COAL COMBUSTION RESIDUAL RULE
GROUNDWATER MONITORING SYSTEM CERTIFICATION

SANDOW 5 GENERATING PLANT
AX LANDFILL
ROCKDALE, TEXAS

OCTOBER 16, 2017

Prepared For:
Luminant Generation Company, LLC
6555 Sierra Drive
Irving, TX 75039

Prepared By:
Pastor, Behling & Wheeler, LLC
2201 Double Creek Drive, Suite 4004
Round Rock, Texas 78664
Texas Engineering Firm No. 4760
PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Pastor, Behling & Wheeler, LLC under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that the groundwater monitoring system installed at the referenced facility has been designed and constructed to meet the requirements of Section 257.91 of the CCR Rule.

Patrick J. Behling, P.E.
Principal Engineer
PASTOR, BEHLING & WHEELER, LLC
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1.0 INTRODUCTION

Luminant Generation Company, LLC (Luminant) operates the Sandow 5 Generating Plant (Sandow) located approximately 7 miles southwest of Rockdale in Milam County, Texas. Unit No. 5 is an approximately 581-megawatt, lignite-fired electric generation unit that was placed into service in 2009. Coal Combustion Residuals (CCRs) including fly ash and bed ash are generated as part of Unit No. 5 operation. CCR material is currently managed in the AX Landfill (the Site) located approximately 7,500 feet south of Unit No. 5 on former mined land that is part of the Sandow Lignite Mine (Figure 1). Disposal of CCRs in the AX Landfill began in May 2015.

The CCR Rule (40 CFR 257 Subpart D - Standards for the Receipt of Coal Combustion Residuals in Landfills and Surface Impoundments) has been promulgated by the EPA to regulate the management and disposal of CCRs as solid waste under Resource Conservation and Recovery Act (RCRA) Subtitle D. The final CCR Rule was published in the Federal Register on April 17, 2015. The effective date of the CCR Rule was October 19, 2015.

The CCR Rule establishes national minimum criteria for existing and new CCR landfills, existing and new CCR surface impoundments, and lateral expansions to landfills/impoundments. Pastor, Behling & Wheeler, LLC (PBW) was retained by Luminant to evaluate and certify that the groundwater monitoring system at the Site has been designed and constructed to meet the requirements in Section 257.91 of the CCR Rule.

1.1 Sandow 5 Units Subject to Groundwater Monitoring System Requirements

The AX Landfill is the only waste management unit associated with Sandow 5 that meets the definition of a CCR landfill. AX Landfill Cells 1, 2, and 2A are collectively considered an “existing landfill” under 40 CFR 257.53.

This groundwater monitoring system evaluation and certification was prepared for the AX Landfill, which includes Cells 1, 2, and 2A.
1.2 Description of AX Landfill Cells 1, 2, and 2A

The AX Landfill consists of Cells 1, 2, and 2A and covers an area of approximately 169 acres. The AX Landfill is located approximately 7,500 feet south of Sandow 5 on reclaimed mine land that is leased by Luminant from Alcoa (Figure 2). The landfill is used to manage fly ash and bed ash generated from Unit No. 5. Fly ash and bed ash are transported to the landfill in trucks and placed in the landfill as dry material.

AX Landfill Cells 1, 2, and 2A are lined landfill cells. Construction of Cell 1 was completed in July 2013 and construction of Cells 2 and 2A was initiated in May 2015. Cell 2 was completed in October 2015 and Cell 2A was completed in July 2016. Placement of Unit No. 5 CCR began in Cell 1 in May 2015 and Cell 2 in September 2016. As of the date of this report, CCR has not been placed in Cell 2A.

1.3 CCR Unit Groundwater Monitoring System Requirements

Section 257.91 of the CCR Rule indicates that existing CCR landfills and surface impoundments be provided with a groundwater monitoring system that consists of sufficient wells, installed at appropriate location and depths, to yield groundwater samples from the uppermost aquifer that meet the following criteria:

- Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit; and
- Accurately represent the quality of groundwater passing the waste boundary of the CCR unit. The downgradient monitoring system must be installed at the waste boundary to ensure detection of groundwater contamination in the uppermost aquifer. All potential contaminant pathways must be monitored.

The specific configuration of the groundwater monitoring system must be determined based on site-specific technical information that must include aquifer thickness, groundwater flow rate, groundwater flow direction (including seasonal and temporal fluctuation in groundwater flow), saturated and unsaturated geologic units and fill materials that overly the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the upmost aquifer, including, but not limited to, thickness, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities.
At a minimum, the monitoring system must consist of at least one upgradient and three downgradient monitoring wells, and any additional monitoring wells necessary to accurately represent the quality of the background groundwater that has not been affected by leakage from the CCR unit and the quality of groundwater passing the waste boundary of the CCR unit.

Monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space above the sampling depth must be sealed to prevent contamination of samples and the groundwater. There must be documentation in the operating record of the design, installation, development, and decommissioning of any monitoring wells, piezometers and other measurement, sampling, and analytical devices. The qualified engineer must have access to and must review this documentation as part of the groundwater monitoring system certification.
2.0 GROUNDWATER MONITORING SYSTEM EVALUATION

2.1 AX Landfill Groundwater Monitoring System

The CCR groundwater monitoring well system at the AX Landfill consists of nine monitoring wells (AXMW-1, AXMW-2, AX-23, AX-24, AX-25, AX-26, AX-27, AX-28, and AX-29) that are each screened in the uppermost aquifer at the Site. The locations of the CCR monitoring wells are shown on Figure 2. Well construction information and survey data for the CCR wells are summarized in Table 1, CCR monitoring well logs are presented in Appendix A, and photographs of the CCR wells are presented in Appendix B.

2.2 Local Geology and Hydrogeology

The AX Landfill is located in the former Sandow Lignite Mine, which is located in the outcrop area of the Eocene-aged Wilcox Group (Barnes, 1974). The Wilcox Group in the vicinity of the Site is divided into the Hooper Formation, the Simsboro Formation, and the Calvert Bluff Formation (listed from oldest to youngest). The overburden interval and lignite seams mined at the Sandow Lignite Mine are part of the Calvert Bluff Formation.

The AX Landfill is constructed within overburden spoil material that was previously excavated and backfilled during lignite mining operations at the Sandow Lignite Mine. Geologic cross sections were constructed through the landfill area using lithologic data from new and existing CCR wells and other historical soil borings completed in the AX Landfill area. Cross section locations are presented on Figure 3 and the cross sections are presented on Figures 4, 5, and 6.

Lithologic descriptions from soil borings completed in the spoil material indicate that the spoil consists of a highly heterogeneous mixture of sand, silty and clayey sand, and clay. The mine spoil extends from ground surface to depths ranging from approximately 100 feet below ground surface (bgs) on the northwest side of the AX Landfill to more than 160 feet bgs on the southeast side of the AX Landfill. Native material encountered below the spoil zone generally consisted of lignite or native clay.

The uppermost aquifer at the Site occurs under unconfined conditions within the overburden spoil and extends to the base of the spoil where lignite and/or clay confining units are encountered.
2.3 **Groundwater Potentiometric Surface Elevations**

Eight background groundwater monitoring events were performed using the AX Landfill CCR monitoring well system from October 2015 to December 2016. Static water levels measured during the background monitoring period indicated water elevations ranging from 383.59 feet above mean sea level (amsl) to 458.55 feet amsl, and depths to water ranging from 23.70 feet bgs to 84.11 feet bgs (Table 2). Groundwater potentiometric surface maps based on data collected during the background monitoring period are presented in Appendix C.

Groundwater elevations were generally highest on the west side of the landfill and lowest on the east side of the landfill, with an inferred groundwater flow direction to the east. An average hydraulic gradient of approximately 0.02 ft/ft in the uppermost aquifer was calculated using the groundwater potentiometric surface maps. Based on the potentiometric surface maps, the location of each CCR monitoring well relative to the AX Landfill is as follows:

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<thead>
<tr>
<th>Upgradient Wells</th>
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<tr>
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2.4 **Uppermost Aquifer Hydraulic Conductivity Testing**

PBW performed slug tests at monitoring wells AXMW-1 and AXMW-2 on October 5, 2015 to evaluate groundwater linear flow velocities of the uppermost aquifer at the Site. Slug test data and time-head change plots used to calculate hydraulic conductivities and transmissivities of the uppermost aquifer are provided in Appendix D. A summary of these hydraulic properties is presented in Table 3.

The average hydraulic conductivities for the test wells ranged from $1.85 \times 10^4$ cm/sec (well AXMW-1) to $2.96 \times 10^4$ cm/sec (well AXMW-2), with a geometric mean for the test wells of $2.34 \times 10^4$ cm/sec.
2.5 Conclusions

The CCR groundwater monitoring well system at the AX Landfill complies with Section 257.91 of the CCR Rule. This conclusion is supported by the following as described in detail in previous sections of this report:

- Nine monitoring wells are included in the CCR groundwater monitoring system – four upgradient monitoring wells and five downgradient monitoring wells.

- Each monitoring well is screened in the uppermost aquifer at the Site. Samples collected from upgradient monitoring wells will be representative of the quality of background groundwater that has not been affected by leakage from the landfill and samples collected from downgradient wells will ensure detection of groundwater contamination in the uppermost aquifer from the landfill.

- The monitoring wells are constructed with appropriate well casing to maintain the integrity of the monitoring well borehole and with slotted well screens to enable collection of groundwater samples. In addition, the annular space above the well screen is appropriately sealed to prevent water from entering the well screen from surface sources.

