CCR Groundwater Monitoring System Report

Laramie River Station
Wheatland, Wyoming

Basin Electric Power Cooperative

Project number: 60506860

October 17, 2017

Quality information

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List of Acronyms

ANOVA	analysis of variance
bgs	below ground surface
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPA	United States Environmental Protection Agency
FGD	Flue Gas Desulfurization
ft	feet
ft/d	feet per day
LRS	Laramie River Station
MW	megawatt
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
SU	standard units
USGS	U.S. Geological Survey

Monitoring System Certification

Basin Electric Power Cooperative Laramie River Station CCR units: Ash Pond 1, Ash Pond 2, Ash Pond 3, Ash Landfill, Emergency Holding Ponds

AECOM ("Consultant") has been retained by Basin Electric Power Cooperative to prepare the following assessment of whether the above-referenced coal combustion residuals ("CCR") surface impoundments and landfill meet the groundwater monitoring system design and construction requirements set out in 40 C.F.R. § 257.91. Presented below are the project background, assessment, limitations, and certification.

BACKGROUND

Pursuant to 40 C.F.R. § 257.90(b), owners and operators of new and existing CCR landfills, and new and existing CCR surface impoundments, and all lateral expansions of a CCR unit must install a groundwater monitoring system, compliant with 40 C.F.R. § 257.91, which requires that said system consist of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and accurately represent the quality of groundwater passing the waste boundary of the CCR unit.

Pursuant to 40 C.F.R. § 257.91(f), the owner or operator must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of 40 C.F.R. § 257.91, including the performance standards specified in 40 C.F.R. § 257.91(a), based on the site-specific information specified in 40 C.F.R. § 257.91(b). If the groundwater monitoring system includes only the minimum number of monitoring wells specified in 40 C.F.R. § 257.91(c)(1), the certification must document the basis supporting this determination.

In support of Consultant's assessment, Consultant completed an evaluation of the groundwater monitoring system for the above-referenced CCR units and determined that sufficient information is available to make the certification required under 40 C.F.R. § 257.91(f).

LIMITATIONS

The signature of Consultant's authorized representative on this document represents that to the best of Consultant's knowledge, information, and belief in the exercise of its professional judgment, it is Consultant's professional opinion that the aforementioned information is accurate as of the date of such signature. Any opinion or decisions by Consultant are made on the basis of Consultant's experience, qualifications, and professional judgment and are not to be construed as warranties or guaranties. In addition, opinions relating to environmental, geologic, and geotechnical conditions or other estimates are based on available data, and actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

CERTIFICATION

I, Gregg Somermeyer, being a Registered Professional Engineer in the State of Wyoming, certify to the best of my knowledge, information, and belief, that the groundwater monitoring system for the CCR units that are the subject of this certification has been designed and constructed to meet the requirements of 40 C.F.R. § 257.91, and that this certification is true and correct and has been prepared in accordance with generally accepted good engineering practices.

SIGNATURE: 

DATE: October 17, 2017

Statistical Method Certification

Basin Electric Power Cooperative Laramie River Station CCR units: Ash Pond 1, Ash Pond 2, Ash Pond 3, Ash Landfill, Emergency Holding Ponds

AECOM ("Consultant") has been retained by Basin Electric Power Cooperative to prepare the following assessment of whether the statistical method for the evaluation of groundwater monitoring data for the above-referenced coal combustion residuals ("CCR") surface impoundments and landfill meet the requirements set out in 40 C.F.R. § 257.93(f)(6). Presented below are the project background, assessment, limitations, and certification.

BACKGROUND

Pursuant to 40 C.F.R. § 257.90(b), owners and operators of new and existing CCR landfills, and new and existing CCR surface impoundments, and all lateral expansions of a CCR unit must install a groundwater monitoring system, compliant with 40 C.F.R. § 257.91, which requires that said system consist of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and accurately represent the quality of groundwater passing the waste boundary of the CCR unit.

Pursuant to 40 C.F.R. § 257.93(f), the owner or operator of the CCR unit must select one of the statistical methods specified in paragraphs (f)(1) through (5) of this section to be used in evaluating groundwater monitoring data for each specified constituent. The statistical test chosen shall be conducted separately for each constituent in each monitoring well, and shall comply with the performance standards specified in 40 C.F.R. § 257.93(g). Per 40 C.F.R. § 257.93(f)(6), the owner or operator must obtain a certification from a qualified professional engineer stating that the statistical method for the evaluation of groundwater monitoring data for the groundwater monitoring system meets the requirements of 40 C.F.R. § 257.93(f)(6), including the performance standards specified in 40 C.F.R. § 257.91(a), based on the site-specific information specified in 40 C.F.R. § 257.91(b).

In support of Consultant's assessment, Consultant completed an evaluation of the groundwater monitoring system for the above-referenced CCR units and determined that sufficient information is available to make the certification required under 40 C.F.R. § 257.93(f).

LIMITATIONS

The signature of Consultant's authorized representative on this document represents that to the best of Consultant's knowledge, information, and belief in the exercise of its professional judgment, it is Consultant's professional opinion that the aforementioned information is accurate as of the date of such signature. Any opinion or decisions by Consultant are made on the basis of Consultant's experience, qualifications, and professional judgment and are not to be construed as warranties or guaranties. In addition, opinions relating to environmental, geologic, and geotechnical conditions or other estimates are based on available data, and actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

CERTIFICATION

I, Gregg Somermeyer, being a Registered Professional Engineer in the State of Wyoming, certify to the best of my knowledge, information, and belief, that the statistical methods selected to evaluate groundwater monitoring data for the CCR units that are the subject of this certification, as identified in Table 6-1 of this report, are appropriate and comply with the performance standards specified in 40 C.F.R. § 257.93(g), and that this certification is true and correct and has been prepared in accordance with generally accepted good engineering practices.

SIGNATURE:  DATE: October 17, 2017

1. Introduction

On behalf of Basin Electric Power Cooperative, (Basin), AECOM prepared this report documenting the Coal Combustion Residuals (CCR) groundwater monitoring system for the CCR units at Basin's Laramie River Station (LRS) located east of Wheatland, Wyoming (see **Figure 1-1**). This report addresses the requirement under Chapter 40 Code of Federal Regulations (CFR) Part 257.105(h) to provide in the Operating Record, as it becomes available, "documentation of the design, installation, development, and decommissioning of any monitoring wells, piezometers and other measurement, sampling, and analytical devices..."

Pursuant to 40 CFR § 257.90(b)(1), by October 17, 2017, an owner and operator of a CCR unit must install a groundwater monitoring system that meets the requirements of 40 CFR § 257.91. The groundwater monitoring system must meet the CCR Rule's performance standard, which requires the system to consist of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that accurately represent the quality of:

1. Background groundwater that has not been affected by leakage from a CCR unit; and
2. Groundwater passing the waste boundary of the CCR unit—the downgradient monitoring system must be installed at the waste boundary that ensures detection of potential groundwater contamination in the uppermost aquifer and must monitor all potential contaminant pathways.

This report summarizes the procedures and field activities associated with drilling and installation of monitoring wells that comprise the CCR monitoring network at LRS, as well as the results of testing and monitoring of monitoring wells to evaluate the network against the requirements of the Final Rule.

This report is organized as follows:

- Chapter 1 includes a brief introduction to this report;
- Chapter 2 provides a brief background with historical information concerning LRS and associated CCR units;
- Chapter 3 describes the geological and hydrogeological setting of LRS;
- Chapter 4 describes selection and installation of the LRS CCR monitoring well network for all CCR units at LRS, including the drilling and installation of monitoring wells to supplement existing monitoring wells at LRS;
- Chapter 5 presents an evaluation of the LRS CCR monitoring compared to the requirements of the CCR Rule;
- Chapter 6 describes the statistical methodology that will be used to evaluate CCR groundwater monitoring data;
- Chapter 7 describes the professional limitations that apply to this report; and
- Chapter 8 lists the references cited in this report.

Certifications pertaining to the design and construction of the groundwater monitoring system and selection of the statistical method for evaluating data acquired using the groundwater monitoring system, are presented before Chapter 1.

2. Background

The LRS is one of the largest consumer-operated, regional, joint power supply ventures in the United States. LRS is a coal-based generating station located in Platte County east of Wheatland, Wyoming, and has a total power output capacity of 1,710 megawatts (MW) from three coal-based units:

- Unit 1, with a rating of 570 MW, which began operating in 1980;
- Unit 2, with a rating of 570 net MW, which began operating in 1981; and
- Unit 3, with a rating of 570 net MW, which began operating in 1982.

Coal ash is disposed at LRS in the following CCR units:

- Ash Landfill
- Ash Pond 1
- Ash Pond 2
- Ash Pond 3
- Emergency Storage Ponds

The three ash ponds and the landfill are located west of the generating units and office complex, near the western edge of the site (**Figure 1-1**). The two emergency holding ponds are located north of the generating units in the northeastern part of the site. The landfill and ash ponds were permitted in 1978 and began receiving coal ash in 1980. The emergency holding ponds were subsequently incorporated due to disposal of flue gas desulfurization (FGD) materials. Basin Electric reported that in 2014 the landfill received 284,119 tons of solid waste, including fly ash, FGD waste, and a minor contribution of solid debris. The landfill is currently accessed via a haul road running generally east to west along the south side of the landfill.

Due to the presence of CCR, the LRS ash ponds, landfill, and emergency holding ponds are regulated by the CCR Rule, promulgated by the U.S. Environmental Protection Agency (EPA) under Chapter 40 Code of Federal Regulations (CFR) Part 257, Subtitle D of the Resource Conservation and Recovery Act (RCRA). The CCR Rule establishes requirements for existing CCR landfills and surface impoundments, including groundwater monitoring and corrective action. The groundwater monitoring provisions of the CCR Rule require the installation of a system of monitoring wells, the specification of procedures for sampling these wells, and analysis of the resulting data to detect the presence of hazardous constituents. A corrective action process is required in the event that hazardous constituents are detected above background concentrations at levels exceeding groundwater protection standards.

3. Geological and Hydrogeological Setting

The geological and hydrogeological setting is important to understanding the groundwater environment in the vicinity of the LRS. The geologic history of Platte County is similar to most areas within the Front Range of the Rocky Mountains. Platte County is underlain by marine and continental deposits of limestone, conglomerate, sandstone, siltstone, shale, and unconsolidated sediments. Deposits range in thickness over the Laramie Range, Hartville uplift, and related features up to 10,000 feet in the east central and southeastern parts of the county. Precambrian rocks generally make up the mountainous (structurally complex) areas, Paleozoic and Mesozoic rocks adjoin the older formations, and Tertiary and Quaternary rocks underlie most of the county east of the Laramie Range (U.S. Geological Survey [USGS] 1960). The Laramide Orogeny was active in the county approximately 70 million years ago marking the beginning the Hartville uplift and Laramie Range. In the Cenozoic, streams eroded the eastern side of the range depositing silts, sands, and gravels of the Brule and Arikaree Formations that underlie the Wheatland area and subsequently Basin Electric LRS.

Precipitation landing on the eastern flank of the Laramie Range supplies surface water to perennial and ephemeral streams that flow east towards the basin. Most surface water west of Wheatland eventually joins with the Laramie River continuing east before discharging into the Platte River near Fort Laramie. Groundwater near Wheatland is recharged primarily through infiltration on the eastern flank of the Laramie Range, and through re-infiltration of irrigation water during the spring, summer, and fall months. Some groundwater in the saturated zones eventually returns to the land surface through seeps and springs, or is discharged by wells and evapotranspiration; however, the majority flows into surface streams. Alluvial drainages bounding the eastern (Wheatland Creek) and western portions (Chugwater Creek) of the facility transport surface water generally northward, discharging to the Laramie River (USGS 1960). Some groundwater within these regions percolates into the Arikaree Formation which holds the uppermost aquifer beneath the facility.

The LRS facility is underlain by a 5- to 30-foot section of Quaternary sediments that overlies the Arikaree Formation. The Arikaree Formation is comprised primarily of loosely to moderately cemented very fine to fine grained sandstone containing interbeds of silts and clays. A lower unit consists of lenses of loosely to well-cemented red to gray coarse sandstone interbedded with lenses of well-cemented conglomerate. A basal conglomerate lies unconformably upon the underlying Brule Formation in many places throughout Platte County (USGS 1960). The 2016 AECOM drilling investigation did not penetrate to depths great enough to expose the lower portions of the Arikaree; however a review of the geologic logs generated during the drilling of the onsite water supply well (Forell-Baumgardner No. 2) suggests the Brule Formation is approximately 820 feet below ground surface in the western portions of the site. Based on this information, the local thickness of the Arikaree Formation onsite is approximately 790 feet thick.

The lithologic characteristics of the Arikaree Formation beneath the LRS are generally consistent, although there are slight differences in the degree of cementation and induration, and minor variations in grain size. Few fractures were noted in borehole soil cores obtained during monitoring well network installation described in Chapter 2. Interbeds with higher silt and clay content, coupled with greater cementation generate thin discontinuous perched groundwater horizons that are interpreted to hold only seasonal groundwater. The perched groundwater would tend to percolate downward to what is interpreted as the uppermost aquifer based on data obtained during monitoring well installation and aquifer testing. The uppermost aquifer is present at a depth of approximately 95 feet below ground surface (ft bgs) in the southeastern portion of the LRS facility, and slopes generally north towards the Laramie River. The hydraulic gradient for the uppermost aquifer beneath the site appears to be controlled dominantly through topographic features and enhanced infiltration zones in permeable shallow alluvium.

4. Monitoring Well System Selection and Installation

A monitoring well system has been established at LRS to comply with the requirements of the EPA CCR Rule published in the Federal Register on April 17, 2015. The system is comprised of several existing monitoring wells that predate the CCR Rule, as well as a number of additional monitoring wells that were installed to complete the system and fully comply with requirements of the Rule.

Monitoring Well Installation in 2016

Sixteen monitoring wells were installed at LRS during the summer of 2016 to target the uppermost aquifer in the vicinity of the LRS CCR units, including nine monitoring wells (MW-32B through MW-40B) around the landfill and ash ponds west of the main plant area, and seven monitoring wells (MW-41B through MW-47B) surrounding the emergency holding ponds generally north of the main plant area (**Figure 4-1**). The monitoring well locations were selected to evaluate the direction of groundwater flow in the vicinity of the LRS CCR units.

Monitoring well installation involved drilling, well construction, development, and aquifer testing, as described below.

Drilling and Well Construction

Sixteen new monitoring wells were installed at LRS targeting the uppermost aquifer within the investigation areas. Nine new monitoring wells (MW-32B through MW-40B) were installed around the ash ponds west of the main plant area, and seven new monitoring wells (MW-41B through MW-47B) were installed surrounding the emergency holding ponds generally north of the main plant area (**Figure 4-1**). The monitoring well locations were selected to evaluate the direction of groundwater flow in the vicinity of the LRS CCR units.

Subsurface utilities in the vicinity of each planned monitoring well installation location were identified by utility representatives following the One-Call of Wyoming notification system. The uppermost 5 feet of each boring location was excavated using a hydro-excavation or hand-auger as an additional precaution against utility strikes.

Monitoring well drilling and construction occurred between July 13 and August 12, 2016. The monitoring wells were installed using sonic drilling methods. Soil cores recovered during drilling operations were photographed and logged by AECOM geologists. Boring logs are included in **Appendix A**. Each boring was drilled 10 to 15 feet below the elevation at which groundwater was encountered. Moist to wet horizons were encountered at multiple depths during drilling. A submersible pump was used to test these zones for water production. If water was not recharging within the test interval, the borehole was advanced deeper until a distinct groundwater horizon was reached, or pump testing yielded significant quantities of groundwater.

