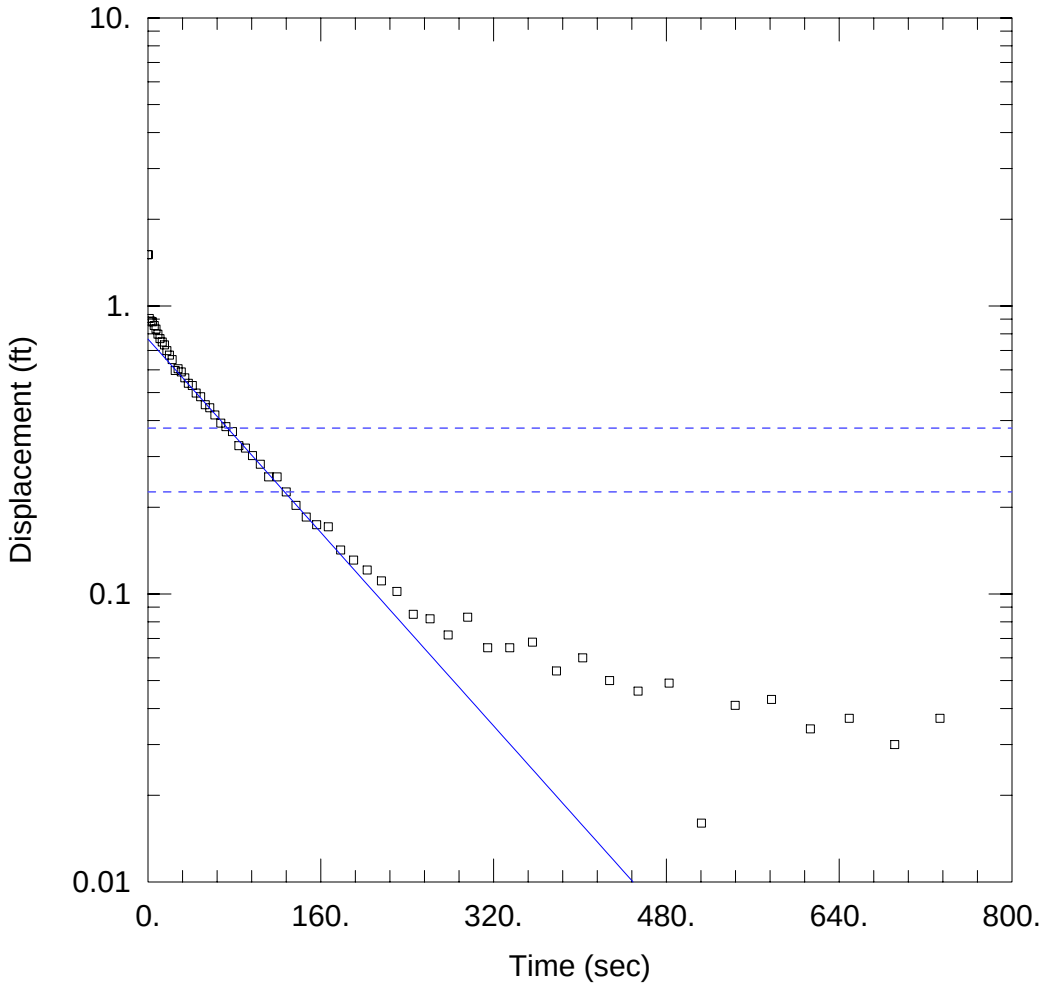
Saturated Thickness: 49.92 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-11D)

Initial Displacement: 2.627 ft
Total Well Penetration Depth: 49.92 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 49.92 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.428E-5 cm/sec
y0 = 1.1 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-10S
Test Date: 8/16/2010