- Appropriate documentation exists in the owner/operator’s operating record concerning the design, installation, and development of the monitoring wells.
3.0 REFERENCES

## TABLE 1
CCR WELL CONSTRUCTION SUMMARY
SANDOW AX LANDFILL

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**Notes:**
1. Abbreviations: ft - feet; amsl - above mean sea level; bgs - below ground surface; TOC - top of casing; in - inches.
## Table 2
### Groundwater Elevation Summary
#### Sandow Ax Landfill

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### TABLE 2
GROUNDWATER ELEVATION SUMMARY
SANOW AX LANDFILL

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<td>12/17/15</td>
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<td>428.77</td>
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<td>06/14/16</td>
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<td>431.07</td>
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<td>10/06/16</td>
<td>56.13</td>
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<td>12/21/16</td>
<td>55.39</td>
<td>432.34</td>
</tr>
</tbody>
</table>

Notes:
1. Abbreviations: TOC - top of casing; ft - feet; amsl - above mean sea level.
### TABLE 3
SUMMARY OF AQUIFER TEST RESULTS
SANDOW AX LANDFILL

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Test Type</th>
<th>Aquifer Type</th>
<th>Analysis Method</th>
<th>Approximate Saturated Thickness (feet)</th>
<th>T (cm²/sec)</th>
<th>K (cm/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AXMW-1</td>
<td>Slug-In</td>
<td>Unconfined</td>
<td>Bouwer-Rice</td>
<td>80</td>
<td>3.32E-01</td>
<td>1.36E-04</td>
</tr>
<tr>
<td>AXMW-1</td>
<td>Slug-Out</td>
<td>Unconfined</td>
<td>Bouwer-Rice</td>
<td>80</td>
<td>5.70E-01</td>
<td>2.34E-04</td>
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<td></td>
<td></td>
<td><strong>Arithmetic Mean</strong></td>
<td><strong>4.51E-01</strong></td>
<td><strong>1.85E-04</strong></td>
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<tr>
<td>AXMW-2</td>
<td>Slug-In</td>
<td>Unconfined</td>
<td>Bouwer-Rice</td>
<td>80</td>
<td>7.77E-01</td>
<td>3.19E-04</td>
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<tr>
<td>AXMW-2</td>
<td>Slug-Out</td>
<td>Unconfined</td>
<td>Bouwer-Rice</td>
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<td>6.64E-01</td>
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<tr>
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<td><strong>Arithmetic Mean</strong></td>
<td><strong>7.21E-01</strong></td>
<td><strong>2.96E-04</strong></td>
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<td></td>
<td><strong>GEOMETRIC MEAN FOR ALL WELLS</strong></td>
<td><strong>5.70E-01</strong></td>
<td><strong>2.34E-04</strong></td>
</tr>
</tbody>
</table>

Notes:
1. Abbreviations: T - transmissivity; K - hydraulic conductivity.
SANDOW STEAM ELECTRIC STATION
ROCKDALE, TEXAS

Figure 1

SITE LOCATION MAP

PROJECT: 5104E
BY: AJD
DATE: MAR., 2017
CHECKED: PJB

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

SOURCE:
EXPLANATION

- CCR Monitoring Well Location
- Monitoring Well - Plugged
- Soil Boring Location
- A A’ Geologic Cross Section Location Lines

SOURCE:
ELEVATION (FEET MSL)

INTERSECTION WITH B-B'
INTERSECTION WITH A-A'