Each new monitoring well was constructed of 2-inch-diameter, schedule 40 polyvinyl chloride (PVC) riser pipe and slotted screen. The screen interval was constructed using 20 feet of 0.010-inch factory-slotted PVC screen straddling the water table. The annular space within the bore hole around the screen was filled with clean 10/20 silica sand filter pack to a minimum of 2 feet above top of screen. Bentonite chips were placed above the filter pack and hydrated with potable water to seal the filter pack from surface influence. The remaining annular space above the bentonite seal was filled with Portland Type I/II grout and allowed to set for a minimum of 24 hours before well development activities were completed. Above-grade stainless steel monuments, lockable J-Plugs, and monument locks were installed to protect and secure the wellhead. Surface monuments were labeled with the well identification number and set within a 2-foot square concrete pad. Steel bollards painted yellow were installed around wells located near traffic areas to enhance visibility and protect the wells. Well construction diagrams are included in **Appendix A**, and construction details are summarized in **Table 4-1**.

Well Development

The newly installed monitoring wells were developed between August 15, 2016, and August 17, 2016. Well development activities included measuring the water level and total depth of the well, surging the well with a PVC surge block, bailing the well with a weighted bailer to remove initial influx of sediment into the well, and finally using a submersible pump to purge the well. After well measurements were taken, a surge block was used to surge water into and out of the screened portion of the well for a minimum of 10 to 15 minutes. Bailers were then used to remove water and sediment from the well prior to pumping using a submersible electric pump. A minimum of ten well volumes of water were removed from each monitoring well during well development. Field parameters (pH, temperature, specific conductance and turbidity) were measured and recorded at regular intervals during pumping. Each well was purged until visibly clear and a minimum ten well casing volumes were removed. Purge water generated during well development was spread on the adjacent ground surface.

Aquifer Testing

A combination of aquifer pumping and slug tests were performed on the 16 new monitoring wells around the emergency ponds and ash ponds to evaluate the hydraulic conductivity of the geologic formation at each well location. The aquifer tests were performed between August 19, 2016 and August 23, 2016 after all wells had been developed.

Slug tests were performed on eight wells (MW-33B, MW-35B, MW-37B, MW-38B, MW-39B, MW-42B, MW-45B, and MW-47B). Wells MW-42B, MW-45B, and MW-47B are located directly adjacent to the Emergency Holding Ponds (**Figure 4-1**). Wells MW-33B, MW-35B, MW-37B, MW-38B, and MW-39B are located around the Ash Ponds to the southwest of the Emergency Holding Ponds. Slug tests were performed by first taking water level and total depth measurements on the well. A transducer was then lowered into each well and set at a depth of approximately 1 to 2 feet off the bottom of the well. The well was then allowed to recover back to the static water level recorded before the transducer was placed in the well. The transducer then began recording data and a slug was lowered into the well. The slug was placed at a depth to be fully submerged in the well above the height of the transducer, making sure that the transducer did not move during placement. The slugs used for the tests at the Basin Electric Laramie River station consisted of a 1-inch by 6-foot long section of PVC capped at both ends and filled with sand. One end of the slug contained an eye hook to allow a nylon rope to be attached to it for placement and retrieval. After slugs were placed in the well, the water level was allowed to return to within 95 percent of the static water level. Once 95 percent of static was achieved, the slug was removed and the water level was once again allowed to return to within 95 percent of static. The transducer in the well recorded the depth of water above the transducer, temperature, and hydraulic head pressure measurements within the well for the entirety of the test. Once a 95 percent static water level was achieved after removing the slug, the test was stopped and equipment was removed and decontaminated before using in the next well to be tested. Manual water level measurements were recorded on field slug test forms (**Appendix B**) and electronic data was removed from the transducer to be used for data evaluation.

Aquifer pumping tests were performed at eight of the newly installed monitoring wells at the site (MW-32B, MW-34B, MW-36B, MW-40B, MW-41B, MW-43B, MW-44B, and MW-46B). Wells MW-41B, MW-44B, MW-46B, and MW-43B are located around the Emergency Holding Ponds (**Figure 4-1**). MW-32B, MW-34B, MW-36B, and MW-40B are located around the Ash Ponds. The pumping tests were performed in a similar manner to the slug testing (reference AECOM SOP 18.0, **Appendix B**). Prior to starting each aquifer test, water level and total well depth measurements were taken. After well measurements were taken, a submersible electric pump was lowered into the well and placed at a level approximately 2 to 3 feet off the bottom. A transducer was attached to the pump tubing approximately 1 foot above the top of the pump. The water level was then allowed to stabilize before the test was started. After water level stabilization, the transducer started recording data and the pump was turned on to a flow rate ranging from 0.5 to 1.5 gallons per minute. The pumping rate was held constant during the test and drawdown in the well was recorded using the transducer and periodic manual water level measurements using an electronic water level meter. The pump remained on until drawdown neared the elevation the transducer was placed, or the water level in the well stabilized. The pump was then shut off and recovery of the water level was measured until 95 percent of the static initial water level was reached, at which time the test was stopped and equipment removed from the well and decontaminated prior to testing of the next well. Manual measurements were recorded on field aquifer testing forms (**Appendix B**) and electronic data was removed from the transducer and used for data evaluation.

Slug Test Analysis

Data from the slug tests performed at the Site were processed and analyzed using the software AQTESOLV (Duffield, 2007), which provides type curve solutions from published methods corresponding to a range of conceptual models for various well completions and aquifer types (e.g., fully penetrating well in an unconfined aquifer), and simplifying hydrologic assumptions (e.g., infinite aquifer extent). After initial processing and analysis, the most appropriate conceptual model was determined to be the Bouwer and Rice Slug Test Solution for Unconfined Aquifers (Bouwer & Rice 1976). This method uses a straight line fit to the observed water-level displacement and is applicable to wells screened below and across the water table. Graphs of the slug test results are included in **Appendix B**. For wells screened across the water table (all except MW-39B and MW-42B), a double straight line can be observed in the data sets when plotted on a log-normal axes, with a line of a steeper slope in early time representing groundwater entering or exiting the well from the filter pack. The second segment of data with a shallower slope represents the behavior of the geologic formation located immediately outside of the filter pack. In these cases an effective casing radius correction factor is applied and the straight line solution is fit to the second slope in the data. Some basic assumptions of the Bouwer-Rice solution include:

- Aquifer has infinite areal extent;
- Aquifer is isotropic and has uniform thickness;
- Aquifer potentiometric surface is initially horizontal;
- Control well is fully or partially penetrating;
- A volume of water, V (the slug), is injected or discharged instantaneously from the control well;
- Flow is steady; and
- Aquifer is confined or unconfined.

Results from the slug test analyses are summarized in **Table 4-2**. AQTESOLV analyses of the slug test data for each well are presented in **Appendix B**. The average estimated hydraulic conductivity of the completed slug tests was 2.16 feet per day (ft/d) with a geometric mean of 1.65 ft/d. The minimum hydraulic conductivity of 0.45 ft/d was estimated at MW-39B. The maximum of 6.28 ft/d was estimated at MW-37B. Although the software calculates a value for aquifer storage from the slug test data, these values are assumed to represent rough approximations as both slug tests and single-well pumping tests are considered relatively poor methods to determine aquifer storage.

Pumping Test Analysis

Pumping test data also were analyzed using the software package AQTESOLV. Type curve solutions for pumping tests available in AQTESOLV typically require observation well data. In cases where observations from only the pumping well are available, aquifer storage calculations are not usable; however hydraulic conductivity calculations are still valid. Data were analyzed as single well pumping tests using the Moench solution for a pumping test in an unconfined aquifer (Moench 1997). The Moench solution is the only available option in AQTESOLV for unconfined aquifers which accounts for wellbore storage. Due to the low flow rate of the pump test, wellbore storage has a clear effect on the data in early time. Although the data most indicative of aquifer behavior is in late time, it is helpful to account for the wellbore storage through derivative plot analysis, ensuring that the conceptual model for the solution is valid. For the pumping test analysis graphs shown in **Appendix B**, the observed data are plotted with black squares, and the Moench solution is plotted with a blue line. The derivate data are plotted with gray crosses and the derivate solution is plotted in a red line.

The Moench solution utilizes the following assumptions:

- Aquifer has infinite areal extent;
- Aquifer is homogeneous, isotropic and of uniform thickness;
- Aquifer is unconfined; and
- Flow is unsteady.

Results from the pumping test analyses are summarized in **Table 4-2**. AQTESOLV analyses of the pump test data for each well are presented in **Appendix B**. The average estimated hydraulic conductivity of the eight pumping tests was 1.40 ft/d with a geometric mean of 1.19 ft/d. The minimum hydraulic conductivity of 0.65 ft/d was estimated at

MW-34B. The maximum of 3.12 ft/d was estimated at MW-41B. During the pumping test on MW-44B, the well began to recharge prior to the completion of the test. No significant fluctuations were observed in the flow rate at this time. It is possible that these results were affected by the drawdown cone reaching a recharge boundary, or insufficient well development. Hydraulic conductivity results for well MW-44B yielded similar results to the other wells tested.

Addition of Existing Monitoring Wells in November 2016

The first CCR baseline groundwater monitoring event at LRS was conducted in September 2016. A review of the resulting data concluded that the assessment of baseline groundwater conditions associated with the ash impoundments and landfill could be improved by modifying the list of monitoring wells included in the CCR monitoring system. Therefore, the monitoring system was modified in November 2016 as described below for subsequent baseline monitoring events:

- Existing monitoring wells MW-14BR, MW-20B, and MW-21B were added to the groundwater monitoring program (**Figure 4-1**). These wells are located downgradient of the ash impoundments and eastern portion of the ash landfill, and supplement the downgradient data provided by MW-36B, MW-37B, MW-38B, and MW-48B.
- Monitoring wells MW-33B, MW-34B, and MW-35B were removed from the groundwater sampling program because they were found to be cross-gradient from the ash impoundments, although groundwater elevations continued to be measured in these wells to support interpretation of site-wide groundwater flow.

Addition of New and Existing Monitoring Wells in 2017

The LRS CCR groundwater monitoring network was modified in July 2017 based on an evaluation of interim baseline data acquired in 2016 through the spring of 2017. The rationale for expanding the network was to provide greater resolution of baseline groundwater quality and flow in the vicinity of the three ash ponds, and support an evaluation of upgradient and downgradient conditions for Ash Pond 1 and a multi-unit consisting of Ash Pond 2, Ash Pond 3, and the Ash Landfill. The monitoring wells added to the network in July 2017 included two existing wells along the northern edge of the ash ponds: MW-22B and MW-23B. In addition to these wells, six new monitoring wells were installed along the northern edge of the ash ponds and between the ash ponds: MW-48B, MW-49B, MW-50B, MW-51B, MW-52B and MW-53B.

The six new monitoring wells were installed using sonic drilling methods consistent with the methods described above to install the monitoring wells in 2016. Drilling and well construction was performed by O'Keefe Drilling of Butte, Montana. Soil cores recovered during drilling were logged by an AECOM geologist. **Appendix A** contains the borings log for each monitoring well. Construction details for the six monitoring wells installed in July 2017 are presented in **Table 4-1**. Each well was constructed of 2-inch-diameter, schedule 40 PVC riser pipe and slotted screen. The well screen was constructed using 20 feet of 0.010-inch factory-slotted PVC screen positioned to straddle the water table. The annular space between the borehole and screen was filled with clean 10/20 silica sand filter pack to a minimum of 2 feet above top of screen. Bentonite chips were placed above the filter pack and hydrated with potable water to seal the filter pack from potential infiltration of surface water. The annular space above the bentonite seal was filled with Portland Type I/II grout and allowed to set for a minimum of 24 hours. All wells except for MW-48B were completed with flush-mount construction to provide protection from vehicular traffic. MW-48B was constructed with an above-grade outer steel casing. The surface monuments were labeled with the well identification number and anchored in a 2-foot square concrete pad. Construction diagrams for the six monitoring wells are included in **Appendix A**.

The six newly installed monitoring wells were developed by surging with a PVC surge block and pumping using a submersible pump. Each well was purged until visibly clear and after a minimum ten well casing volumes were removed. Purge water generated during development was spread onto the adjacent ground surface. Aquifer testing was not performed on the six new monitoring wells because sufficient data was obtained during testing of the sixteen wells installed in 2016 to adequately characterize the hydrogeological characteristics of the uppermost aquifer in the vicinity of the LRS CCR units.

5. System Evaluation

The Final CCR Rule establishes the following general performance standard for CCR groundwater monitoring systems:

- All groundwater monitoring systems must consist of a sufficient number of appropriately located wells (at least one upgradient and three downgradient wells) in order to yield groundwater samples from the uppermost aquifer that represent the quality of background groundwater and the quality of groundwater passing the CCR waste boundary.
- The objective of a groundwater monitoring system is to intercept groundwater to determine whether the groundwater has been contaminated by the CCR disposal unit. The number, spacing, and depths of the monitoring wells must be determined based on a thorough characterization of the site, including a number of specifically identified factors relating to the hydrogeology of the site.

The "uppermost aquifer" and "aquifer" are defined in the Final CCR Rule in § 257.53, as follows:

"Uppermost aquifer" means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season.

"Aquifer" means a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs.

As described in the drilling and well construction discussion in **Chapter 4**, drilling equipment and procedures were employed to identify the uppermost aquifer and ensure each new monitoring well was installed with appropriate total depth and placement of the well screen to: (1) facilitate collection of representative samples of the uppermost aquifer, and (2) accurately measure water table elevations to support evaluation of groundwater gradient and flow direction.

Also as described in **Chapter 4**, selection and construction of the CCR monitoring system for LRS evolved and adapted based on the results obtained from baseline groundwater monitoring in 2016 and 2017. The final monitoring system consists of 19 monitoring wells that will be sampled as part of the detection monitoring program. The list of wells selected for sampling background and downgradient groundwater quality for each CCR unit or multi-unit is summarized below:

CCR unit/multi-unit	Background wells	Downgradient wells
Ash Pond 1	MW-52B, MW-53B	MW-49B, MW-21B, MW-38B
Ash Pond 2, Ash Pond 3, Ash Landfill	MW-39B, MW-32B	MW-36B, MW-37B, MW-20B, MW-14BR, MW-40B, MW-52B, MW-53B
Emergency Holding Ponds	MW-41B, MW-42B, MW-43B	MW-44B, MW-45B, MW-46B, MW-47B

The following eight monitoring wells are included in the monitoring system only for the purpose of measuring groundwater elevations and evaluating groundwater flow direction and velocity in the vicinity of the ash ponds and landfill:

- MW-22B, MW-23B, MW-33B, MW-34B, MW-35B, MW-48B, MW-50B, MW-51B.

Potentiometric surface maps have been constructed using the depth to groundwater measurements obtained during baseline groundwater monitoring, and monitoring well locations and elevations measured by a licensed professional land surveyor. Maps of the potentiometric surface for December 2016, July 2017 and September 2017 are presented as **Figures 5-1**, **5-2** and **5-3**, respectively. The associated depth to groundwater measurements and calculated groundwater elevations are presented in **Table 5-1**. Groundwater elevations were calculated at each well by subtracting the measured depth to groundwater from the surveyed top of casing elevation. Groundwater elevations for each monitoring well are posted on the figures, with inferred isoelevation contours of the groundwater potentiometric surface. The direction of groundwater flow is generally to the northeast, perpendicular to the

potentiometric contour lines. **Figures 5-1**, **5-2** and **5-3** illustrate the relatively consistent pattern of groundwater flow beneath the LRS CCR units, and support the selection of the wells listed above to represent background groundwater quality and the quality of groundwater downgradient of the CCR units.