AQUIFER DATA

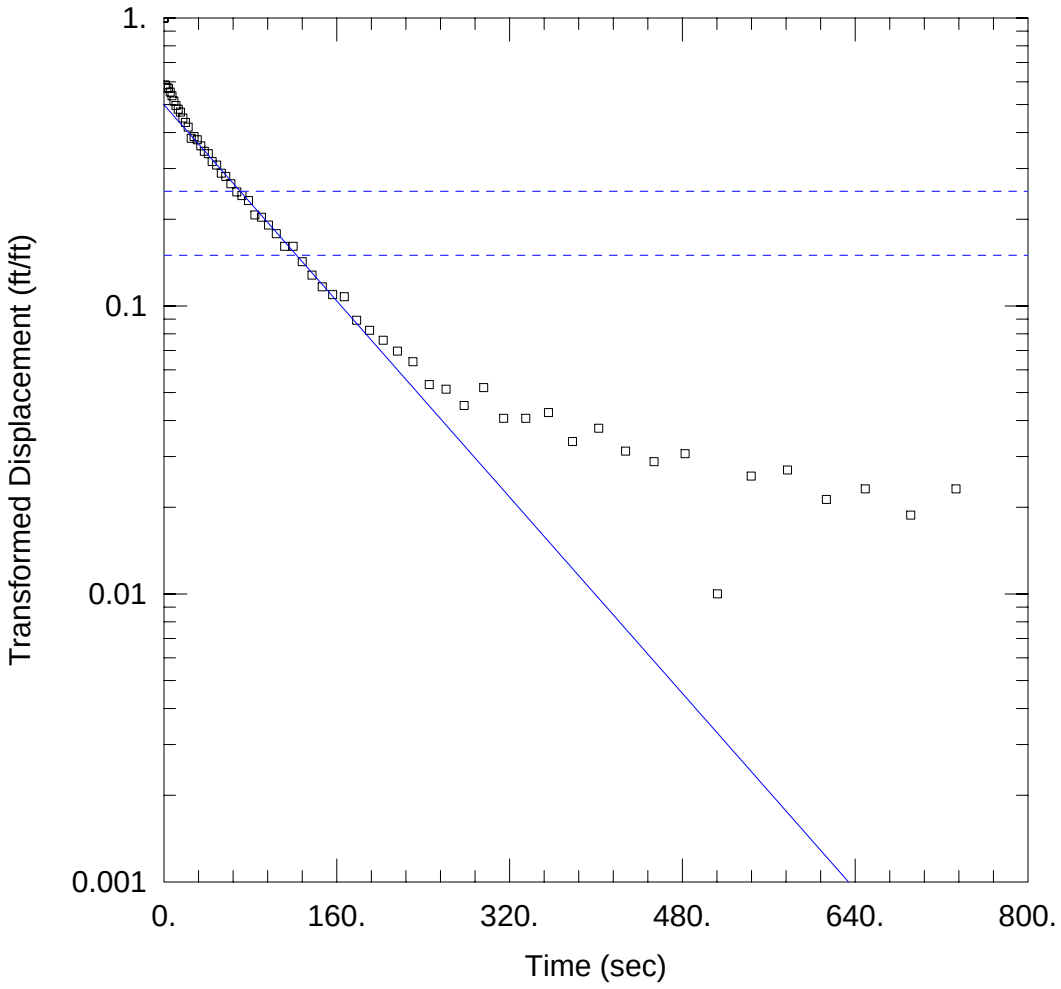
Saturated Thickness: 12.8 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-10S)

Initial Displacement: 1.506 ft
Total Well Penetration Depth: 12.8 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 12.8 ft
Screen Length: 12.8 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.001361 cm/sec
y0 = 0.7673 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-10S
Test Date: 8/16/2010

AQUIFER DATA

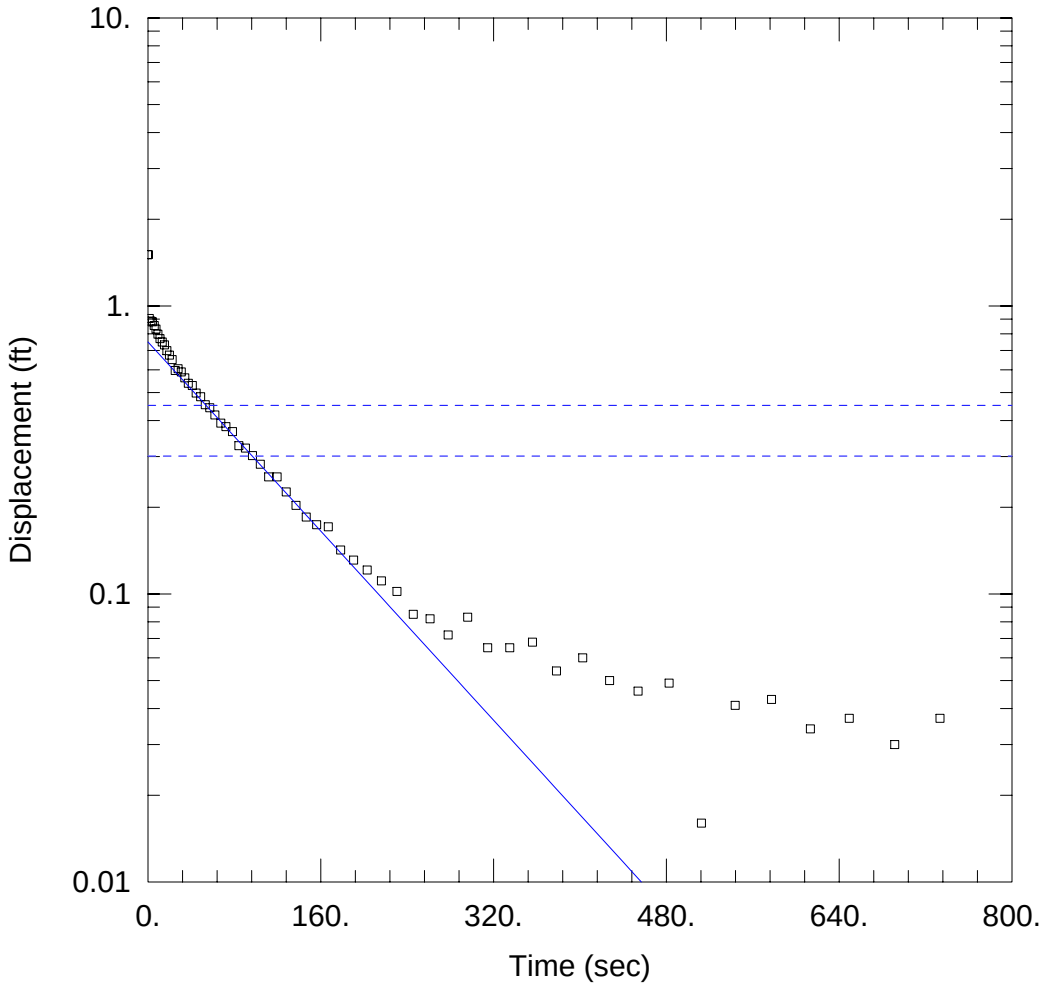
Saturated Thickness: 12.8 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-10S)