TOTAL DEPTH
SCREENED INTERVAL

EXPLANATION
MONITORING WELL CONSTRUCTION
CLAY
LIGNITE
SAND
Appendix A

CCR Monitoring Well Logs
## Log of Boring: AX-23

**Sandow 5 Generating Plant**  
Rockdale, TX

**PBW Project No. 5164E**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Well Materials</th>
<th>Recovery (ft/ft)</th>
<th>USCS</th>
<th>Lithologic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>4.0/10.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>9.2/10.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>10.0/10.0</td>
<td>CL</td>
<td>(0 - 59) Silty, sandy CLAY spoil, dark gray and brown, dry to moist, moisture content increases with depth, none to weak cementation, soft to hard, none to medium plasticity, abundant roots (0'-2'), more cohesive with depth, higher sand content (11'-15'), color change to brown with orange and rust colored mottling (11'-15'), lower sand content and light gray and dark gray clay laminations (15'-17', 23'-27', 36'-39'), orange sand lenses in dark gray clay (17'-23' and 30'-36'), higher sand content (27'-36'), dark gray with light gray and orange mottling (39'-47' and 53'-56'), lower clay content with depth (56'-59')</td>
</tr>
<tr>
<td>15</td>
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<td>9.0/10.0</td>
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</tr>
<tr>
<td>20</td>
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<td>10.0/10.0</td>
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<td></td>
</tr>
<tr>
<td>25</td>
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<td>8.0/10.0</td>
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</tr>
<tr>
<td>30</td>
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<td>10.0/10.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td>9.7/10.0</td>
<td>SM</td>
<td>(59 - 60) Silty SAND spoil, light gray, very moist, moderate cementation, unconsolidated, gradual contact</td>
</tr>
<tr>
<td>40</td>
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<td>9.0/10.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>8.7/10.0</td>
<td>SC/CL</td>
<td>(60 - 90) Sandy CLAY/ clayey SAND spoil, dark gray, orange and light gray mottling throughout, very moist, weak to moderate cementation, soft to very firm, low to medium plasticity, light gray sand lenses, 1' thick orange and dark gray clay layer at 66', sand layers with higher moisture content (6&quot; thick at 72', 1' thick at 89', 1' thick at 85', and 2&quot; thick light gray sand lensate at 89'), lignite layer at 90'</td>
</tr>
<tr>
<td>50</td>
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<tr>
<td>55</td>
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</tr>
<tr>
<td>60</td>
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<td>65</td>
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<td>75</td>
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<td>80</td>
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<tr>
<td>85</td>
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</tr>
<tr>
<td>90</td>
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<td></td>
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</tr>
</tbody>
</table>

## Notes:
1. This log should not be used separately from the report to which it is attached.

### Well Materials

- (2.48-65) Casing, 4" Sch 40 FJT PVC
- (65-85) Screen, 4" Sch 40 FJT PVC, 0.010" slot

### Annular Materials

- (0'-61") Grout
- (61'-63") Bentonite pellets
- (63'-85") 20/40 sand

**PBW**  
Pastor, Behling & Wheeler, LLC  
2201 Double Creek Dr., Suite 4004  
Round Rock, TX 78664  
Tel (512) 671-3434  Fax (512) 671-3446
# Log of Boring: AX-24

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Well Materials</th>
<th>Recovery (ft/ft)</th>
<th>USCS</th>
<th>Lithologic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>3.0/10.0</td>
<td>SM</td>
<td>(0 - 17) Silty SAND spoil, light gray, dry, soft, unconsolidated, tan/brown with some orange (5'-10'), gradual increase in clay content with depth</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>2.8/10.0</td>
<td>SC/CL</td>
<td>(17 - 80) Sandy CLAY/ clayey SAND spoil, dark gray, dry to moist (moisture increases with depth), weak cementation, soft with firm clay layers, clay layer at 19' (dark brown, dark gray, and light gray laminations), higher clay content (20'-27'), 2&quot; tan sand lens at 25', higher sand content (27'-30'), interbedded light gray/tan sand and dark gray clay layers (sand at 32'-33', 33.5'-34.5', 35'-40', 41'-42', 44'-45', and 48'-50), dark gray silty clay layer (53'-58'), dark gray with brown/tan (60'-62'), silty clay layer with tan sand lenses (62'-68'), rusty colored and orange mottling (64'-65'), 1' thick tan and very moist sand layer at 74', higher clay content (74'-76'), light gray sand layer at 77', 1' thick dark gray/ brown clay layer at 78'</td>
</tr>
<tr>
<td>80</td>
<td></td>
<td>10.0/10.0</td>
<td>SM</td>
<td>(80 - 90) Silty SAND spoil, dark gray/ brown, wet (80'-84') and very moist (84'-90'), color change to light gray at 84', small lignite pieces (less than 0.5&quot; diameter) at 84'.</td>
</tr>
</tbody>
</table>

**Notes:**

1. This log should not be used separately from the report to which it is attached.

**Well Materials**

- (2.26-61) Casing, 2" Sch 40 FJT PVC
- (2.01-61) Screen, 2" Sch 40 FJT PVC, 0.010" slot