6. Statistical Methodology

Regulatory Guidance

Regulatory guidance provided in 40 CFR §257.90 specifies that a CCR groundwater monitoring program include selection of the statistical procedures to be used for evaluating groundwater quality data as required by 40 CFR §257.93. Groundwater quality monitoring data will be collected under the detection monitoring program outlined in this plan and will include collection and analysis of a minimum of eight independent groundwater samples from each background and downgradient compliance well, for each CCR unit or multi-unit, as required by 40 CFR §257.94(b). The groundwater samples will be analyzed for the constituents listed in 40 CFR §257 Appendices III and IV.

After the eight sets of groundwater samples are collected and analyzed, these data must be statistically evaluated to determine if there are any statistically significant increases over background concentrations for the Appendix III and IV constituents. In determining whether a statistically significant increase has occurred, the constituent concentrations at the downgradient wells and the background wells for each unit/multi-unit will be compared using one or more of the statistical methods discussed below.

40 CFR §257.93(f) outlines the statistical methods available to evaluate groundwater monitoring data. The statistical test(s) chosen will be conducted separately for each constituent in each monitoring well and will be appropriate for the constituent data and their distribution. The available statistical methods include the following:

- A parametric analysis of variance (ANOVA) followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's mean and the background mean levels for each constituent;
- An ANOVA based on ranks followed by multiple comparison procedures to identify statistically significant evidence of impacts. The method must include estimation and testing of the contrasts between each compliance well's median and the background median levels for each constituent;
- A tolerance or prediction interval procedure, in which an interval for each constituent is established from the distribution of the background data and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit;
- A control chart approach that gives control limits for each constituent; or
- Another statistical test method that meets the performance standards of 40 CFR257.94(g) outlined in the paragraph below.

The chosen statistical method will comply with the following performance standards, as appropriate, based on the statistical test method used. The performance standards include the following:

- The statistical method used to evaluate groundwater monitoring data will be appropriate for the constituent distribution (i.e., parametric or nonparametric).
- If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a groundwater protection standard, the test shall be done at a Type I error level no less than 0.01 or 0.05, depending on the method chosen. This performance standard does not apply to tolerance intervals, prediction intervals, or control charts.
- If a control chart approach is used to evaluate groundwater monitoring data, the specific type of control chart and its associated parameter values shall be such that this approach is at least as effective as any of the other statistical analysis approaches specified above.
- If a tolerance interval or a prediction interval is used to evaluate groundwater monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, shall be such that this approach is at least as effective as any of the other statistical analysis approaches specified above.

- The statistical method must account for data below the limit of detection with one or more statistical procedures that shall be at least as effective as any of the other statistical analysis approaches specified above.
- If necessary, the statistical method must include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

Per 40 CFR §257.93(h)(2), statistical analysis of the first eight rounds of data must be completed within 90 days after completing the initial groundwater sampling and analysis to determine whether there has been a statistically significant increase over background for any constituent. The first eight rounds of groundwater sampling and analysis must be completed no later than October 17, 2017. In accordance with 40 CFR §257, LRS must obtain a certification from a qualified professional engineer stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area. The certification must include a narrative description of the statistical method selected to evaluate the groundwater monitoring data.

Assessment monitoring is required per 40 CFR §257.95 whenever a statistically significant increase over background levels has been detected for one or more of the indicator parameters listed in 40 CFR §257 Appendix III. An assessment monitoring program also includes annual groundwater sampling and analysis for the constituents listed in 40 CFR §257 Appendix IV. The purpose of assessment monitoring is to determine if releases of CCR constituents have occurred.

The facility can return to detection monitoring once assessment monitoring results are at or below background values for two consecutive assessment monitoring events. If the assessment monitoring demonstrates an exceedance of a groundwater protection standard for any of the CCR constituents specified in 40 CFR 257 Appendices III and IV, groundwater corrective action must be initiated.

Statistical Analysis Approach

There is no single method of statistical analysis that is appropriate for each groundwater constituent dataset. It is most prudent to use a suite of statistical methods that are dependent on the data and their distributions. The statistical analyses will be based on an interwell and/or an intrawell approach for the purpose of determining if an LRS CCR unit/multi-unit has impacted groundwater quality. The statistical algorithms used for the interwell and intrawell approaches will be chosen based on the groundwater constituent data and their distributions as well as consideration of natural seasonally- or spatially-varying groundwater constituent concentrations.

Eight rounds of baseline groundwater monitoring data were collected and analyzed for the 40 CFR 257 Appendices III and IV constituents. These data will be used to represent background groundwater quality for the LRS CCR units. The detection monitoring data collected at the downgradient wells will be used to determine if any of tne CCR units/multi-unit have impacted groundwater quality. The initial eight rounds of detection monitoring sampling and analysis were completed prior to the October 17, 2017 deadline established in the CCR Rule (40 CFR §257.94).

A preliminary, exploratory statistical analysis was conducted after the eight rounds of baseline data were obtained to initially assess the constituent data and determine the most appropriate statistical approach(es) for the data. The data were examined for outliers and the percentage of non-detect values to verify that the data collected are suitable for statistical analysis. The data were also examined using goodness-of-fit tests to determine the most appropriate statistical distribution and time series plots and areal maps were used to determine if seasonal or spatial variations in constituent concentrations were present. Based on this preliminary evaluation of the data, an interwell statistical approach was selected as appropriate for evaluating groundwater at LRS, as described below.

Per 40 CFR 257.93(h)(2), statistical analysis of all eight rounds of data must be completed within 90 days after completing groundwater sampling and analysis to determine whether there has been a statistically significant increase over background for any Appendix III constituent.

Interwell Statistical Approach

Interwell tests compare the statistical differences between (upgradient) background and downgradient compliance wells. An interwell statistical approach will be used during detection monitoring for the following reasons:

- Sufficient data are available in the upgradient background well to ensure adequate degrees of statistical power to detect real exceedances above background levels, and also reasonable control over the site-wide false positive rate so that spurious exceedances have little chance of being identified.
- Although there is evident spatial variation among most, if not all, of the Appendix III constituents, it is unclear to what extent the similarly evident variation among the downgradient wells is due strictly to natural differences in groundwater quality and/or other factors unrelated to management of the CCR ash. Because of this uncertainty, an interwell comparison strategy appears to be initially more appropriate for LRS.

As a caveat to this approach, for constituents that occur naturally and vary substantially in concentration across LRS due to natural hydrogeologic or geochemical factors — thus, exhibiting significant spatial variability — an interwell testing scheme will not always be helpful. Using an interwell approach, constituent concentrations greater than background might be attributed to anthropogenic contamination, when in fact the differences are actually natural and due to locally varying distributions of groundwater constituents. In such cases, an intrawell approach may be warranted.

Furthermore, there is no requirement either in RCRA or the CCR Rule to use exactly the same statistical method or approach for every constituent. Depending on characteristics of LRS and data that are collected, a mix of interwell and intrawell tests may be warranted. At this site, the initial statistical screening suggests that interwell comparisons are most appropriate despite evident spatial variability. However, that conclusion could change as additional data are collected during future detection monitoring. If new information indicates that constituent concentrations remain relatively stable and that the existing spatial variation is unrelated to the CCR units, a modification of the statistical approach to intrawell testing may be recommended for one or more constituents.

Under an interwell statistical approach in detection monitoring, the actual statistical method(s) chosen will be determined based on the constituent data distribution (as outlined below), which in turn is influenced both by the percentage and pattern of non-detect measurements as well as the temporal stability of the concentration levels.

When (1) the percentage of non-detects is low to moderate (i.e., less than 50-60 percent), (2) the background data can be normalized (perhaps via a standard transformation), and (3) the results are stationary (i.e., stable over time), the following statistical methods are highly recommended by USEPA (2009):

- Interwell control charts with retesting; or
- Parametric interwell prediction limit methods with retesting.

When the background data cannot be normalized (perhaps due to a large percentage of non-detects), but the data are stationary (i.e., stable over time), the following statistical method is recommended by USEPA (2009):

- Non-parametric interwell prediction limits with retesting.

Note that the specific retesting method in each of these options will be chosen to account for the size of the well network, the amount of background data available, the number of constituents being monitored, the site-specific mix of intrawell and interwell tests, and the impact of these factors on the statistical power and accuracy of the test. At this site, the upgradient background wells relative to the number of downgradient wells to be tested on a semi-annual basis will enable use of a 1-of-2 retesting plan. This necessitates collection of a single independent resample at any location in which the initial routine measurement exceeds its respective statistical limit. A confirmed statistical exceedance will not be recorded unless both the initial measurement and resample value both exceed the statistical limit.

If the upgradient background data are non-stationary and thus exhibit a clear trend, it will suggest that factors unrelated to the CCR unit are impacting upgradient groundwater quality. Three general scenarios will be considered:

- Older background data may no longer be representative of current site conditions and may need to be excluded from statistical calculations. In this case, the interwell statistical limits will be updated to include only the most representative background data.
- The compliance wells will be examined to see if similar trends are occurring downgradient. If so, a common trend component will be estimated across the site and removed from every well. The residual data will then be used to construct revised statistical limits and tested as described above.

- If the trend in upgradient background wells is not reflected in downgradient wells, further investigation may be needed to determine if the upgradient data still serve as a reasonable background with which to compare downgradient compliance measurements. If not, the statistical approach will be modified to an appropriate intrawell strategy.

Because of the decision matrix needed to establish the correct statistical approach, the background data for each constituent will be periodically screened prior to construction of new or revised statistical limits. This screening will examine the proportion and pattern of outliers and potential data anomalies (perhaps due to laboratory or field sampling factors), the presence or absence of statistically significant trends over time, the presence or absence of statistically significant outliers, and the identification of an appropriate statistical distribution. In particular, any confirmed background outliers will be excluded from statistical calculations, so as not to unduly bias the statistical limits.

Proposed Statistical Methods for Appendix III Analytes

Table 6-1 provides a summary of the proposed statistical method by well for Appendix III analytes. This table is based on a preliminary screening of the background and downgradient well data collected to date. The proposed statistical method may be modified when all of the background data have been validated and statistically evaluated for the annual report to be submitted in January 2018.

7. Limitations

The signature of AECOM's (Consultant's) authorized representative on this document represents that, to the best of Consultant's knowledge, information, and belief in the exercise of its professional judgment, it is Consultant's professional opinion that the aforementioned information is accurate as of the date of such signature. Any opinion or decisions by Consultant are made on the basis of Consultant's experience, qualifications, and professional judgment and are not to be construed as warranties or guaranties. In addition, opinions relating to environmental, geologic, and geotechnical conditions or other estimates are based on available data, and actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

8. References

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Figures

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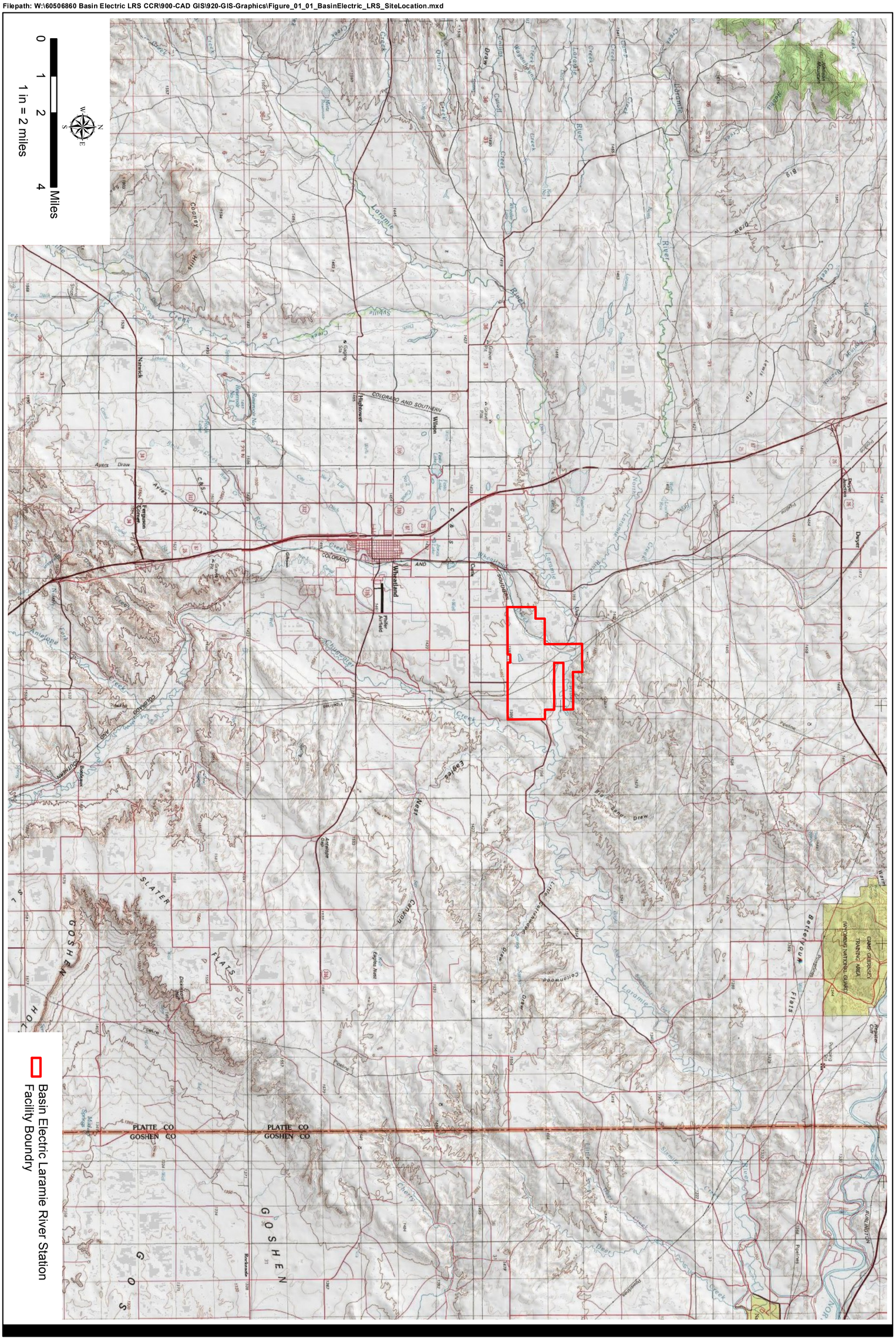

Basin Electric
Laramie River Station
Platte County, Wyoming
Project No.: 60506860 Date: 09/28/2016