Initial Displacement: 1.506 ft
Total Well Penetration Depth: 12.8 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 12.8 ft
Screen Length: 12.8 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Dagan
K = 0.0009221 cm/sec
y0 = 0.7748 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-10S
Test Date: 8/16/2010

AQUIFER DATA

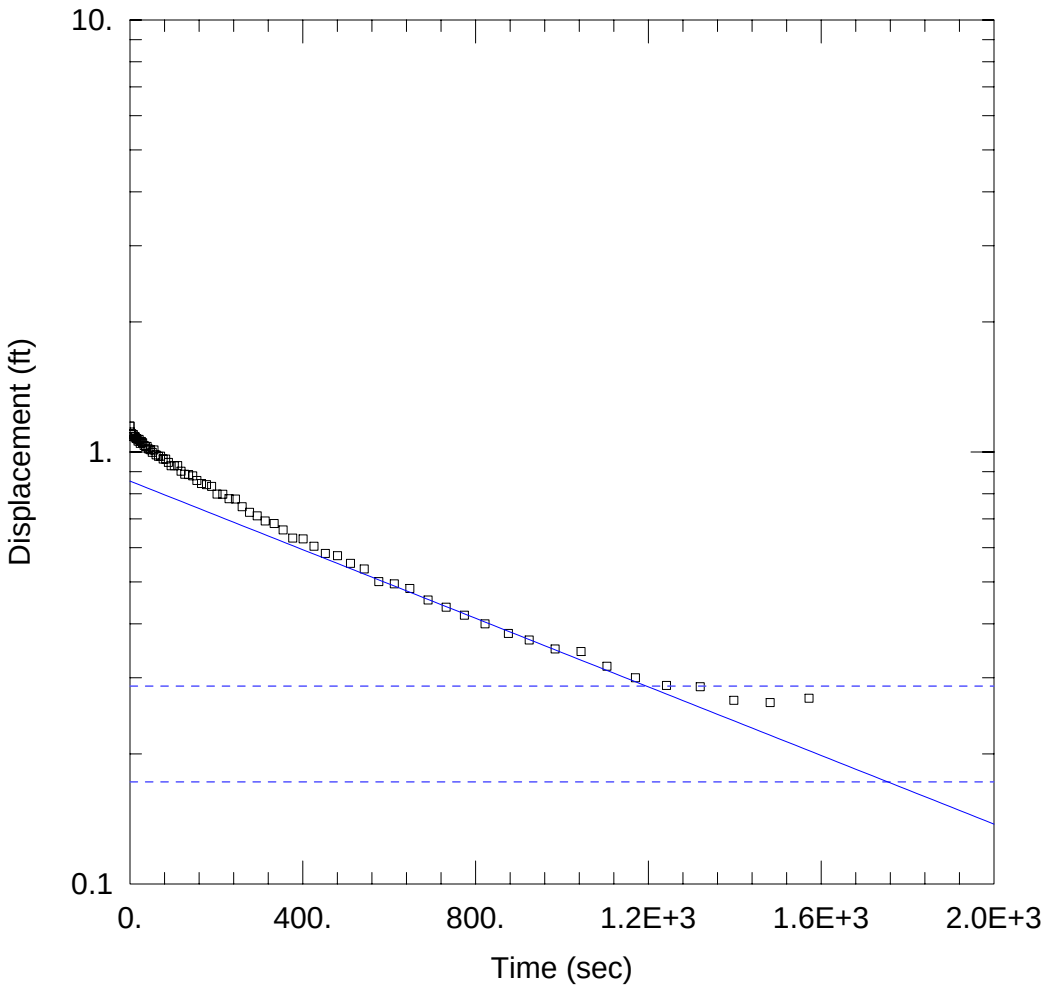
Saturated Thickness: 12.8 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-10S)