**Annular Materials**

- (0'-57') Grout
- (57'-59') Bentonite pellets
- (59'-81') 20/40 sand
# Luminant

## Log of Boring: AX-25

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<th>Well Materials</th>
<th>Recovery (ft/ft)</th>
<th>USCS</th>
<th>Lithologic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td></td>
<td></td>
<td>(0 - 25) Silty CLAY spoil, brown and dark gray with some orange and light gray, dry, weak cementation, soft to firm, unconsolidated (13'-17'), some lignite pieces at 9' and 12', becomes more sandy (very fine grained) with depth, clay and lignite mixed 21'-22', piece of wood (4&quot; thick) at 24'</td>
</tr>
<tr>
<td>25</td>
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<td></td>
<td>SC</td>
<td>(25 - 29) Clayey SAND spoil, light gray and tan, dry, soft, none to weak cementation</td>
</tr>
<tr>
<td>34</td>
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<td></td>
<td>SM</td>
<td>(29 - 34) Silty SAND spoil with clay lenses, slightly moist, soft, unconsolidated</td>
</tr>
<tr>
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<td></td>
<td>SC/CL</td>
<td>(34 - 70) Clayey SAND/ sandy CLAY spoil, light gray with orange mottling (34'-40'), slightly moist, moisture content increases with depth, none to weak cementation, unconsolidated, none to low plasticity, piece of wood at 39', interbedded sandy clay and clayey sand, gray and tan with orange, dark gray and brown mixed in (40'-50'), hard 2&quot; thick gray clay layer at 47', ~1&quot; thick clay lenses (medium plasticity, dark gray, light gray, and dark brown) throughout 50'-60', color transition to dark gray/brown at 60', higher sand content and higher moisture content (63'-64'), trace amounts of lignite at 63', higher clay content (very firm, dark gray, medium plasticity) (64'-68'), dark brown and orange (67'-68')</td>
</tr>
<tr>
<td>70</td>
<td></td>
<td></td>
<td>SM</td>
<td>(70 - 74) Silty SAND spoil with clay lenses, light and dark gray, wet, weak cementation, unconsolidated, none to low plasticity</td>
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<td>74</td>
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<td></td>
<td>SC/CL</td>
<td>(74 - 80) Clayey SAND/ sandy CLAY spoil, dark gray and brown, moist, weak to moderate cementation, soft to firm, none to low plasticity, higher clay content with depth, 2&quot; thick orange layer with lignite pieces at 79'</td>
</tr>
</tbody>
</table>

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---

**Pastor, Behling & Wheeler, LLC**  
2201 Double Creek Dr., Suite 4004  
Round Rock, TX 78664  
Tel (512) 671-3434  Fax (512) 671-3446
## Log of Boring: AX-26

<table>
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<tr>
<th>Depth (ft)</th>
<th>Well Materials</th>
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<th>Lithologic Description</th>
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<tbody>
<tr>
<td>0</td>
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<td>5.0/10.0</td>
<td>CL</td>
<td>(0 - 10) Silty CLAY spoil, dark brown, dry, weak cementation, soft, none to low plasticity, orange, dark gray, and light gray clay lenses, more compact with depth, higher plasticity with depth</td>
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<tr>
<td>4</td>
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<td>6.0/10.0</td>
<td>SC</td>
<td>(10 - 12) Clayey SAND spoil, gray and tan, slightly moist, none to weak cementation, unconsolidated</td>
</tr>
<tr>
<td>8</td>
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<td>6.0/10.0</td>
<td>CL</td>
<td>(12 - 20) Silty CLAY spoil, dark brown, slightly moist, weak cementation, firm, lower sand content (17'-20'), color change to dark gray with light gray lamination, friable</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>6.0/10.0</td>
<td>SC/CL</td>
<td>(20 - 65) Sandy CLAY/clayey SAND spoil, light gray and brown with dark gray clay lenses, moist, weak cementation, soft with firm clay lenses, none to medium plasticity, ~1' thick dark gray, firm, and friable clay layer, purple and orange clay lenses (25'-30'), higher sand content (30'-32'), higher clay content (32'-35'), light gray and dark gray laminations (35'-38'), orange and gray clay lenses (38'-40'), dark gray (40'-43') transitions to light gray (43'-45'), dark purple, light gray, and brown clay lenses (45'-47'), higher sand content (45'-50'), higher dark gray clay content (50'-51'), higher sand content (light gray/tan) (51'-53'), higher clay content with dark and light laminations (53'-54'), higher sand content (light gray) (54'-55'), dark gray with orange mottling (55'-65'), 2&quot; thick sand layer at 65'</td>
</tr>
<tr>
<td>72</td>
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<td>7.0/10.0</td>
<td>CL</td>
<td>(65 - 80) Silty CLAY spoil with some sand, dark gray, moist, weak to moderate cementation, firm, low to medium plasticity, very wet (70'-74'), slightly moist (74'-80')</td>
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### Notes:
1. This log should not be used separately from the report to which it is attached.
### Log of Boring: AX-27

#### Lithologic Description

<table>
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<th>Well Materials</th>
<th>Recovery (ft.)</th>
<th>USCS</th>
<th>Description</th>
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</thead>
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<td>5.7/10.0</td>
<td>SM</td>
<td>(0 - 4) Silty SAND spoil with clay, dark brown, dry, none to weak cementation, unconsolidated to consolidated, organic smell, more cohesive with depth</td>
</tr>
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<td>5.0/10.0</td>
<td>CL</td>
<td>(4 - 8) Sandy, silty CLAY spoil, dark brown, dry, weak to moderate cementation, firm, low plasticity, 2&quot; thick organic layer at 5', metallic nodule at 7'</td>
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<tr>
<td>10</td>
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<td>5.0/10.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
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<td>5.3/10.0</td>
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<td>5.3/10.0</td>
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<td>5.3/10.0</td>
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<tr>
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<tr>
<td>100</td>
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<td>5.3/10.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Notes:
1. This log should not be used separately from the report to which it is attached.