Site Location Map

AECOM

Figure: 1-1

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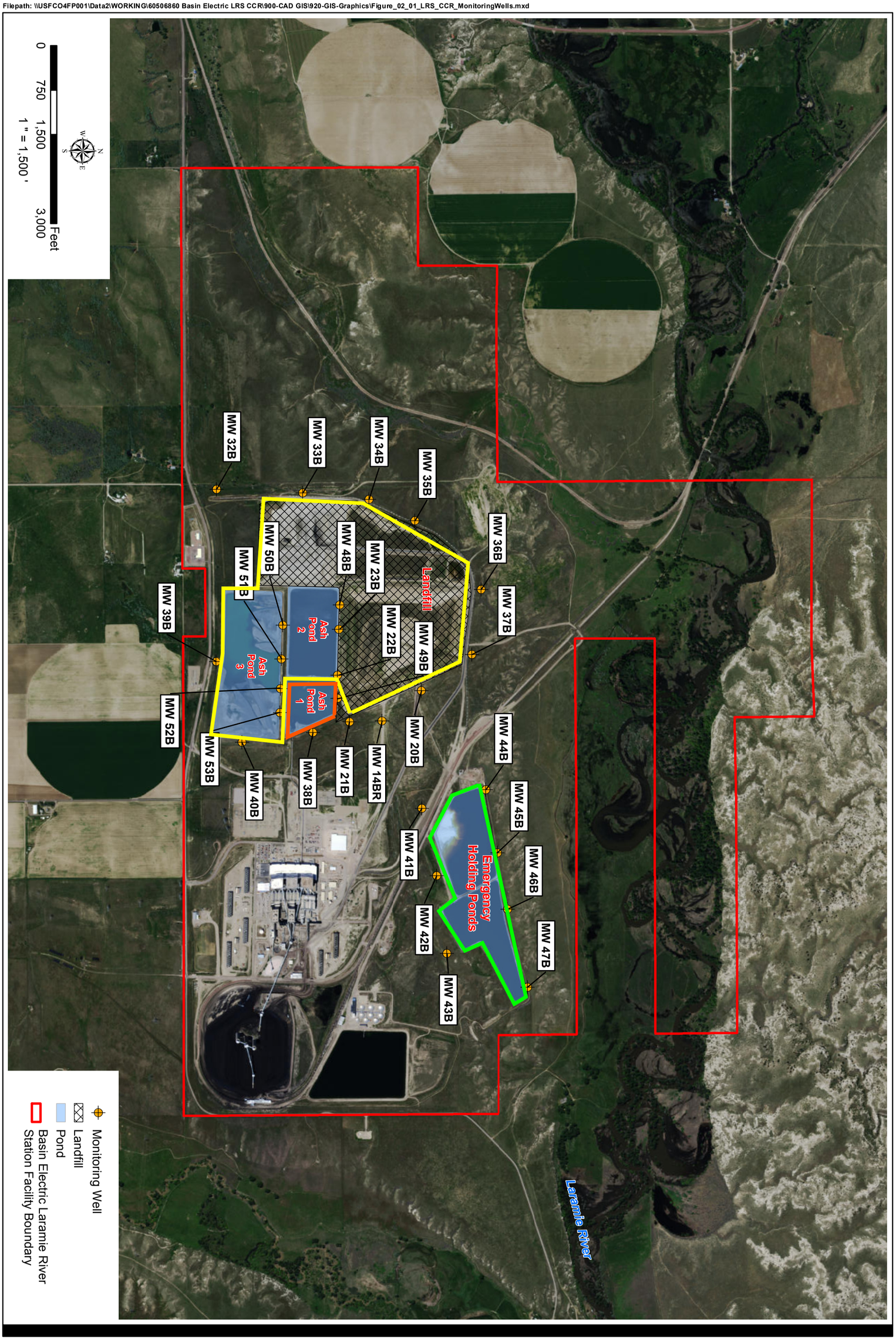

Basin Electric
Laramie River Station
Platte County, Wyoming
Project No.: 60506860 Date: 9/13/2017

Monitoring Wells

AECOM

Figure: 4-1

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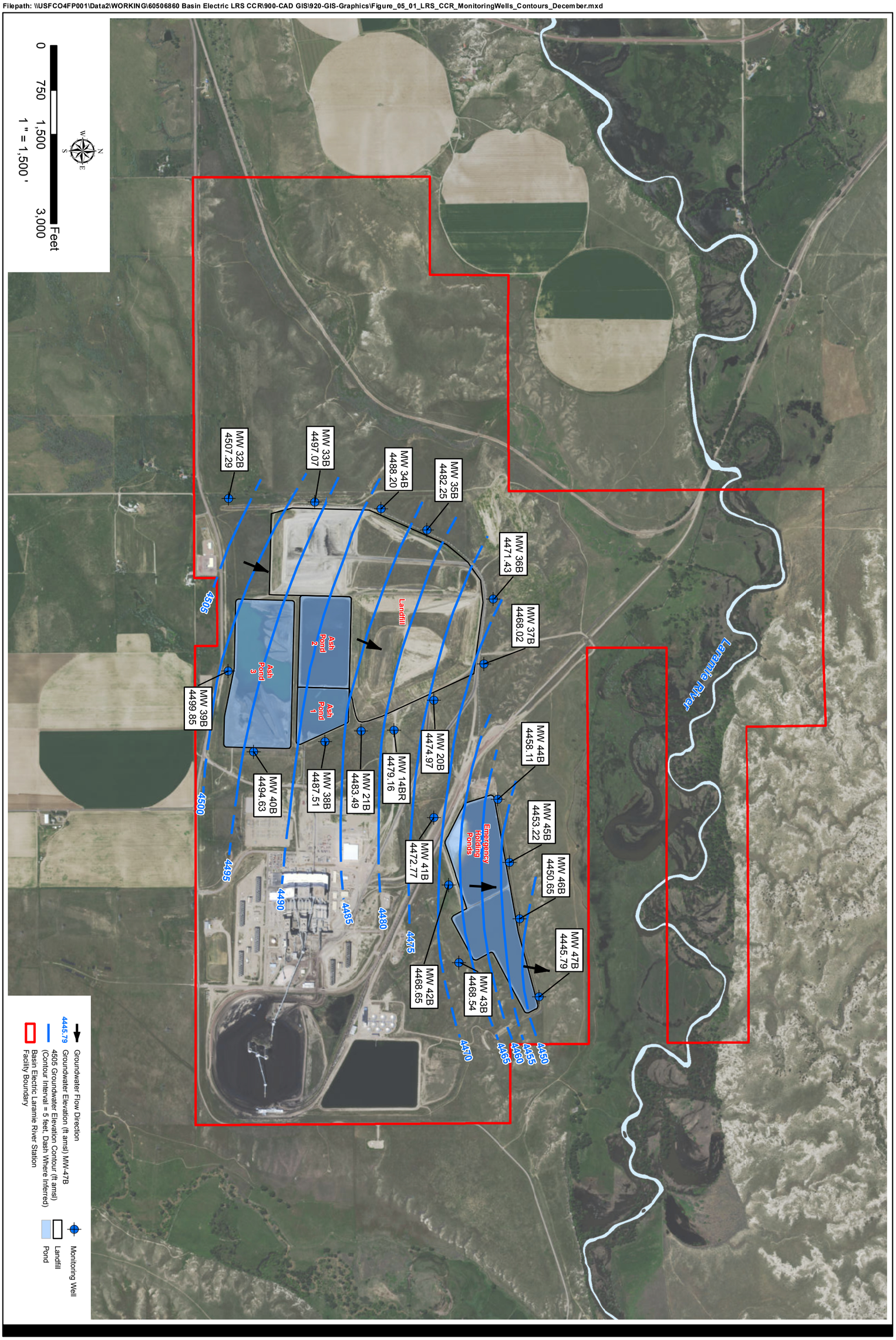

Basin Electric
Laramie River Station
Platte County, Wyoming
Project No.: 60506860 Date: 1/31/2017

Potentiometric Surface Map
December 14, 2016

Figure: 5-1

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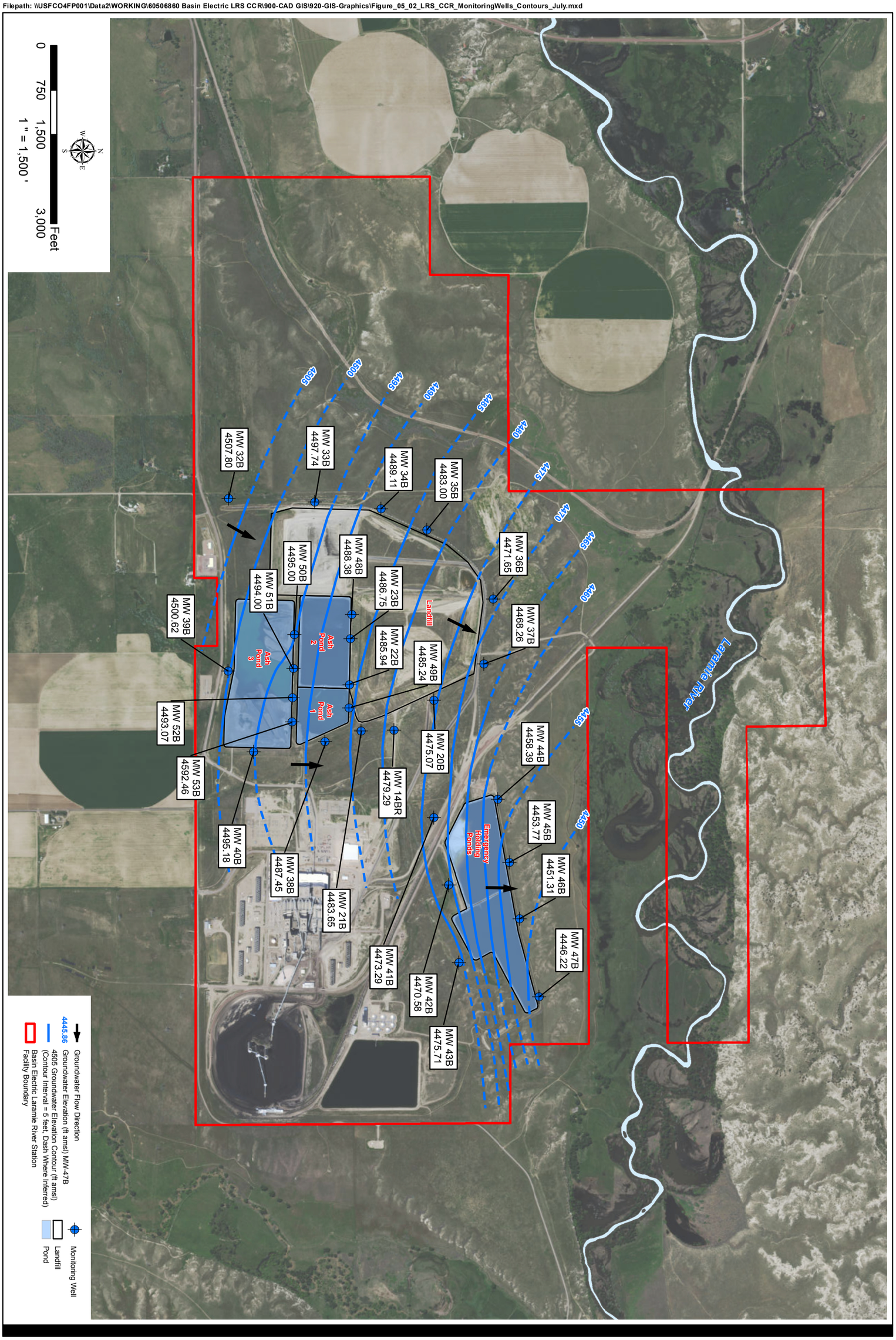

Basin Electric
Laramie River Station
Platte County, Wyoming
Project No.: 60506860 Date: 10/5/2017

Potentiometric Surface Map
July 19-27, 2017

AECOM

Figure: 5-2

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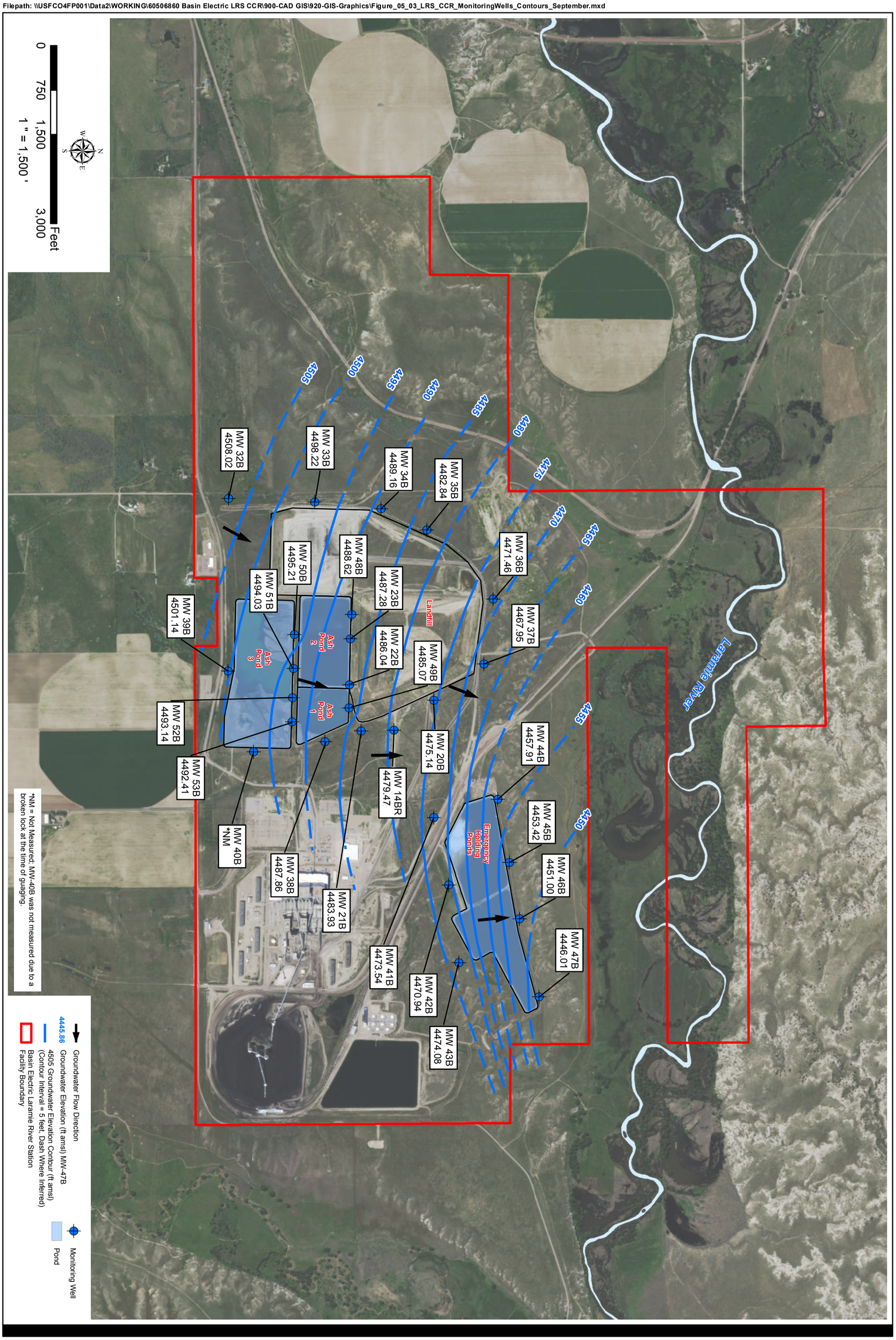

Basin Electric
Laramie River Station
Platte County, Wyoming
Project No.: 60506860 Date: 10/4/2017