Initial Displacement: 1.506 ft
Total Well Penetration Depth: 12.8 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 12.8 ft
Screen Length: 12.8 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.000749 cm/sec
y0 = 0.7498 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-10D
Test Date: 8/16/2010

AQUIFER DATA

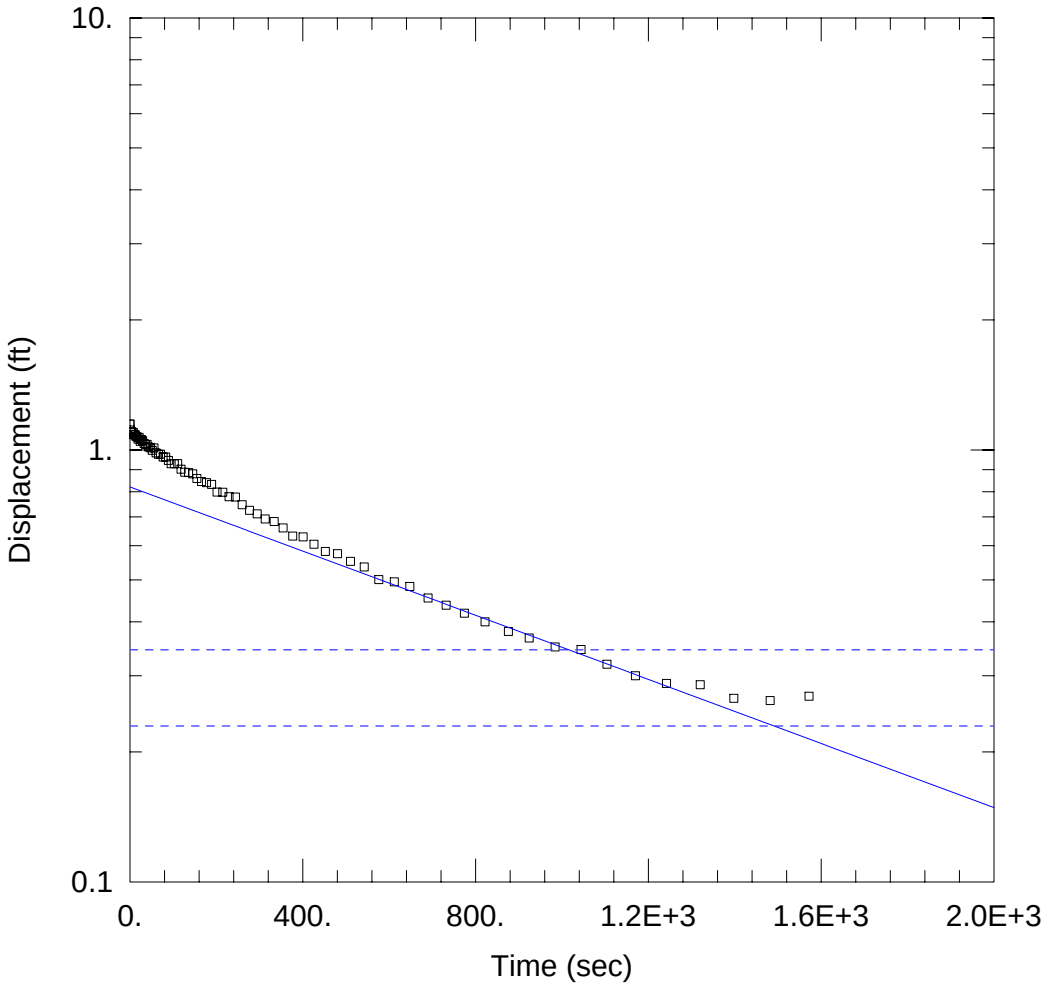
Saturated Thickness: 71.46 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-10D)

Initial Displacement: 1.148 ft
Total Well Penetration Depth: 87.69 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 71.46 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0001192 cm/sec
y0 = 0.856 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-10D
Test Date: 8/16/2010