#### Well Materials
- Sandow 5 Generating Plant Rockdale, TX
- Luminant

#### Annular Materials
- Luminant

#### Sampling Method
- 4"x10' Core barrel
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Well Materials</th>
<th>Recovery (ft/ft)</th>
<th>USCS</th>
<th>Lithologic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>7.0/10.0</td>
<td>CL</td>
<td>(0 - 10) Sandy CLAY spoil, dark brown, dry to moist, weak cementation, soft to firm, none to low plasticity, organics present (roots, twigs), lower sand content with depth</td>
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<td>4.8/10.0</td>
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<td>(10 - 43) Silty SAND spoil with some clay, light gray to tan, moist, weak cementation, unconsolidated, none to low plasticity, rust colored staining (~6&quot; thick) at 15’, interbedded dark gray, hard clay layers with some purple and rust coloring, 6&quot; clay layer at 20’ and 8&quot; clay layer at 35’, higher clay content with depth, color change to dark brown/ dark gray at 30’, becomes wet (39’-43’)</td>
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<td>(43 - 50) Sandy CLAY spoil, dark gray, slightly moist, moderate cementation, firm to hard, none to low plasticity, rust colored and black nodules present</td>
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<td>(16.5 - 31) Silty CLAY, dark gray and brown with some purple mottling, moist, weak to moderate cementation, soft to firm, medium plasticity, plasticity decreases with depth, organic smell, roots present, becomes less cohesive with depth, 2&quot; sand lens at 21', higher sand content with depth, pieces of wood at 29'</td>
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<td>SM</td>
<td>(31 - 60) Silty SAND, fine grained, light gray/tan with some orange mottling at 33', slightly moist, weak cementation, unconsolidated, organics present throughout, interbedded clay (gray) and sand (brown) with orange and rust colored staining (35'-38'), clay layers have medium plasticity, higher clay content (45'-50'), purple brown clay lense at 58'</td>
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<tr>
<td>60</td>
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<td>SC</td>
<td>(60 - 69) Slightly clayey SAND, dark gray with light gray and tan mottling, fine to medium grained, very moist, weak cementation, soft, low plasticity, 4&quot; thick laminated dark and light gray clay layer (firm) at 65'</td>
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<td>(72 - 100) Silty CLAY, interbedded dark and light gray, friable, slightly moist, moderate cementation, hard, none to low plasticity, higher moisture content and sand content (very fine grained) with depth, gradual transition to sandy clay (77'-90'), lower sand content (90'-100')</td>
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**Notes:**
1. This log should not be used separately from the report to which it is attached.
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<td>(8 - 13) SILTY SAND, SM, yellowish brown, with pebbles, and hematite.</td>
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<td>(13 - 18) SANDY CLAY, CL, very dark grayish brown, poorly sorted.</td>
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<td>(18 - 33) CLAYEY SAND, SC, dark yellowish brown, some lignite fragments.</td>
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<tr>
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<td>(33 - 38) SAND, light olive brown, medium grained, sub-rounded, moderately sorted.</td>
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<td>38</td>
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<td>(38 - 53) CLAYEY SAND, SC, yellowish brown, medium grained, sub-angular, poorly sorted.</td>
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**Notes:** All material is mine spoil

**Luminant**

**Log of Boring: AXMW-1**

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<td>TOC Elev. (ft AMSL):</td>
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**PBW Project No. 1815**

**Lithologic Description**

- **(0.0 - 8) SILTY CLAY, CL, very dark gray, with sand.**
- **(8 - 13) SILTY SAND, SM, yellowish brown, with pebbles, and hematite.**
- **(13 - 18) SANDY CLAY, CL, very dark grayish brown, poorly sorted.**
- **(18 - 33) CLAYEY SAND, SC, dark yellowish brown, some lignite fragments.**
- **(33 - 38) SAND, light olive brown, medium grained, sub-rounded, moderately sorted.**
- **(38 - 53) CLAYEY SAND, SC, yellowish brown, medium grained, sub-angular, poorly sorted.**

**Annular Materials**

- **(0.0 - 1.0) Concrete**
- **(1.0 - 28.0) BenSeal**
- **(28.0 - 30.0) Bentonite Chips**
- **(30.0 - 53.0) Filter Pack (16/30)**

**Well Materials**

- **(+3.0 - 33.0) Casing, 2" Sch 40 FJT PVC**
- **(33.0 - 53.0) Screen, 2" Sch 40 FJT PVC, 0.01 slot**