Potentiometric Surface Map
September 18-19, 2017

AECOM
Figure: 5-3

Tables

Table 4-1 Monitoring Well Construction Details

Well Name	Year of Construction	State Plane WY East Zone Coordinates		Top of Casing Elevation (ft amsl)	Ground Surface Elevation (ft amsl)	Total Depth (ft bgs)	Well Screen Interval (ft bgs)	Well Screen Lithology
		Northing	Easting					
Ash Ponds/Landfill								
MW-14BR	2001	587906.6	730355.4	4537.90	4534.53	72.0	62-72	Silty Sandstone
MW-20B	1982	587906.6	729846.4	4535.47	4534.41	73.0	43.3-73	Silty Sandstone
MW-21B	1982	587358.2	730371.0	4539.58	4538.54	80.0	39.3-79	Sandstone
MW-22B	1982	587159.1	729587.2	4569.21	4565.87	96.0	66.3-96	Sandstone
MW-23B	1982	587179.9	728811.2	4569.11	4565.07	90.0	60.2-90	Silty Sandstone
MW-32B	2016	585117.1	726449.5	4567.11	4564.93	75.0	55-75	Sand with Silt
MW-39B	2016	585111.6	729357.3	4581.45	4579.36	109.3	89.3-109.3	Sand with Silt
MW-33B	2016	586570.9	726509.5	4566.61	4564.30	89.0	65-85	Sand with Silt
MW-34B	2016	587689.7	726621.3	4554.72	4552.15	89.0	66-86	Sand with Silt
MW-35B	2016	588465.4	726979.2	4548.67	4546.19	90.0	66-86	Silty Sand
MW-36B	2016	589573.8	728145.6	4532.44	4530.26	79.0	58-78	Sand with Silt
MW-37B	2016	589424.0	729236.4	4530.37	4528.08	79.0	57.5-77.5	Sand with Silt
MW-38B	2016	586742.1	730549.7	4547.48	4544.70	88.0	55-75	Sand with Silt
MW-40B	2016	585540.5	730716.8	4589.59	4587.40	108.0	87.9-107.9	Sand with Silt
MW-48B	2017	587197.1	728402.3	4571.27	NM	100.0	80-100	Sand with Silt
MW-49B	2017	587153.4	729978.4	4566.97	NM	100.0	80-100	Sand and Sandstone
MW-50B	2017	586231.9	728742.5	4590.95	NM	120.0	100-120	Sand with Silt
MW-51B	2017	586215.1	729312.9	4591.51	NM	120.0	100-120	Sand with Silt
MW-52B	2017	586198.0	729809.7	4592.21	NM	125.0	104.6-124.6	Sand with Silt
MW-53B	2017	586189.0	730213.8	4591.84	NM	120.0	100-120	Sandstone
Emergency Holding Ponds								
MW-41B	2016	588577.1	731829.2	4529.64	4527.38	79.0	53-73	Sand with Silt
MW-42B	2016	588829.6	732965.3	4515.83	4513.30	69.0	48.5-68.5	Sand with Silt
MW-43B	2016	589002.8	734274.6	4498.00	4501.44	79.0	58.5-78.5	Sand with Silt
MW-44B	2016	589659.8	731518.4	4529.39	4527.32	99.0	72.1-92.1	Sand with Silt
MW-45B	2016	589851.3	732581.2	4530.92	4528.66	89.0	69-89	Silty Sand
MW-46B	2016	590022.2	733532.2	4527.72	4525.33	94.0	73-93	Sand with Silt
MW-47B	2016	590358.4	734848.3	4522.60	4520.43	89.0	69-89	Silty Sand

Notes:
ft amsl = feet above mean sea level
ft bgs = feet below ground surface
NM = not measured

Table 4-2 Aquifer Test Results

Well ID	Test Type	Aquifer Thickness (ft)	Hydraulic Conductivity (ft)	Transmissitivty (ft^2/d)
MW-33B	Slug In	16.36	3.11	50.88
	Slug Out		2.27	37.14
MW-35B	Slug In	19.96	3.50	69.86
	Slug Out		1.72	34.33
MW-37B	Slug In	16.14	6.04	97.49
	Slug Out		6.28	101.36
MW-38B	Slug In	15.83	0.99	15.67
	Slug Out		1.09	17.25
MW-39B	Slug In	25.17	0.45	11.33
	Slug Out		0.55	13.84
MW-42B	Slug In	21.62	1.23	26.59
	Slug Out		1.28	27.67
MW-45B	Slug In	12.80	1.27	16.26
	Slug Out		2.35	30.08
MW-47B	Slug In	12.53	1.11	13.91
	Slug Out		1.36	17.04
MW-32B	Pumping	12.59	1.29	16.21
MW-34B	Pumping	16.62	0.65	10.88
MW-36B	Pumping	14.97	2.42	36.22
MW-40B	Pumping	11.39	0.79	8.99
MW-41B	Pumping	15.02	3.12	46.84
MW-43B	Pumping	20.00	0.75	14.90
MW-44B	Pumping	19.69	1.40	27.59
MW-46B	Pumping	17.10	0.76	13.00

Table 5-1 Groundwater Elevations - December 14, 2016

Location ID	TOC Elevation (feet amsl)	Depth To Water (feet)	Water Level Elevation (feet amsl)
MW-14BR	4537.90	58.74	4479.16
MW-20B	4535.47	60.50	4474.97
MW-21B	4539.58	56.09	4483.49
MW-32B	4567.106	59.82	4507.29
MW-33B	4566.607	69.54	4497.07
MW-34B	4554.720	66.52	4488.20
MW-35B	4548.665	66.42	4482.25
MW-36B	4532.438	61.01	4471.43
MW-37B	4530.367	62.35	4468.02
MW-38B	4547.479	59.97	4487.51
MW-39B	4581.452	81.60	4499.85
MW-40B	4589.593	94.96	4494.63
MW-41B	4529.637	56.87	4472.77
MW-42B	4515.831	47.18	4468.65
MW-43B	4501.444	32.90	4468.54
MW-44B	4529.389	71.28	4458.11
MW-45B	4530.921	77.70	4453.22
MW-46B	4527.717	77.07	4450.65
MW-47B	4522.595	76.81	4445.79

Notes:
TOC = top of casing
amsl = above mean sea level

Table 5-2 Groundwater Elevations - July 19-27, 2017

Location ID	Date	TOC Elevation (feet amsl)	Depth To Water (feet)	Water Level Elevation (feet amsl)
MW-14BR	07/26/17	4537.90	58.61	4479.29
MW-20B	07/26/17	4535.47	60.40	4475.07
MW-21B	07/26/17	4539.58	55.93	4483.65
MW-22B	07/20/17	4569.21	83.27	4485.94
MW-23B	07/20/17	4569.11	82.36	4486.75
MW-32B	07/26/17	4567.106	59.31	4507.80
MW-33B	07/26/17	4566.607	68.87	4497.74
MW-34B	07/26/17	4554.720	65.61	4489.11
MW-35B	07/26/17	4548.665	65.67	4483.00
MW-36B	07/26/17	4532.438	60.79	4471.65
MW-37B	07/26/17	4530.367	62.11	4468.26
MW-38B	07/26/17	4547.479	60.03	4487.45
MW-39B	07/26/17	4581.452	80.83	4500.62
MW-40B	07/26/17	4589.593	94.41	4495.18
MW-41B	07/26/17	4529.637	56.35	4473.29
MW-42B	07/27/17	4515.831	45.25	4470.58
MW-43B	07/26/17	4501.444	25.73	4475.71
MW-44B	07/27/17	4529.389	71.00	4458.39
MW-45B	07/27/17	4530.921	77.15	4453.77
MW-46B	07/27/17	4527.717	76.41	4451.31
MW-47B	07/27/17	4522.595	76.38	4446.22
MW-48B	07/20/17	4568.663	80.28	4488.38
MW-49B	07/20/17	4564.355	79.12	4485.24
MW-50B	07/19/17	4588.343	93.34	4495.00
MW-51B	07/19/17	4588.898	94.90	4494.00
MW-52B	07/19/17	4589.595	96.53	4493.07
MW-53B	07/19/17	4589.231	96.77	4492.46

Notes:
TOC = top of casing
amsl = above mean sea level

Table 5-3 Groundwater Elevations - September 18-19, 2017

Location ID	Date	TOC Elevation (feet amsl)	Depth To Water (feet)	Water Level Elevation (feet amsl)
MW-14BR	9/19/2017	4537.90	58.43	4479.47
MW-20B	9/19/2017	4535.47	60.33	4475.14
MW-21B	9/19/2017	4539.58	55.65	4483.93
MW-22B	9/19/2017	4569.205	83.17	4486.04
MW-23B	9/19/2017	4569.481	82.20	4487.28
MW-32B	9/19/2017	4567.106	59.09	4508.02
MW-33B	9/19/2017	4566.607	68.39	4498.22
MW-34B	9/19/2017	4554.720	65.56	4489.16
MW-35B	9/19/2017	4548.665	65.83	4482.84
MW-36B	9/19/2017	4532.438	60.98	4471.46
MW-37B	9/19/2017	4530.367	62.42	4467.95
MW-38B	9/19/2017	4547.479	59.62	4487.86
MW-39B	9/19/2017	4581.452	80.31	4501.14
MW-40B	9/19/2017	4589.593	NM	NM
MW-41B	9/19/2017	4529.637	56.10	4473.54
MW-42B	9/19/2017	4515.831	44.89	4470.94
MW-43B	9/19/2017	4501.444	27.36	4474.08
MW-44B	9/19/2017	4529.389	71.48	4457.91
MW-45B	9/19/2017	4530.921	77.50	4453.42
MW-46B	9/19/2017	4527.717	76.72	4451.00
MW-47B	9/19/2017	4522.595	76.59	4446.01
MW-48B	9/19/2017	4568.663	80.04	4488.62
MW-49B	9/19/2017	4564.355	79.29	4485.07
MW-50B	9/19/2017	4588.343	93.13	4495.21
MW-51B	9/18/2017	4588.898	94.87	4494.03
MW-52B	9/18/2017	4589.595	96.46	4493.14
MW-53B	9/18/2017	4589.231	96.82	4492.41

Notes:

TOC = top of casing

amsl = above mean sea level

NM = Not Measured; MW-40B lock was jammed at the time of gauging

Table 6-1 Proposed Statistical Methods for Appendix III Constituents in Background Wells

CCR Unit/Multi-unit	Background Wells	Statistical Method	Constituents
Ash Pond 1	MW-52B, MW-53B	Parametric Prediction Interval	Boron, Calcium, Fluoride, pH
	MW-52B, MW-53B	Nonparametric Prediction Interval	Chloride, Sulfate, Total Dissolved Solids
Ash Pond 2, Ash Pond 3, Ash Landfill Multi-unit	MW-32B, MW-39B	Parametric Prediction Interval	Boron, Calcium, Fluoride, pH
	MW-32B, MW-39B	Nonparametric Prediction Interval	Chloride, Sulfate, Total Dissolved Solids
Emergency Holding Ponds Multi-unit	MW-41B, MW-42B, MW-43B	Parametric Prediction Interval	Calcium
	MW-41B, MW-42B, MW-43B	Nonparametric Prediction Interval	Boron, Chloride, Fluoride, pH, Sulfate, Total Dissolved Solids

Appendix A

Boring Logs and Well Construction Diagrams

AECOM

WELL NUMBER MW-32B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 7/19/2016 **COMPLETED** 7/20/2016 **GROUND ELEVATION** 4564.93 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic **AT TIME OF DRILLING** ---

LOGGED BY Matt Hartz **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 4567.106 N 4564.93 E **12hrs AFTER DRILLING** 58.35 ft / Elev 4506.58 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						Hand potholed until 6' bgs
	N/A	0				
5						
						6.0 4558.9
	SONIC 1	100		SW		SAND, very fine to coarse-grained, some silt, some gravel and pebble, lightly weathered to weathered; loose, dry, light gray-brown Minerology consists primarily of granite clasts (qtz, k-spar, lithies)
10						
	SONIC 2	100				13.0 4551.9
15				SW		S.A.A., moist
20						

Casing Top Elev: 2.176 (ft)
Casing Type: 2" PVC Pipe

WELL DIAGRAM

Top of Casing (2.176' ags)

Grout (0' - 47' bgs)

PVC Pipe (2.176' ags - 75' bgs)

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:00 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
20				SW		20.5 4544.4 SAND, very fine to fine-grained, subround, some silt, massive/no apparent bedding; firm to stiff, predominantly dry with moist intervals (typically on top of SS Caliche horizons), light brown	
25	SONIC 3	100		SP		@28-29' bgs: light gray SS Caliche, hard, well cemented	Grout (0' - 47' bgs)
30	SONIC 4	100				@30-33' bgs: intervals of very stiff (nearly SS), intervals contained calcium carbonate stringers and nodules (cemented sands)	PVC Pipe (2.176' ags - 75' bgs)
35	SONIC 5	100	SANDSTONE			33.0 4531.9 SANDSTONE, very fine to fine-grained, some silt, well indurated, laminae of Caliche silts and clays, interbeds of dense unconsolidated sands (same as 30-33' bgs interval); hard, moist, light gray-brown	
40	SONIC 6	100		SP		38.0 4526.9 SAND, very fine to fine-grained, subround, some silt, trace clay, very thin beds (appear as chips in core) of calcareous, cemented sands; loose, dry to moist, light gray-brown @39-42' bgs: color change from light gray-brown to brown	

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:00 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
45	SONIC 7	100		SP		SAND, poorly graded, subround, some silt, trace clay, very thin beds (appear as chips in core) of calcareous, cemented sands; loose, dry to moist, brown @43-49' bgs: dry
50	SONIC 8	100				@49-56' bgs: moist
55	SONIC 9	100				@56.5-57.5' bgs: 1' of SS Caliche, well cemented; very dense, moist on top and bottom of interval @59-60' bgs: wet to saturated
60	SONIC 10	100				
65						

WELL DIAGRAM

- Grout (0' - 47' bgs)
- PVC Pipe (2.176' ags - 75' bgs)
- 3/8" Bentonite Chips (47' - 52' bgs)
- 10/20 Silica Sandpack (52' - 75' bgs)
- 0.010 Slotted Pipe (55' - 75' bgs)

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:00 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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AECOM

WELL NUMBER MW-32B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
	SONIC 11	100		SP		SAND, poorly graded, subround, some silt, trace clay, very thin beds (appear as chips in core) of calcareous, cemented sands; loose, wet to saturated, brown	10/20 Silica Sandpack (52' - 75' bgs)
70							0.010 Slotted Pipe (55' - 75' bgs)
	SONIC 12	100				@71-75' bgs: medium-grained sand, interbedded zones (<6"); saturated	
75						75.0 4489.9 Bottom of borehole at 75.0 feet.	Total Depth of Well 75' bgs

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:01 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

WELL NUMBER MW-33B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 7/20/2016 **COMPLETED** 7/20/2016 **GROUND ELEVATION** 4579.362 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic **AT TIME OF DRILLING** ---

LOGGED BY Matt Hartz **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 4566.607 N 4564.303 E **AFTER DRILLING** 68.21 ft / Elev 4511.15 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0						Hand potholed until 6' bgs	Casing Top Elev: 2.304 (ft) Casing Type: 2" PVC Pipe Top of Casing (2.304' ags)
5	N/A	0					
	SONIC 1	100				6.0 4573.4 SILTY SAND, very fine to medium-grained, subround to subangular, some gravel and pebbles, lightly weathered; loose, dry Pebbles consist primarily of granite clasts; sand composed of weathered granite fragments	
10	SONIC 2	100		SM			Grout (0' - 57.7' bgs) PVC Pipe (2.304' ags - 85' bgs)
15	SONIC 3	100		SP		15.0 4564.4 SAND, fine to medium-grained, subround, some silt, lenses (<1") of coarse-grained sand, lightly to moderately weathered; loose, dry to moist, brown	
20	SONIC 4	100		SP		21.0 4558.4 SAND, very fine to fine-grained, subround, some silt, unweathered, laminae or concretions (<.5") of calcium carbonate, trace small (5 mm) clasts of clay and SS Caliche; firm to stiff, moist, brown	
25							

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:01 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
25	SONIC 5	100		SP		SAND, very fine to fine-grained, subround, some silt, unweathered, laminae or concretions (<.5") of calcium carbonate, trace small (5 mm) clasts of clay and SS Caliche; firm to stiff, moist, brown	
30	SONIC 6	100		CALICHE		31.0 4548.4 CALICHE SAND, very fine to fine-grained, well cemented, well indurated, calcarious; very hard, dry, light gray to white	Grout (0' - 57.7' bgs)
35	SONIC 7	100		SP		35.5 4543.9 SAND, poorly graded, subround, some silt, trace clay, no apparent bedding but tends to break along irregular planes (horizontal), small pockets of weathered silt and sand; loose to firm, dry, brown	PVC Pipe (2.304' ags - 85' bgs)
40	SONIC 8	100		SP		40.0 4539.4 SAND, poorly graded, subround, some silt, trace clay, no apparent bedding but tends to break along irregular planes (horizontal), small pockets of weathered silt and sand; loose to firm, dry, brown @43' bgs: moist on top of thin Caliche interbed (<1") @44-47' bgs: interbeds of uncemented, well indurated SS (same description as formation interbeds, no thicker than 1"); hard	
45	SONIC 9	100		SP			
50	SONIC 10	100		SP		@53-54' bgs: Caliche SS, well cemented and indurated; very hard, light gray	

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:01 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
55	SONIC 11	100		SP		SAND, poorly graded, subround, some silt, trace clay, no apparent bedding but tends to break along irregular planes (horizontal), small pockets of weathered silt and sand; loose to firm, dry, brown @55-58' bgs: increase in SS interbeds (not Caliche), well indurated; hard, brown	Grout (0' - 57.7' bgs) PVC Pipe (2.304' ags - 85' bgs)
60	SONIC 12	80				60.0 4519.4 SAND, poorly graded, subround, some silt, contains thin beds (<2") of SS and zones (1" - 1' thick) of SS Caliche; loose, dry to moist @63-64' bgs: just below a Caliche horizon, moist @64-69' bgs: firm, moist	3/8" Bentonite Chips (55.4' - 61.5' bgs)
65	SONIC 13	100				@69-77.5' bgs: wet to saturated (moisture decreases just below 77.5' bgs)	10/20 Silica Sandpack (62' - 85' bgs)
70	SONIC 14	100		SP			0.010 Slotted Pipe (65' - 85' bgs)
75						@79-89' bgs: wet	
80							

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:01 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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AECOM

WELL NUMBER MW-33B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
85	SONIC 15	100		SP		SAND, poorly graded, subround, some silt, contains thin beds (<2") of SS and zones (1" - 1' thick) of SS Caliche; loose, wet	10/20 Silica Sandpack (62' - 85' bgs) 0.010 Slotted Pipe (65' - 85' bgs) Total Depth of Well 85' bgs Native Clay Below Well - Natural Collapse
						89.0 4490.4	

Bottom of borehole at 89.0 feet.