AQUIFER DATA

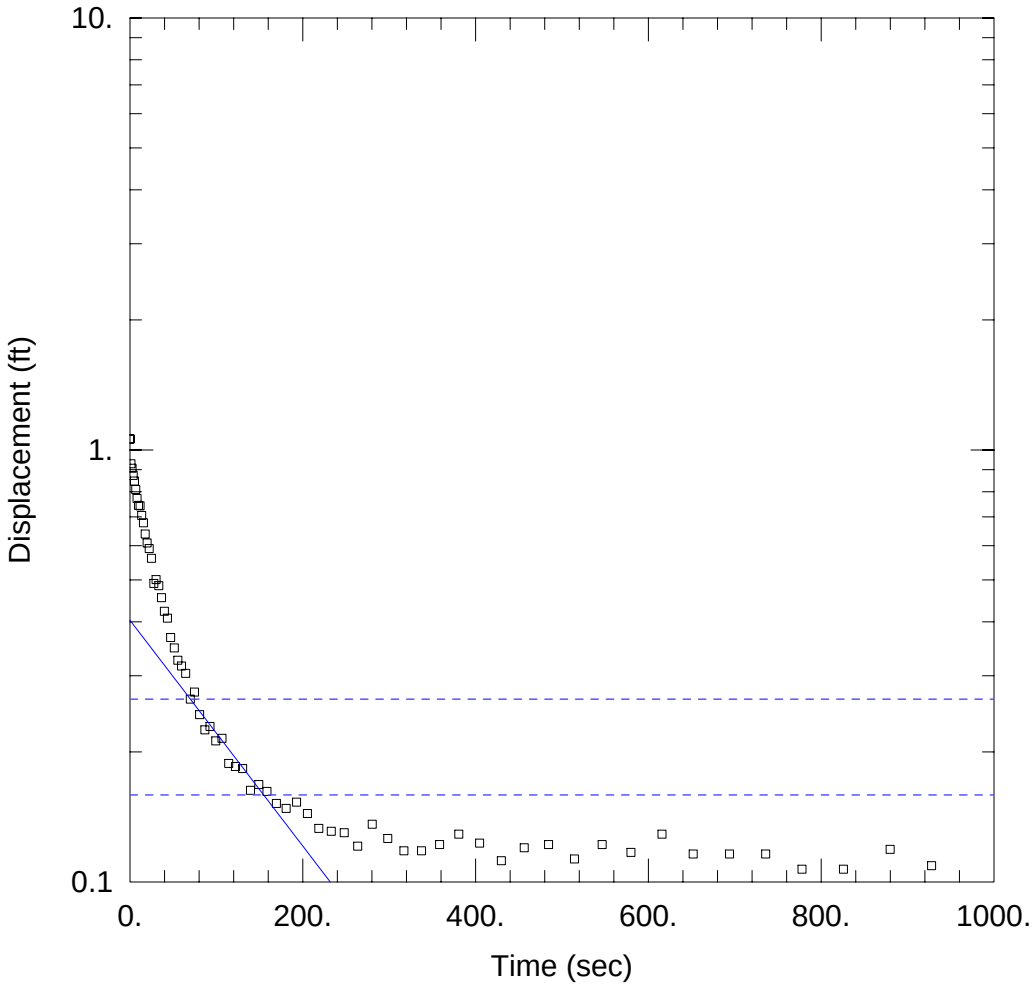
Saturated Thickness: 71.46 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-10D)

Initial Displacement: 1.148 ft
Total Well Penetration Depth: 87.69 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 71.46 ft
Screen Length: 5. ft
Well Radius: 0.157 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0001129 cm/sec
y0 = 0.8209 ft



RISING HEAD TEST

PROJECT INFORMATION

Company: MACTEC
Client: Duke Energy
Project: 6228-10-5284
Location: Marshall Steam Station
Test Well: MW-14S
Test Date: 8/16/2010

AQUIFER DATA

Saturated Thickness: 10.77 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-14S)

Initial Displacement: 1.06 ft
Total Well Penetration Depth: 10.77 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 10.77 ft
Screen Length: 10.77 ft
Well Radius: 0.26 ft
Gravel Pack Porosity: 0.28

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.001007 cm/sec
y0 = 0.4034 ft