**PBW**

**Pastor, Beiling & Wheeler, LLC**

2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

**Pastor, Beiling & Wheeler, LLC**

2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446
### Log of Boring: AXMW-2

**Luminant**

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**Sandow 5 Generating Plant**

**Rockdale, TX**

**Well Materials**

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<td>(8 - 13) CLAYEY SILT with sand, ML, dark grayish brown.</td>
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<tr>
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<td>CL</td>
<td>(13 - 63) SILTY CLAY, CL, dark gray, moist, some sand and lignite fragments.</td>
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</tbody>
</table>

**PBW**

**Pastor, Behling & Wheeler, LLC**

2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434  Fax (512) 671-3446

Notes: All material is mine spoil.
Appendix B

Photographs of CCR Monitoring Wells
Appendix B – Photographs of CCR Groundwater Monitoring Wells
Sandow AX Landfill

Photograph 1: AX-23

Photograph 2: AX-24
Appendix B – Photographs of CCR Groundwater Monitoring Wells
Sandow AX Landfill

Photograph 3: AX-25

Photograph 4: AX-26
Appendix B – Photographs of CCR Groundwater Monitoring Wells
Sandow AX Landfill

Photograph 5: AX-27

Photograph 6: AX-28
Appendix B – Photographs of CCR Groundwater Monitoring Wells
Sandow AX Landfill

Photograph 7: AX-29

Photograph 8: AXMW-1
Appendix B – Photographs of CCR Groundwater Monitoring Wells
Sandow AX Landfill

Photograph 9: AXMW-2
Appendix C

Groundwater Potentiometric Surface Maps
EXPLANATION

+ CCR Monitoring Well

(414.49) Groundwater Potentiometric Surface (ft. MSL)

400 Groundwater Potentiometric Surface Contour (C.I. = 10 ft.)

EXPLANATION

- CCR Monitoring Well
- (414.48) Groundwater Potentiometric Surface (ft. MSL)
- 400 Groundwater Potentiometric Surface Contour (C.I. = 10 ft.)

SOURCE:
EXPLANATION

CCR Monitoring Well

414.49

Groundwater Potentiometric Surface (ft. MSL)

400

Groundwater Potentiometric Surface Contour (C.I. = 10 ft.)

SOURCE:
EXPLANATION

• CCR Monitoring Well

(414.49) Groundwater Potentiometric Surface (ft. MSL)

– 400 Groundwater Potentiometric Surface Contour (C.I. = 10 ft.)

SANDOW 5 GENERATING PLANT
AX LANDFILL

Figure C-6

AX LANDFILL GROUNDWATER POTENTIAL SURFACE MAP
AUGUST 9-10, 2016

PROJECT: 5164E BY: AJD REVISIONS
DATE: SEPT., 2017 CHECKED: PJB

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

SOURCE:
EXPLANATION

- **CCR Monitoring Well**

- **(414.48)** Groundwater Potentiometric Surface (ft MSL)

- **400** Groundwater Potentiometric Surface Contour (C.I. = 10 ft.)

SOURCE:
Appendix D
Aquifer Test Data
### WELL TEST ANALYSIS

Data Set: J:\...\AXMW-1 Slug IN.aqt  
Date: 11/18/15  
Time: 09:52:45

### PROJECT INFORMATION

- Company: PBW  
- Client: Luminant  
- Project: 5164-E  
- Location: Sandow AX  
- Test Well: AXMW-1  
- Test Date: 10-5-15

### AQUIFER DATA

- Saturated Thickness: 28.12 ft  
- Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (AXMW-1)

- Initial Displacement: 2.2 ft  
- Total Well Penetration Depth: 28.12 ft  
- Casing Radius: 0.083 ft  
- Static Water Column Height: 28.12 ft  
- Screen Length: 20. ft  
- Well Radius: 0.33 ft

### SOLUTION

- Aquifer Model: Unconfined  
- Solution Method: Bouwer-Rice

\[ K = 0.002861 \text{ cm/sec} \]  
\[ y_0 = 1.155 \text{ ft} \]
Data Set: J:\5164 - Luminant CCR Well Installation and GW Sampling\5164-E_Sandow 5\Slug Tests\Sandow Slug Tests
Date: 11/18/15
Time: 09:54:08

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-E
Location: Sandow AX
Test Date: 10-5-15
Test Well: AXMW-1

AQUIFER DATA

Saturated Thickness: 28.12 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: AXMW-1

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

Initial Displacement: 2.2 ft
Static Water Column Height: 28.12 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
Well Skin Radius: 0.33 ft
Screen Length: 20. ft
Total Well Penetration Depth: 28.12 ft

No. of Observations: 581

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AQTESOLV for Windows

Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 63.11

VISUAL ESTIMATION RESULTS

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\[ T = K*b = 2.452 \text{ cm}^2/\text{sec} \]
WELL TEST ANALYSIS