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:01 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-34B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 7/24/2016 **COMPLETED** 7/24/2016 **GROUND ELEVATION** 4564.303 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic **AT TIME OF DRILLING** ---

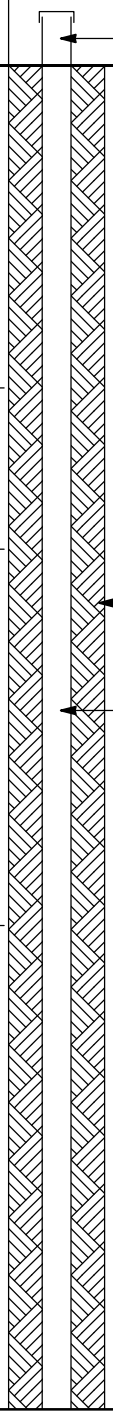
LOGGED BY Matt Hartz **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 4554.72 N 4552.152 E **AFTER DRILLING** 68.71 ft / Elev 4495.59 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						Hand potholed until 6' bgs
5	N/A	0				
						6.0 4558.3
	SONIC 1	100		SP		SAND, very fine to fine-grained, subround, some silt, trace gravel and pebbles; loose, dry, light brown
						9.0 4555.3
10						FILL, sand, gravel, pebbles, and cobbles, angular to subangular; loose, dry, light gray
	SONIC 2	100		FILL		
15	SONIC 3	100				
						16.0 4548.3
						SAND, very fine to fine-grained, subround, some silt, no apparent bedding, interbedded SS (<1"), unweathered; loose to firm and firm to stiff at depth, dry, light brown @17-18' bgs: silt interbed, light gray
20	SONIC 4	100		SP		
25						@24-25.5' bgs: slight moisture increase just above SS interbed (perched, not holding significant water year-round)

Casing Top Elev: 2.568 (ft)
Casing Type: 2" PVC Pipe

WELL DIAGRAM



LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:02 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
25	SONIC 5	100		SP		SAND, very fine to fine-grained, subround, some silt, no apparent bedding, interbedded SS (<1"), unweathered; loose to firm and firm to stiff at depth, dry, light brown	
30	SONIC 6	100				@30-36' bgs: SS beds increase in frequency; firm to stiff	
35	SONIC 7	100					Grout (0' - 55.4' bgs); PVC Pipe (2.568' ags - 86' bgs)
40	SONIC 8	100				@39-44' bgs: moisture content increases above stiff sand interval	
45	SONIC 9	100				@46-50' bgs: thin SS interbed above zone of saturation; wet to saturated	
50	SONIC 10	100				@53-54' bgs: SS intebed, cemented, possibly Caliche; hard, dry, light gray	

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
				SP		54.0 4510.3 SAND, fine-grained, subround, some silt, no SS beds; loose, moist, light brown to brown	Grout (0' - 55.4' bgs) PVC Pipe (2.568' ags - 86' bgs)
55	SONIC 11	100		SP			
60	SONIC 12	80				60.0 4504.3 SAND, fine-grained, subround, some silt, no SS beds; loose, moist, light brown to brown tends to break along irregular bedding planes (<1")	3/8" Bentonite Chips (55.4' - 61.5' bgs)
65	SONIC 13	100					
70	SONIC 14	100		SP		▼ @69-79' bgs: lightly weathered between bedding panes; zones of saturation @74-76' bgs: laminae of well compacted, dense, stiff SS	10/20 Silica Sandpack (61.5' - 86.1' bgs) 0.010 Slotted Pipe (66' - 86' bgs)
75	SONIC 15	100				@79-89' bgs: saturated	
80							

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:02 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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AECOM

WELL NUMBER MW-34B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
85	SONIC 16	100		SP		SAND, fine-grained, subround, some silt, no SS beds; loose, saturated, light brown to brown tends to break along irregular bedding planes (<1")	10/20 Silica Sandpack (61.5' - 86.1' bgs) 0.010 Slotted Pipe (66' - 86' bgs) Total Depth of Well 86' bgs Native Clay Below Well - Natural Collapse
						89.0 4475.3	

Bottom of borehole at 89.0 feet.

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:02 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-35B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 7/31/2016 **COMPLETED** 8/1/2016 **GROUND ELEVATION** 4552.152 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic **AT TIME OF DRILLING** ---

LOGGED BY Chris Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 4548.665 N 4546.185 E **AFTER DRILLING** 63.70 ft / Elev 4488.45 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0							Casing Top Elev: 2.48 (ft) Casing Type: 2" PVC Pipe Top of Casing (2.480' ags)
	N/A	0				Hand potholed until 6' bgs	
5						6.0 4546.2	
	SONIC 1	100		SP-GP		SAND, poorly graded, with subangular gravel, trace fines, no odor or staining; very loose, moist, brown (10YR 5/5)	
						9.0 4543.2	
10	SONIC 2	75		SP-GP		S.A.A., round gravel	Grout (0' - 59.5' bgs)
						11.0 4541.2	
	SONIC 3	80		SP-GP		SAND, poorly graded, with subangular gravel and pebbles, little fines, no odor or staining; very loose, moist, light brownish gray (10YR 6/2)	PVC Pipe (2.480' ags - 86' bgs)
						14.4 4537.8	
15				SP		15.1 4537.1 SAND, very fine to fine-grained, traces fines and gravel; very loose, dry, light gray (10YR 7/1)	
	SONIC 4	76		SW		SAND, very fine to coarse-grained, little subangular gravel, trace fines; very loose, moist, light gray (10YR 7/1) @16.9-17.8' bgs: increasing fines, little silt	
						19.0 4533.2	
20				SM		SILTY SAND, very fine to fine-grained, noncohesive, no odor or staining; very loose, moist, grayish brown (10YR 5/2)	
						20.4 4531.8	
	SONIC 5	100		ML		SILT, with dark gray, fractured, blocky claystone (1"), trace sand, no odor or staining; soft, moist (sticky when wet), light gray	
						24.0 4528.2	
25				ML		SILT, noncohesive, nonplastic, no oxidation or staining or odor; very soft, moist, pale brown (10YR 6/3)	

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:41 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
25								
	SONIC 6	100		ML		SILT, noncohesive, nonplastic, no oxidation or staining or odor; very soft, moist, pale brown (10YR 6/3)		
						27.0	4525.2	
				ML		SILT, trace very fine sand, noncohesive, nonplastic, no oxidation or staining or odor, blocky sturctures (1") that break in hand; very stiff, moist, dark gray (10YR 4/1)		
30						30.0	4522.2	
	SONIC 7	100		SM		SILTY SAND, very fine to fine-grained, slow dilatancy, no odor or staining; soft, wet, dark yellowish brown @30-35' bgs: perched aquifer		
						34.7	4517.5	Grout (0' - 59.5' bgs)
35			SANDSTONE			35.0	4517.2	
						SANDSTONE, no odor or staining; hard, dry		
				ML		SANDY SILT, with gravel, slow dilatancy, noncohesive, nonplastic, no odor or staining; very soft, wet, gray (10YR 5/1)		
						36.2	4516.0	PVC Pipe (2.480' ags - 86' bgs)
	SONIC 8	100		ML		SILT, with gravel (15% subangular standstone), noncohesive, nonplastic; loose, dry, white (10YR 6/1)		
						38.3	4513.9	
				SP		SAND, poorly graded, little fines, with thinnly bedded sandstone lenses (.5"-1"), no odor or staining; loose, dry, pale brown (10YR 6/3)		
						39.0	4513.2	
40				SM		SILTY SAND, very fine to fine-grained, slow dilatancy, no odor or staining; medium dense, wet (perched aquifer), brown (10YR 5/3)		
	SONIC 9	100				41.5	4510.7	
				SM		S.A.A., 10% of 3/4"-1" blocky sandstone; moist, light gray (10YR 7/2)		
						44.0	4508.2	
45				SP-SM		SAND, very fine to fine-grained, with silt, with 3/4"-1" hard sandstone, no odor or staining; loose, moist, brown		
						46.1	4506.1	
	SONIC 10	100		SM		46.4	4505.8	
						SILTY SAND, very fine to fine-grained; very hard, moist, dark gray		
				SP		SAND, very fine to fine-grained, with silt, with 3/4"-1" hard sandstone, no odor or staining; loose, moist, brown @49-50.1' bgs: 1" hard fragments of sandstone; wet (due to drilling waters)		
50								
	SONIC 11	94						

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:41 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
				SP		54.0	4498.2	
55	SONIC 12	100		SP		SAND, very fine to fine-grained, with silt, no odor or staining; medium dense, wet, yellowish brown (10YR 5/4), mottled dark gray (10YR 4/1)		Grout (0' - 59.5' bgs)
						55.7	4496.5	
				SP		SAND, very fine to fine-grained; medium dense, moist, light brownish gray (10YR 6/1)		
						57.1	4495.1	PVC Pipe (2.480' ags - 86' bgs)
				ML		SANDY SILT, slow dilatancy, noncohesive, nonplastic; soft, wet, grayish brown, mottled very dark gray (10YR 5/1)		
						58.0	4494.2	
				SM		SILTY SAND, very fine to fine-grained; medium dense, wet, grayish brown (10YR 5/2)		
60						60.5	4491.7	
	SONIC 13	70		SM		S.A.A., soft, decreasing in moisture		3/8" Bentonite Chips (59.5' - 64' bgs)
						64.0 ▼	4488.2	
				SP-SM		SAND, very fine to fine-grained, with silt; soft, wet, brown (10YR 5/3)		
65						65.7	4486.5	
	SONIC 14	100	4.0	SILTSTONE		SILTSTONE, massive, blocky; hard, moist, brown (10YR 4/3)		
						67.0	4485.2	
				SILTSTONE		S.A.A., brown (10YR 5/3)		10/20 Silica Sandpack (64' - 86' bgs)
70						71.0	4481.2	
	SONIC 15	100	2.0	SM		SILTY SAND; stiff, moist, brown		
						72.0	4480.2	0.010 Slotted Pipe (66' - 86' bgs)
				SANDSTONE		72.5 SANDSTONE, some hard sand; loose, white and tan	4479.7	
				SM		SILTY SAND, very fine to fine-grained; medium dense, moist, brown		
						74.0	4478.2	
				SM		S.A.A., moist		
75						75.0	4477.2	
	SONIC 16	100		SM		SILTY SAND, very fine to fine-grained, slow dilatancy; soft, wet, brown		
						77.0	4475.2	
				SM		S.A.A., medium dense, moist		
			>4.0			78.3	4473.9	
				SM		S.A.A., stiff		
						79.0	4473.2	
80				ML		SANDY SILT, noncohesive, nonplastic, massive, slow dilatancy; very soft, wet, grayish brown		
	SONIC 17	74						

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:41 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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AECOM

WELL NUMBER MW-35B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
85				ML		SANDY SILT, noncohesive, nonplastic, massive, slow dilatancy; very soft, wet, grayish brown	10/20 Silica Sandpack (64' - 86' bgs)
	SONIC 18	75					0.010 Slotted Pipe (66' - 86' bgs)
						85.5 4466.7	
				SM		SILTY SAND, very fine to fine-grained, slow dilatancy, no odor or staining; loose, wet, brown Note: drillers drilled to 89', but all of it fell back into the hole because outer casing was not used.	Total Depth of Well 86' bgs
90						90.0 4462.2	Native Clay Below Well - Natural Collapse

Bottom of borehole at 90.0 feet.

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:41 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-36B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 8/1/2016 **COMPLETED** 8/2/2016 **GROUND ELEVATION** 4546.185 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic ▽ **AT TIME OF DRILLING** 35.96 ft / Elev 4510.23 ft

LOGGED BY Chris Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 4532.438 N 4530.256 E ▼ **AFTER DRILLING** 59.35 ft / Elev 4486.84 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0							Casing Top Elev: 2.182 (ft) Casing Type: 2" PVC Pipe Top of Casing (2.182' ags)
	N/A	0				Hand potholed until 5' bgs	
5						5.0 / 4541.2	
	SONIC 1	100		SW-GP		SAND, fine to coarse-grained, with gravel, no odor or staining; loose, moist brown	
						9.0 / 4537.2	Grout (0' - 51.5' bgs)
10	SONIC 2	100		SW-GP		S.A.A., increasing gravel content, subround; too hot for sleeves	PVC Pipe (2.182' ags - 78' bgs)
						14.0 / 4532.2	
15	SONIC 3	96		SM		SILTY SAND, very fine to fine-grained, no odor or staining; loose, moist, brown (10YR 5/3)	
						17.8 / 4528.4	
				GP		GRAVEL, poorly graded, subround (1-2"), little clay, little sand, no odor or staining; loose, moist to wet, brown	
						19.0 / 4527.2	
20				SM		SILTY SAND, very fine to fine-grained, trace gravel, no odor or staining; loose, moist, brown (10YR 5/3)	

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:03 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
20								
	SONIC 4	94		SM		SILTY SAND, very fine to fine-grained, trace gravel, no odor or staining; loose, moist, brown (10YR 5/3)		
						24.0	4522.2	
25	SONIC 5	98		SM		S.A.A., little gravel		
						29.0	4517.2	Grout (0' - 51.5' bgs)
30	SONIC 6	100		ML		SANDY SILT, noncohesive, nonplastic, blocky, no staining; very soft, moist, dark grayish brown (10YR 4/2)		PVC Pipe (2.182' ags - 78' bgs)
						32.0	4514.2	
			SANDSTONE			SANDSTONE, broken; dry to moist, white and tan		
						32.8	4513.4	
				SM		SILTY SAND, very fine to fine-grained, little gravel, no odor or staining; medium dense, moist, pale brown (10YR 6/3)		
						34.0	4512.2	
35	SONIC 7	100	0.75	ML		SANDY SILT, noncohesive, nonplastic, massive; medium dense, moist, brown (10YR 4/3)		
						35.2	4511.0	
				SM		SILTY SAND, very fine to fine-grained, no odor or staining; loose, moist, brown		
						37.2	4509.0	
				ML		37.4	4508.8	SILT, with sand, trace gravel, noncohesive, nonplastic, no odor or staining; soft, wet, brown
			SANDSTONE			SANDSTONE, with wet silt in between bedding, noncohesive, nonplastic; hard, moist to wet, brownish gray		
						39.0	4507.2	
				ML		SILT, noncohesive, nonplastic, blocky, no oxidation; hard, moist, brown		
40						40.0	4506.2	
	SONIC 8	69		SM		SILTY SAND, very fine to fine-grained, trace gravel; hard, moist, brown		