B

Appendix B - Permit Condition A(11) Attachment XX, Version 1.1, June 15, 2011

A. (6) GROUNDWATER MONITORING WELL CONSTRUCTION AND SAMPLING

1. The permittee shall conduct groundwater monitoring as may be required to determine the compliance of this NPDES permitted facility with the current groundwater Standards found under 15A NCAC 2L .0200
2. WELL CONSTRUCTION. Within 120 days of permit issuance, monitoring wells, as proposed on Attachment XX, shall be installed to monitor groundwater quality.
   a. Monitoring wells shall be constructed in accordance with 15A NCAC 02C .0108 (Standards of Construction for Wells Other than Water Supply) and any other jurisdictional laws and regulations pertaining to well construction. The general locations for all monitoring wells are indicated on Attachment XX.
   b. Within 30 days of completion of well construction, a completed Well Construction Record (Form GW-1) must be submitted for each monitoring well to Division of Water Quality, Aquifer Protection Section, 1636 Mail Service Center, Raleigh, NC 27699-1636.
   c. The Mooresville Regional Office, telephone number (704) 663-1699, shall approve the location of new monitoring wells prior to installation. The regional office shall be notified at least 48 hours prior to the construction of any monitoring well and such notification to the Aquifer Protection Section's regional supervisor shall be made from 8:00 a.m. until 5:00 p.m. on Monday through Friday, excluding State Holidays.
   d. Within 60 days of completion of the monitoring wells, the Permittee shall submit two original copies of a site map with a scale no greater than 1-inch equals 500 feet. At a minimum, the map shall include the following information:
      i. The location and identity of each monitoring well.
      ii. The location of major components of the waste disposal system.
      iii. The location of property boundaries within 500 feet of the disposal areas.
      iv. The latitude and longitude of the established horizontal control monument.
      v. The elevation of the top of the well casing (i.e., measuring point) relative to a common datum.
      vi. The depth of water below the measuring point at the time the measuring point is established.
      vii. The location of compliance and review boundaries.
      viii. The date the map is prepared and/or revised.
      ix. Topographic contours in no more than ten (10) foot intervals
   e. The above information should be overlaid on the most recent aerial photograph taken of the site. Control monuments shall be installed in such a manner and made of such materials that the monument will not be destroyed due to activities taking place on the property. The map and any supporting documentation shall be sent to the Division of Water Quality, Aquifer Protection Section, 1636 Mail Service Center, Raleigh, NC 27699-1636.
   f. The well(s) must be constructed by a North Carolina Certified Well Contractor, the property owner, or the property lessee according to General Statutes 87-98.4. If the construction is not performed by a certified well contractor, the property owner or lessee, provided they are a natural person, must physically perform the actual well construction activities.

g. The monitoring wells shall be regularly maintained. Such maintenance shall include ensuring that the well caps are rust-free and locked at all times, the outer casing is upright and undamaged, and the well does not serve as a conduit for contamination.

3. GROUNDWATER SAMPLING AND COMPLIANCE. Monitoring wells shall be sampled after construction and thereafter at the frequencies and for the parameters as specified in Attachment XX. All maps, well construction forms, well abandonment forms and monitoring data shall refer to the permit number and the well nomenclature as provided on Attachment XX.

a. Per 15A NCAC 02H .0800, a Division certified laboratory shall conduct all laboratory analyses for the required effluent, groundwater or surface water parameters.

b. The measurement of water levels shall be made prior to purging the wells. The depth to water in each well shall be measured from the surveyed point on the top of the casing. The measurement of pH shall be made after purging and prior to sampling for the remaining parameters.

c. The measuring points (top of well casing) of all monitoring wells shall be surveyed to provide the relative elevation of the measuring point for each monitoring well. The measuring points (top of casing) of all monitoring wells shall be surveyed relative to a common datum.

d. For monitoring wells that are not located at the Compliance Boundary, the Compliance Monitoring Form (GW-59CCR) is not required. However, predictive calculations or modeling shall be submitted to the Regional Office annually (i.e. 12 months after permit issuance) demonstrating groundwater quality standards at the Compliance Boundary.

e. Two copies of the monitoring well sampling shall be submitted on a Compliance Monitoring Form (GW-59CCR), and received no later than the last working day of the month following the sampling month. Copies of the laboratory analyses shall be kept on site, and made available upon request. The Compliance Monitoring Form (GW-59CCR) shall include this permit number and the appropriate well identification number. All information shall be submitted to the following address:

Division of Water Quality
Information Processing Unit
1617 Mail Service Center
Raleigh, North Carolina 27699-1617

f. For groundwater samples that exceed the ground water quality standards in 15A NCAC 02L .0202, the Regional Office shall be contacted within 30 days after submission of the groundwater monitoring report; an evaluation may be required to determine the impact of the waste disposal activities. Failure to do so may subject the permittee to a Notice of Violation, fines, and/or penalties.

4. COMPLIANCE BOUNDARY. The compliance boundary for the disposal system shall be specified in accordance with 15A NCAC 02L .0107(a). This disposal system was individually permitted prior to December 30, 1983; therefore, the compliance boundary is established at either 500 feet from the effluent disposal area, or at the property boundary, whichever is closest to the effluent disposal area. An exceedance of groundwater standards at or beyond the compliance boundary is subject to remediation action according to 15A NCAC 02L .0106(c) as well as enforcement actions in accordance with North Carolina General Statute 143-215.6A through 143-215.6C.