Data Set: J:\...\AXMW-1 Slug OUT.aqt
Date: 11/18/15  Time: 09:54:33

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-E
Location: Sandow AX
Test Well: AXMW-1
Test Date: 10-5-15

AQUIFER DATA

Saturated Thickness: 28.12 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (AXMW-1)

Initial Displacement: 2.2 ft
Total Well Penetration Depth: 28.12 ft
Casing Radius: 0.083 ft
Static Water Column Height: 28.12 ft
Screen Length: 20. ft
Well Radius: 0.33 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

\[ K = 0.005144 \text{ cm/sec} \]
\[ y_0 = 1.469 \text{ ft} \]
PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-E
Location: Sandow AX
Test Date: 10-5-15
Test Well: AXMW-1

AQUIFER DATA

Saturated Thickness: 28.12 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: AXMW-1

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

Initial Displacement: 2.2 ft
Static Water Column Height: 28.12 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
Well Skin Radius: 0.33 ft
Screen Length: 20. ft
Total Well Penetration Depth: 28.12 ft

No. of Observations: 201

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**SOLUTION**

Slug Test  
Aquifer Model: Unconfined  
Solution Method: Bouwer-Rice  
\( \ln(Re/rw) = 63.11 \)

**VISUAL ESTIMATION RESULTS**

Estimated Parameters

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\[ T = K \times b = 4.409 \text{ cm}^2/\text{sec} \]
WELL TEST ANALYSIS

Data Set: J:\..\AXMW-2 Slug IN.aqt
Date: 11/18/15
Time: 10:02:45

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-E
Location: Sandow AX
Test Well: AXMW-2
Test Date: 10-5-15

AQUIFER DATA

Saturated Thickness: 39.22 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA (AXMW-2)

Initial Displacement: 2.28 ft
Total Well Penetration Depth: 39.22 ft
Casing Radius: 0.083 ft
Static Water Column Height: 39.22 ft
Screen Length: 20. ft
Well Radius: 0.33 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0004255 cm/sec
y0 = 1.341 ft
**PROJECT INFORMATION**

- **Company:** PBW
- **Client:** Luminant
- **Project:** 5164-E
- **Location:** Sandow AX
- **Test Date:** 10-5-15
- **Test Well:** AXMW-2

**AQUIFER DATA**

- Saturated Thickness: 39.22 ft
- Anisotropy Ratio (Kz/Kr): 1.

**SLUG TEST WELL DATA**

- **Test Well:** AXMW-2
- **X Location:** 0. ft
- **Y Location:** 0. ft
- **Initial Displacement:** 2.28 ft
- **Static Water Column Height:** 39.22 ft
- **Casing Radius:** 0.083 ft
- **Well Radius:** 0.33 ft
- **Well Skin Radius:** 0.33 ft
- **Screen Length:** 20. ft
- **Total Well Penetration Depth:** 39.22 ft
- **No. of Observations:** 333

**Observation Data**

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SOLUTION

Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 3.573

VISUAL ESTIMATION RESULTS

Estimated Parameters

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T = K*b = 0.5086 cm²/sec
### PROJECT INFORMATION

- **Company:** PBW
- **Client:** Luminant
- **Project:** 5164-E
- **Location:** Sandow AX
- **Test Well:** AXMW-2
- **Test Date:** 10-5-15

### AQUIFER DATA

- **Saturated Thickness:** 39.22 ft
- **Anisotropy Ratio (Kz/Kr):** 1.

### WELL DATA (New Well)

- **Initial Displacement:** 2.28 ft
- **Total Well Penetration Depth:** 39.22 ft
- **Casing Radius:** 0.083 ft
- **Static Water Column Height:** 39.22 ft
- **Screen Length:** 20. ft
- **Well Radius:** 0.33 ft

### SOLUTION

- **Aquifer Model:** Unconfined
- **Solution Method:** Bouwer-Rice
- **K = 0.0003512 cm/sec**
- **y0 = 1.287 ft**
PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-E
Location: Sandow AX
Test Date: 10-5-15
Test Well: AXMW-2

AQUIFER DATA

Saturated Thickness: 39.22 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: New Well
X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.28 ft
Static Water Column Height: 39.22 ft
Casing Radius: 0.083 ft
Well Radius: 0.33 ft
Well Skin Radius: 0.33 ft
Screen Length: 20. ft
Total Well Penetration Depth: 39.22 ft

No. of Observations: 242

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**SOLUTION**

Slug Test  
Aquifer Model: Unconfined  
Solution Method: Bouwer-Rice  
\( \ln(Re/rw) = 3.573 \)

**VISUAL ESTIMATION RESULTS**

Estimated Parameters

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\[ T = Kb = 0.4199 \text{ cm}^2/\text{sec} \]