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:03 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
				SM		SILTY SAND, very fine to fine-grained, trace gravel; hard, moist, brown		
						44.0	4502.2	
45	SONIC 9	100		SM		S.A.A., increasing in moisture		Grout (0' - 51.5' bgs)
								PVC Pipe (2.182' ags - 78' bgs)
						49.0	4497.2	
50	SONIC 10	100	2.5	SP-SM		SAND, very fine to fine-grained, with silt, no odor or staining; very stiff, moist, grayish brown (10YR 5/2)		
						50.7	4495.5	
			>4.0	SP-SM		S.A.A., loose, pale brown (10YR 4/3)		
						53.0	4493.2	
				SP-SM		S.A.A., blocky; hard, grayish brown (10YR 5/2)		3/8" Bentonite Chips (51.5' - 56' bgs)
55	SONIC 11	0		SP-SM		55.7	4490.5	
						SAND, very fine to fine-grained, with silt; moist, light brown @57.6' bgs: increasing in moisture and fines		
						59.0	4487.2	10/20 Silica Sandpack (56' - 78' bgs)
60	SONIC 12	100		SP-SM		SAND, very fine to fine-grained, with silt; soft, wet, yellowish brown		0.010 Slotted Pipe (58' - 78' bgs)
						61.3	4484.9	
				ML		SANDY SILT, noncohesive, nonplastic, massive; hard, moist, brown		
						62.3	4483.9	
				SM		SILTY SAND, very fine-grained; soft, moist to wet, yellowish brown		
						64.0	4482.2	
65				SP		SAND, very fine to fine-grained, some silt, slow dilatancy; medium dense, wet, yellowish brown		

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:03 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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AECOM

WELL NUMBER MW-36B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
				SP		SAND, very fine to fine-grained, some silt, slow dilatancy; medium dense, wet, yellowish brown		10/20 Silica Sandpack (56' - 78' bgs)
70								0.010 Slotted Pipe (58' - 78' bgs)
						72.3	4473.9	
				ML		SILT, noncohesive, nonplastic; soft, wet, gray		
						73.1	4473.1	
	SONIC 13	98		SP		SAND, very fine to fine-grained, some silt, slow dilatancy; medium soft, wet, grayish brown		
						74.0	4472.2	
75						S.A.A., little silt; yellowish brown		
				SP				Total Depth of Well 78' bgs Native Clay Below Well - Natural Collapse
						79.0	4467.2	

Bottom of borehole at 79.0 feet.

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:04 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-37B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 8/2/2016 **COMPLETED** 8/3/2016 **GROUND ELEVATION** 4530.256 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic ▽ **AT TIME OF DRILLING** 68.00 ft / Elev 4462.26 ft

LOGGED BY Chris Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 4530.367 N 4528.075 E **AFTER DRILLING** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
0								Casing Top Elev: 2.292 (ft) Casing Type: 2" PVC Pipe Top of Casing (2.292' ags)
	N/A	0				Hand potholed until 5.5' bgs		
5						5.5	4524.8	
	SONIC 1	100		SP-GP		SAND, very fine to medium-grained, with gravel, no odor or staining; loose, moist, brown		
						9.0	4521.3	Grout (0' - 50' bgs)
10				SW-GP		SAND, very fine to coarse-grained, with subround gravel, no odor or staining; loose, moist, brown		
	SONIC 2	98				11.8	4518.5	PVC Pipe (2.292' ags - 77.5' bgs)
				GP		GRAVEL, poorly graded, subangular, with fine to coarse-grained sand, trace fines, no odor or staining; loose, moist, tan		
						12.6	4517.7	
				ML		SANDY SILT, noncohesive, nonplastic, no odor or staining; loose, moist, light brown		
						14.0	4516.3	
15						SILTY SAND, very fine-grained, trace fine grained sand, no odor or staining; loose, moist, light brown		
	SONIC 3	98		SM				
20						20.0	4510.3	

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 17:31 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
20							
	SONIC 4	100		SM		SILTY SAND, very fine-grained; loose, moist, brown 21.7 4508.6	
				ML		SILT, little sand, noncohesive, nonplastic, blocky, no odor or staining; hard, moist, pale brown 24.0 4506.3	
25	SONIC 5	100		ML		SANDY SILT, noncohesive, nonplastic, no odor or staining, blocky; soft, moist, brown 27.0 4503.3	
				ML		S.A.A., slow dilatancy; wet (perched) 29.0 4501.3	
30	SONIC 6	94		SM		SILTY SAND, very fine to fine-grained, no odor or staining; loose, wet (due to drilling waters), brown 30.0 4500.3	Grout (0' - 50' bgs) PVC Pipe (2.292' ags - 77.5' bgs)
				SM		S.A.A., moist 32.9 4497.4	
				SM		S.A.A., blocky; hard 34.0 4496.3	
35	SONIC 7	100		ML		SILT, with sand, noncohesive, nonplastic, slow dilatancy; soft, wet, grayish brown (10YR 5/2), mottled gray (10YR 5/1) 35.5 4494.8	
				SM		SILTY SAND, very fine to fine-grained, no odor or staining; soft, wet, brown 37.3 4493.0	
				SM		S.A.A., decreasing moisture 39.0 4491.3	
40	SONIC 8	100		SM		SILTY SAND, very fine to fine-grained, no staining; loose, moist, brown	

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:04 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
				SM		SILTY SAND, very fine to fine-grained, no staining; loose, moist, brown		
45						45.0	4485.3	
				SW		45.4 SAND, very fine to coarse-grained, with round gravel, no odor or staining; loose, wet (due to drilling waters), brown	4484.9	Grout (0' - 50' bgs)
	SONIC 9	100		SM		SILTY SAND, very fine to fine-grained, no odor or staining; loose, moist, brown		PVC Pipe (2.292' ags - 77.5' bgs)
						49.0	4481.3	
50				SP		SAND, very fine to fine-grained, little silt; stiff, moist, brown		
						51.0	4479.3	
	SONIC 10	100	1.25	SP		S.A.A., loose		3/8" Bentonite Chips (50' - 54' bgs)
						54.0	4476.3	
55				SP-SM		SAND, very fine to fine-grained, with silt, no odor or staining; loose, moist, brown		
						56.0	4474.3	10/20 Silica Sandpack (54' - 77.5' bgs)
	SONIC 11	88		SM		SILTY SAND, very fine to fine-grained; soft, wet, yellowish brown		
						56.9	4473.4	
				SM		S.A.A., moist		
						59.6	4470.7	0.010 Slotted Pipe (57.5' - 77.5' bgs)
60				SP-SM		SAND, very fine to fine-grained, with silt; loose, moist, yellowish brown		
						62.0	4468.3	
				SP-SM		S.A.A., slow dilatancy; wet		
	SONIC 12	48						
65								

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:04 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-37B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
			2.0	SM		66.2 4464.1 SILTY SAND, very fine to fine-grained; stiff, moist, yellowish brown	10/20 Silica Sandpack (54' - 77.5' bgs)
				SP-SM		68.0 ▽ 4462.3 SAND, very fine to fine-grained, with silt, slow dilatancy; loose, wet, yellowish brown	
						69.0 4461.3 No recovery	0.010 Slotted Pipe (57.5' - 77.5' bgs)
70	SONIC 13	43					
75						76.3 4454.0 SAND, very fine to fine-grained, with silt; loose, wet, grayish brown	
				SP-SM		77.9 4452.4	Total Depth of Well 77.5' bgs
				ML		78.4 4451.9 SANDY SILT, noncohesive, nonplastic, no odor or staining; soft, wet, gray	Native Clay Below Well - Natural Collapse
				SM		79.0 4451.3 SILTY SAND, very fine-grained, no odor or staining; soft, wet, gray	

Bottom of borehole at 79.0 feet.

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:04 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-38B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 7/14/2016 **COMPLETED** 7/14/2016 **GROUND ELEVATION** 4528.075 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic **AT TIME OF DRILLING** ---

LOGGED BY Matt Hartz **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 4547.479 N 4544.695 E **AFTER DRILLING** 56.90 ft / Elev 4471.18 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0							Casing Top Elev: 2.784 (ft) Casing Type: 2" PVC Pipe Top of Casing (2.784' ags)
	N/A	0				Hand potholed until 5' bgs	
5						5.0 4523.1	
				SP		SAND, very fine to fine-grained, subround, some silt, trace clay; loose, moist, light brown Thin beds of medium to coarse-grained sand (k-spar, qtz, minor lithies) loosely cemented	
						9.0 4519.1	
10	SONIC 1	100		FILL		FILL, fine to coarse grained sand, with gravel and cobbles Mixed lithologies throughout	Grout (0' - 62' bgs) PVC Pipe (2.874' ags - 75' bgs)
15	SONIC 2	100					
						17.0 4511.1	
				SM		SILTY SAND, very fine to fine-grained, round; loose, moist to dry, light brown	
20						20.0 4508.1	
	SONIC 3	100		SM		SILTY SAND, very fine to fine-grained, round; loose, moist to dry, light brown @21.5-25' bgs: thinly bedded sandstone with sand matrix, loosely cemented	
25							

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:05 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
25						SILTY SAND, very fine to fine-grained, round; loose, moist to dry, light brown	
30	SONIC 4	100		SM			Grout (0' - 49.6' bgs)
35							PVC Pipe (2.874' ags - 75' bgs)
40	SONIC 5	100				@40-47' bgs: increase in overall competency of sand, thin beds of loosely consolidated sandstone	
45							
50	SONIC 6	100					3/8" Bentonite Chips (49.6' - 52.9' bgs)
							10/20 Silica Sandpack

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:05 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
55				SM		SILTY SAND, very fine to fine-grained, round; loose, moist to dry, light brown @56' bgs: increase in moisture content @57-57.5': well-graded, competent SS, cemented (likely calcareous); dense, white	(52.9' - 76.4' bgs)
60	SONIC 7	100				60.0 4468.1 SILTY SAND, very fine to fine-grained, round, slightly more competent zones/beds of moderately cemented SS; loose, moist, light brown to brown intervals with increasing moisture	
65							10/20 Silica Sandpack (52.9' - 76.4' bgs) 0.010 Slotted Pipe (55' - 75' bgs)
70	SONIC 8	100		SM			
75							Total Depth of Well 75' bgs
80							Bentonite Chip Fill Below Well

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:05 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-38B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
85	SONIC 9	100		SM		SILTY SAND, very fine to fine-grained, round, slightly more competent zones/beds of moderately cemented SS; loose, moist, light brown to brown intervals with increasing moisture	Bentonite Chip Fill Below Well
						88.0 4440.1	

Bottom of borehole at 88.0 feet.

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:05 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-39B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 7/17/2016 **COMPLETED** 7/18/2016 **GROUND ELEVATION** 4544.695 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic **AT TIME OF DRILLING** ---

LOGGED BY Matt Hartz **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 4581.452 N 4579.362 E **AFTER DRILLING** 78.30 ft / Elev 4466.40 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0							Casing Top Elev: 2.09 (ft) Casing Type: 2" PVC Pipe Top of Casing (2.090' ags)
	N/A	0				Hand potholed until 6' bgs	
5						6.0 4538.7	
	SONIC 1	100		SP		SAND (possibly fill), fine to medium-grained, some silt, trace gravel and cobbles; dry, light brown 9.0 4535.7	
10						SILTY SAND, very fine to fine-grained, subround, trace clay, no apparent bedding; loose, dry, light brown to brown with light gray intervals Lithology is granite (qtz, k-spar, trace lithies)	Grout (0' - 74' bgs)
	SONIC 2	100		SM			PVC Pipe (2.090' ags - 109.3 bgs)
15							
	SONIC 3	100				@16-17' bgs: thin beds (<2") of well indurated and cemented SS, possibly Caliche; light gray 19.0 4525.7	
20						SAND, very fine to fine-grained, subround, some silt; firm to stiff, moist, brown with trace white sand stringers visible within laminae	
	SONIC 4	100		SP			
25							
30						30.0 4514.7	

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:05 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
30	SONIC 5	100		SP		SAND, very fine to fine-grained, subround, some silt; firm to stiff, moist, brown with trace white sand stringers visible within laminae @33-34' bgs: welll indurated SS (possibly Caliche); light brown with light gray	
35	SONIC 6	100				36.0 4508.7 SAND, very fine to fine-grained, subround, some silt, trace clay, irregular, thin bedding planes (0.5"); loose, dry @36-38' bgs: weathered zone: occurs predominantly between bedding planes within clays; brown, red, and gray @36-49' bgs: interbedded hard, light gray planes, well cemented (likely Caliche)	Grout (0' - 74' bgs) PVC Pipe (2.090' ags - 109.3 bgs)
40	SONIC 7	100					
45	SONIC 8	100		SP			
50	SONIC 9	100				@51.5-52.5' bgs: moist (perched moisture interval, not water-bearing) @54-56.5: firm to dense, moist (perched moisture interval, not water-bearing)	
55	SONIC 10	100					
60	SONIC 11	100		SP		60.0 4484.7 SAND, very fine to fine-grained, subround, some silt, trace clay, irregular, thin bedding planes (1"); loose, dry with moist intervals	

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:05 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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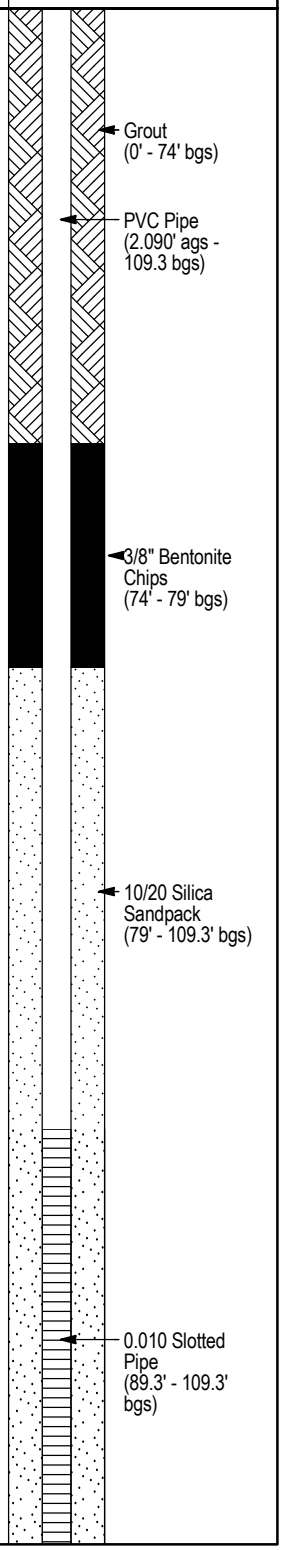
CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
65	SONIC 12	100		SP		SAND, very fine to fine-grained, subround, some silt, trace clay, irregular, thin bedding planes (1"); loose, dry with moist intervals
70	SONIC 13	100				
75						@75-78' bgs: moist (perched moisture interval, not water-bearing)
	SONIC 14	100				
80						@82-88' bgs: moist (due to drilling waters)
85	SONIC 15	100				
90						@91-99' bgs: moist to wet
95	SONIC 16	100				@96-98' bgs: increase in well consolidated SS interbedding (2"), siliceous cementation; hard



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AECOM

WELL NUMBER MW-39B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
100	SONIC 17	100		SP		SAND, very fine to fine-grained, subround, some silt, trace clay, irregular, thin bedding planes (1"); loose, dry with moist intervals @101-107' bgs: moist to wet intervals within medium-grained sand interbeds (<2") within native formation, potentially water-bearing	10/20 Silica Sandpack (79' - 109.3' bgs)
105							0.010 Slotted Pipe (89.3' - 109.3' bgs)
					109.3	4435.4	Total Depth of Well 109.3' bgs

Bottom of borehole at 109.3 feet.