ATTACHMENT XX – GROUNDWATER MONITORING PLAN

Permit Number: NC0004987 **Version 1.1**

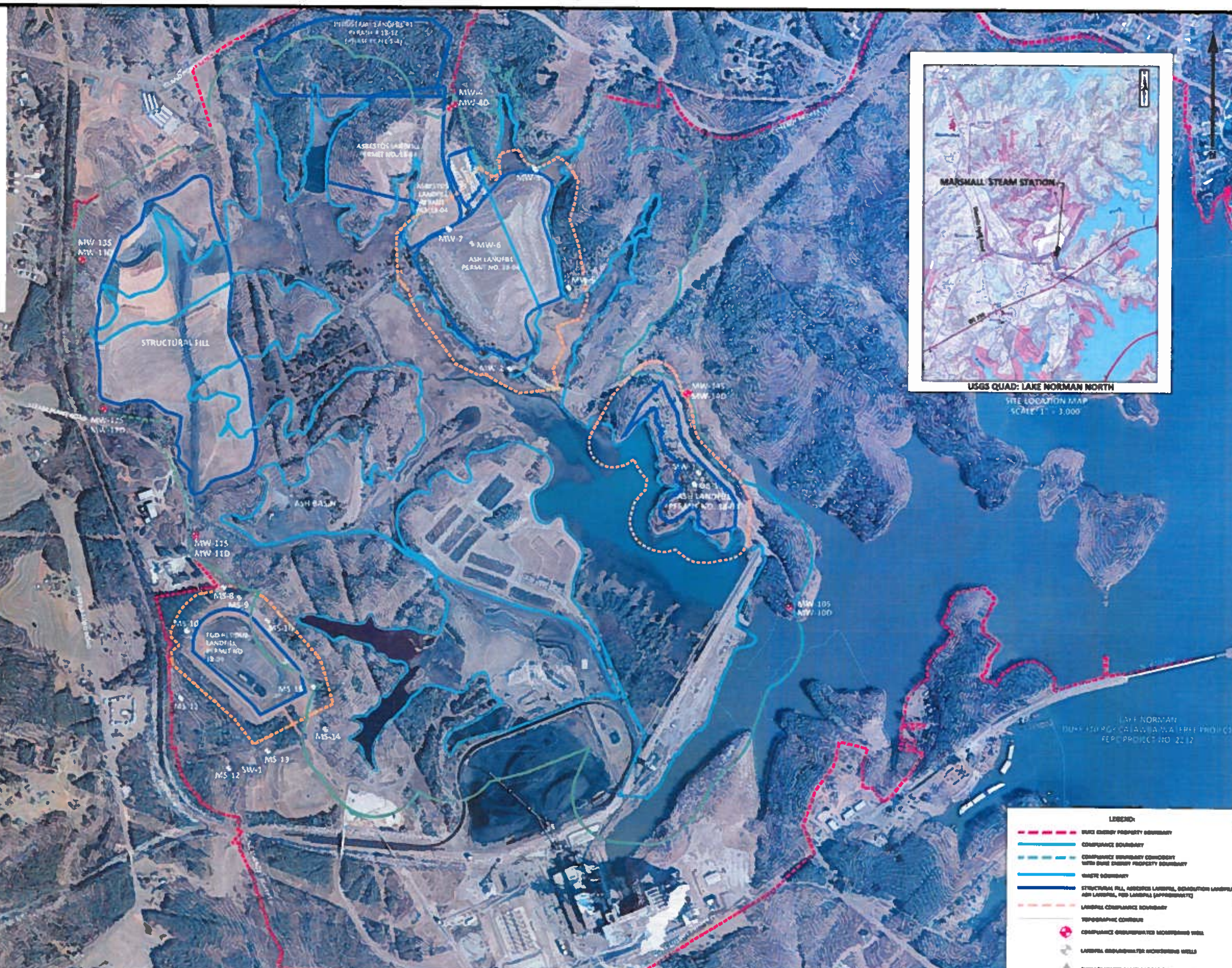
WELL NOMENCLATURE	PARAMETER DESCRIPTION				FREQUENCY
Monitoring Wells: MW-4, MW-4D, MW-10S, MW- 10D, MW-11S, MW-11D, MW-12S, MW-12D, MW-13S, MW-13D, MW-14S, MW-14D	**Antimony**	**Chromium**	**Nickel**	**Thallium**	February, June, October
	Arsenic	**Copper**	**Nitrate**	**Water Level**	
	Barium	**Iron**	**pH**	**Zinc**	
	Boron	**Lead**	**Selenium**		
	Cadmium	**Manganese**	**Sulfate**		
	Chloride	**Mercury**	**TDS**		

Note 1: For locations of monitoring wells, see attached map.

Note 2: Monitoring revisions may be considered, as applicable, if there are no significant detections prior to permit renewal.

Marshall Steam Station
Ash Basin Compliance Groundwater Monitoring Well Construction Data
As-Built Data

Well ID	Northing (feet)	Easting (feet)	TOC Elevation (feet)	Screen Interval (feet bgs)	Top of Rock (feet bgs)
MW-4	686,723.33	1,414,467.78	866.42	37.4 - 47.4	---
MW-4D	686,715.82	1,414,462.36	866.74	55.5 - 60.5	50.5
MW-10S	681,328.43	1,418,114.26	772.05	12 - 27	---
MW-10D	681,327.13	1,418,119.07	772.04	80.4 - 85.4	75.0
MW-11S	682,062.41	1,411,706.21	884.99	37 - 52	---
MW-11D	682,060.69	1,411,710.71	884.67	85.5 - 90.5	81.0
MW-12S	683,414.08	1,410,714.04	871.86	7 - 22	---
MW-12D	683,409.20	1,410,712.50	871.88	90 - 95	94.0
MW-13S	685,021.83	1,410,462.33	847.49	3 - 18	---
MW-13D	685,017.16	1,410,464.23	847.05	41.5 - 46.5	36.0
MW-14S	683,629.12	1,416,995.37	811.29	28 - 43	---
MW-14D	683,626.47	1,416,999.23	811.43	55 - 60	50.0



SHEET NO.	OF
1	2

ASH BASIN COMPLIANCE GROUNDWATER MONITORING WELLS

DUKE ENERGY MARSHALL STEAM STATION
CATAWBA COUNTY, NORTH CAROLINA

Duke Energy

REV	DATE	DESCRIPTION	BY	CHK	APV
0	06/07/11	SUBMITTED TO NCDENR	PD	WMM	JDL

ALTAMONT ENVIRONMENTAL, INC.
ENGINEERING & HYDROGEOLOGY
231 HAYWOOD STREET, ASHEVILLE, NC 28801
TEL 828 281 3350 FAC 828 281 3351
www.altamontenvironmental.com
NC ENGINEERING FIRM #C-2185

DRAWN BY: PAUL DORR
PROJECT MANAGER: BILL MILLER
CLIENT: DUKE ENERGY

SCALE (FEET)
250' 0 250' 500
1" = 500'

NORTH CAROLINA PROFESSIONAL SEAL 1768 ENGINEER WILLIAM M. MILLER

C

Appendix C - Monitoring Well Locations

004411-377814 Marshall Steam Station Monitoring Well Locations

Description	Northing	Easting	Elevation	Description	Elevation
TOP OF PVC MW-4D	686715.82	1414462.36	866.74	MAG NAIL SET MW-4D	863.38
TOP OF PVC MW-4S	686723.33	1414467.78	866.42	MAG NAIL SET MW-4S	864.26
TOP OF PVC MW-6D	682253.49	1417831.24	791.19	MAG NAIL SET MW-6D	788.16
TOP OF PVC MW-6S	682250.04	1417836.99	790.35	MAG NAIL SET MW-6S	787.47
TOP OF PVC MW-6	685227.06	1414674.45	919.65	MAG NAIL SET MW-6	917.18
TOP OF PVC MW-7D	681379.43	1417631.76	776.85	MAG NAIL SET MW-7D	773.04
TOP OF PVC MW-7S	681375.90	1417629.95	775.99	MAG NAIL SET MW-7S	773.11
TOP OF PVC MW-7	685380.11	1414418.05	859.16	MAG NAIL SET MW-7	856.56
TOP OF PVC MW-8D	680944.28	1417513.62	775.18	MAG NAIL SET MW-8D	771.42
TOP OF PVC MW-8S	680948.92	1417509.83	775.34	MAG NAIL SET MW-8S	771.65
TOP OF PVC MW-9D	680637.88	1417358.10	777.38	MAG NAIL SET MW-9D	774.35
TOP OF PVC MW-9S	680639.63	1417349.54	777.34	MAG NAIL SET MW-9S	774.28
TOP OF PVC MW-10D	681327.13	1418119.07	772.04	MAG NAIL SET MW-10D	770.00
TOP OF PVC MW-10S	681328.43	1418114.26	772.05	MAG NAIL SET MW-10S	769.75
TOP OF PVC MW-11D	682060.69	1411710.71	884.67	MAG NAIL SET MW-11D	882.12
TOP OF PVC MW-11S	682062.41	1411706.21	884.99	MAG NAIL SET MW-11S	882.29
TOP OF PVC MW-12D	683409.20	1410712.50	871.88	MAG NAIL SET MW-12D	869.37
TOP OF PVC MW-12S	683414.08	1410714.04	871.86	MAG NAIL SET MW-12S	869.23
TOP OF PVC MW-13D	685017.16	1410464.23	847.05	MAG NAIL SET MW-13D	844.53
TOP OF PVC MW-13S	685021.83	1410462.33	847.49	MAG NAIL SET MW-13S	845.06
TOP OF PVC MW-14D	683626.47	1416999.23	811.43	MAG NAIL SET MW-14D	808.67
TOP OF PVC MW-14S	683629.12	1416995.37	811.29	MAG NAIL SET MW-14S	808.37

Note1: Coordinates shown are based on the North Carolina State Plane Coordinate System

Note2: Horizontal Datum of NC Grid NAD 1983 (NSRS 2007)

Note3: Elevations shown are referenced to the NAVD 88 vertical datum

Note4: Coordinates and elevations shown are in U.S. Survey Foot

Note5: Coordinates and elevations shown only for as-built wells as requested by NCDENR

Note6: Mag nails set in concrete base of each well for future elevation checks

Note7: Survey information provided by Duke Energy