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WELL NUMBER MW-40B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 7/15/2016 **COMPLETED** 7/16/2016 **GROUND ELEVATION** 4587.399 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic **AT TIME OF DRILLING** ---

LOGGED BY Matt Hartz **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 4589.593 N 4587.399 E **AFTER DRILLING** 38.11 ft / Elev 4549.29 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						Hand potholed until 5' bgs
5	N/A	0				5.0 / 4582.4
10	SONIC 1	100		FILL		FILL, sand and silt matrix with gravel to large cobbles Varying lithologies
15	SONIC 2	100				12.0 / 4575.4
20	SONIC 3	100		SM		SILTY SAND, fine to medium-grained, trace clay, unconsolidated, irregular thin beds, silts and clays within bedding planes; soft to firm, moist, light brown
25	SONIC 4	100				23' bgs: firm, moist to wet
30						28' bgs: firm, moist to wet 28-30' bgs: moderately consolidated, firm to stiff, moist (on the verge of SS) 30.0 / 4557.4

Casing Top Elev: 2.194 (ft)
Casing Type: 2" PVC Pipe

WELL DIAGRAM

Top of Casing (2.194' ags)

Grout (0' - 81' bgs)

PVC Pipe (2.194' ags - 107.9 bgs)

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:06 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
30							
35	SONIC 5	100		SM		SILTY SAND, fine to medium-grained, trace clay, unconsolidated, irregular thin beds, silts and clays within bedding planes; soft to firm, moist, light brown 30-35' bgs: moderately consolidated, firm to stiff, moist (on the verge of SS) 35-36' bgs: interbeds (<6") of consolidated SS (primarily qtz), very fine to fine-grained, siliceous cementation; dry, white	Grout (0' - 81' bgs) PVC Pipe (2.194' ags - 107.9 bgs)
40	SONIC 6	100				38.0 ▼ 4549.4 SAND, very fine to fine-grained, subround, some silt, trace clay, minimal weathering, interbeds (<6") of sandstones; firm, moist, light brown to brown	
45							
50	SONIC 7	100		SP			
55						@57-60' bgs: wet (water-bearing)	
60	SONIC 8	100				@60-64' bgs: wet (water-bearing)	

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
65						SAND, very fine to fine-grained, subround, some silt, trace clay, minimal weathering, interbeds (<6") of sandstones; firm, moist, light brown to brown	Grout (0' - 81' bgs)
						@68-78' bgs: moist	
70							PVC Pipe (2.194' ags - 107.9 bgs)
	SONIC 9	100					
75							
						@80-82' bgs: increase in moisture above SS unit	
80				SP			
						@82' bgs: SS horizon (2"), well indurated and silified; hard, dry, gray with white clay at top and bottom	
	SONIC 10	100				@83-85' bgs: increase in moisture below SS unit	3/8" Bentonite Chips (81' - 85.1' bgs)
85							
						@87-96' bgs: increase in grain size to fine to medium-grained; saturated (not water-bearing zone, either perched or due to drilling waters)	
90							10/20 Silica Sandpack (85.1' - 18' bgs)
	SONIC 11	100					
							0.010 Slotted Pipe (87.9' - 107.9' bgs)
95							
					96.0	4491.4	
			SANDSTONE			SANDSTONE, fine to medium-grained, subround to subangular, well indurated, well-cemented (siliceous); moist, brown	
					98.0	4489.4	
				SP		See next page	

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AECOM

WELL NUMBER MW-40B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
100	SONIC 12	100		SP		SAND, very fine to medium-grained, subround to subangular, some silt, slight zones of weathered, dark brown, oxidized beds; firm to stiff, wet, light brown to brown	10/20 Silica Sandpack (85.1' - 18' bgs)
105							0.010 Slotted Pipe (87.9' - 107.9' bgs)
						108.0 4479.4	Total Depth of Well 107.9' bgs

Bottom of borehole at 108.0 feet.

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:06 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-41B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 8/3/2016 **COMPLETED** 8/3/2016 **GROUND ELEVATION** 4527.383 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic ▽ **AT TIME OF DRILLING** 69.00 ft / Elev 4458.38 ft

LOGGED BY Chris Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 588577.1 N 731829.2 E **AFTER DRILLING** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0						Hand potholed until 6' bgs	Casing Top Elev: 2.254 (ft) Casing Type: 2" PVC Pipe Top of Casing (2.254' ags)
	N/A	0					
5							
						6.0 4521.4	
	SONIC 1	100		SP-GP		SAND, very fine to fine-grained, with gravel, some cobbles, little silt; loose, dry, brown	
						9.0 4518.4	Grout (0' - 44.6' bgs)
				SM		SILTY SAND, very fine to fine-grained; loose, moist, brown	
10						10.0 4517.4	
				SP-GP		SAND, very fine to medium-grained, with round gravel; loose, moist, light gray	PVC Pipe (2.254' ags - 73' bgs)
						12.0 4515.4	
	SONIC 2	46		SW-SM		SAND, very fine to coarse-grained, with silt, little angular gravel, no odor or staining; loose, moist, brown	
15							
	SONIC 3	100					
						19.0 4508.4	
				ML		SANDY SILT, nonplastic, noncohesive, no odor or staining; very soft, wet, grayish brown	
20							

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
20				ML		SANDY SILT, nonplastic, noncohesive, no odor or staining; very soft, wet, grayish brown		
						21.0	4506.4	
				SM		SILTY SAND; soft, moist, gray		
						21.8	4505.6	
				ML		SILT, nonplastic, noncohesive; medium, moist, gray and mottled brown and gray		
						23.0	4504.4	
	SONIC 4	77		SM		SILTY SAND, very fine to fine-grained, no staining; loose, moist, brown, no mottling		
25						27.0	4500.4	
				ML		SILT, with sand, nonplastic, noncohesive, no odor or staining; very soft, wet, brownish gray		
						29.0	4498.4	Grout (0' - 44.6' bgs)
				SM		SILTY SAND, very fine to fine-grained; loose, wet, grayish brown wetness due to drilling waters		
30						30.4	4497.0	
				SM		SILTY SAND, very fine to fine-grained, little subangular gravel; loose, moist, grayish brown (10YR 5/2)		PVC Pipe (2.254' ags - 73' bgs)
	SONIC 5	80				31.5	4495.9	
				SP		SAND, very fine to fine-grained, trace silt, no odor or staining; loose, moist, light brownish gray		
						32.2	4495.2	
				SP		S.A.A., light gray (10YR 7/1)		
						34.0	4493.4	
				SP		SAND, very fine to medium-grained, little silt; medium dense, moist, dark grayish brown (10YR 4/2)		
						34.5	4492.9	
35				SP		S.A.A., little subangular gravel; light brownish gray (10YR 6/2)		
	SONIC 6	100				37.0	4490.4	
				SP		S.A.A., no gravel; light gray (10YR 7/1)		
						39.0	4488.4	
				SM		SILTY SAND, very fine to fine-grained, no odor or staining; loose, wet, yellowish brown		
40								

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
45	SONIC 7	76		SM		SILTY SAND, very fine to fine-grained, no odor or staining; loose, wet, yellowish brown		Grout (0' - 44.6' bgs); PVC Pipe (2.254' ags - 73' bgs)
						48.5	4478.9	3/8" Bentonite Chips (44.6' - 50.6' bgs)
50				SP-SM		SAND, very fine to fine-grained, with silt, no odor or staining; loose, moist, pale brown (10YR 6/3)		
	SONIC 8	69				50.3	4477.1	
				SP-SM		S.A.A., brown (10YR 5/3)		
						54.0	4473.4	
55				ML		SILT, with gravel, nonplastic, noncohesive, massive, no odor or staining; very stiff, moist, grayish brown (10YR 5/2)		
						56.0	4471.4	
	SONIC 9	100	3.0	SM		SILTY SAND, very fine-grained; medium dense, moist, grayish brown (10YR 5/2)		
						58.0	4469.4	
				SM		S.A.A., with gravel (sandstone); moist		
						59.0	4468.4	0.010 Slotted Pipe (53' - 73' bgs)
60				SM		SILTY SAND, very fine to fine-grained, no odor or staining; loose, wet, grayish brown (10YR 5/2)		
						62.0	4465.4	10/20 Silica Sandpack (50.6' - 73' bgs)
				SM		S.A.A., medium dense, wet		
	SONIC 10	85						
65			4.0			65.1	4462.3	
				ML		See next page		

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AECOM

WELL NUMBER MW-41B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
				ML		SILT, nonplastic, noncohesive, blocky, no odor or staining; stiff, moist, light brownish gray (10YR 6/2), no mottling	0.010 Slotted Pipe (53' - 73' bgs)
						69.0 ▽ 4458.4	
70				SP-GW		SAND, poorly graded, with gravel; very loose, wet, grayish brown	
						70.0 4457.4	
				ML		SILT, nonplastic, noncohesive; soft, wet, grayish brown and mottled gray (10YR 6/1) and light brownish gray (10YR 6/2)	
						71.0 4456.4	
				SM		SILTY SAND, very fine to fine-grained, no odor or staining; loose, wet, grayish brown	Total Depth of Well 73' bgs
	SONIC 11	78				74.0 4453.4	
75						S.A.A., decreasing in moisture	
				SM			Native Clay Below Well - Natural Collapse
						79.0 4448.4	

Bottom of borehole at 79.0 feet.

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 17:39 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-42B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 8/9/2016 **COMPLETED** 8/9/2016 **GROUND ELEVATION** 4513.297 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic **AT TIME OF DRILLING** ---

LOGGED BY Jeremy Hurshman **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 588829.6 N 732965.3 E **AFTER DRILLING** 40.00 ft / Elev 4473.30 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0							Casing Top Elev: 2.534 (ft) Casing Type: 2" PVC Pipe Top of Casing (2.534' ags)
	N/A	0				Hand potholed until 5.5' bgs	
5						5.5 4507.8	
	SONIC 1	100		SM		SILTY SAND, fine-grained; loose, dry, medium brown to tan	
						9.0 4504.3	Grout (0' - 42' bgs)
10						SILTY SAND, fine-grained, poorly cemented sandstone lenses, no odor or staining; moist to wet, light tan	
	SONIC 2	100		SM			PVC Pipe (2.534' ags - 68.5' bgs)
						14.0 4499.3	
15						SILTY SAND; dry, light tan 14-16' bgs: poorly cemented sandstone lenses, lenses broken by drilling	
	SONIC 3	100		SM			
20							

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:07 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
20				SM		SILTY SAND; dry, light tan		
						22.0	4491.3	
	SONIC 4	100		SM		SILTY SAND, fine-grained, subround, trace sandstone lenses; moist, light brown		
25						27.0	4486.3	
	SONIC 5	100		SP		SAND, fine-grained; loose with hard sections (breaks in hand), moist		
						29.0	4484.3	Grout (0' - 42' bgs)
30	SONIC 6	100		SP		SAND, fine-grained, few poorly cemented sandstone lenses, minor clay, no odor or staining, crumbles; dry to moist, brown		PVC Pipe (2.534' ags - 68.5' bgs)
						34.0	4479.3	
35	SONIC 7	100		SM		SILTY SAND, subround to round; loose, moist to wet (due to drilling waters), brown		
						38.0	4475.3	
				SP		SAND, fine-grained; dry, light tan		
						@38' bgs: 1 inch of hard zone of visible thin channel, brown silt deposits		
						39.0	4474.3	
40				SP		SAND, fine-grained, round, little silt, tight and compact; stiff, wet		

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
45	SONIC 8	100		SP		SAND, fine-grained, round, little silt, tight and compact; stiff, wet		3/8" Bentonite Chips (42' - 45.75' bgs)
						@45' bgs: gradational contact: increasing silt and decreasing sand		
						46.0	4467.3	
				ML		SILT, with fine-grained sand, few interbedded clay nodules, low to medium plasticity; stiff, wet, brown		
						49.0	4464.3	
50						SILTY SAND, fine-grained, no visible structures; medium dense, wet, brown		10/20 Silica Sandpack (45.75' - 68.5' bgs)
								0.010 Slotted Pipe (48.5' - 68.5' bgs)
55	SONIC 9	100		SM				
						59.0	4454.3	
60			SANDSTONE			SANDSTONE, fine-grained, fractured from drilling; hard, light gray to tan		
						60.0	4453.3	
				SP		SAND, fine-grained, little silt; medium dense, wet, brown		
65	SONIC 10	100						

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AECOM

WELL NUMBER MW-42B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
				SP		SAND, fine-grained, little silt; medium dense, wet, brown	10/20 Silica Sandpack (45.75' - 68.5' bgs)
							0.010 Slotted Pipe (48.5' - 68.5' bgs)
							Total Depth of Well 68.5' bgs
							Native Clay Below Well - Natural Collapse
					69.0	4444.3	

Bottom of borehole at 69.0 feet.

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:08 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-43B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 8/10/2016 **COMPLETED** 8/10/2016 **GROUND ELEVATION** 4498.003 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic ▽ **AT TIME OF DRILLING** 69.00 ft / Elev 4429.00 ft

LOGGED BY Jeremy Hurshman **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 589002.8 N 734274.6 E **AFTER DRILLING** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0							Casing Top Elev: 3.441 (ft) Casing Type: 2" PVC Pipe Top of Casing (3.441' ags)
	N/A	0				Hand potholed until 5' bgs	
5						5.0 4493.0	
	SONIC 1	100		ML		SILT, with fine-grained, subround to round, sand, trace clay, no odor or staining; dry, moist @7-9' bgs: moist increasing sand with depth	
						9.0 4489.0	Grout (0' - 50' bgs)
10						SILTY SAND, fine-grained; moist to dry @9-10' bgs: minor round gravel (0.4-0.8" in size) little recovery due to bit being blocked	PVC Pipe (3.441' ags - 78.5' bgs)
	SONIC 2	50		SM			
15							
						19.0 4479.0	
				GW		SANDY GRAVEL, well graded, fine to coarse-grained, subround to round, little silt, no odor or staining; wet, brown to light tan	
20						20.0 increasing silt with depth 4478.0	

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/11/16 12:29 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
20	SONIC 3	90		GW		SANDY GRAVEL, well graded, fine to coarse-grained, subround to round, little silt, no odor or staining; dry, brown to light tan increasing silt with depth		
							24.0 4474.0	
25				ML		SILT, with fine-grained sand, minor clay, low plasticity; moist, brown (gradiational contact)		
							26.0 4472.0	
	SONIC 4	100		SM		SILTY SAND, fine-grained sand, trace clay, no plasticity; moist to wet, brown		
							29.0 4469.0	
30	SONIC 5	100		ML		SILT, with minor sand, trace clay; dense, moist, brown		Grout (0' - 50' bgs)
								PVC Pipe (3.441' ags - 78.5' bgs)
							34.0 4464.0	
35	SONIC 6	100		ML		S.A.A, increasing sand; moist to wet		
							39.0 4459.0	
40			SANDSTONE			SANDSTONE, fine-grained sand, poorly cemented; hard, dry, light gray	40.0 4458.0	
				ML		SILT, with fine-grained sand, little clay, low plasticity; medium dense, moist, brown		

(Continued Next Page)

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
45	SONIC 7	100		ML		SILT, with fine-grained sand, little clay, low plasticity; medium dense, moist, brown		Grout (0' - 50' bgs); PVC Pipe (3.441' ags - 78.5' bgs)
						49.0	4449.0	
50			SANDSTONE			SANDSTONE or SILTSTONE, fine-grained, fractured from drilling; hard, wet in fractures and at bottom (may be due to drilling waters), light tan to light gray		
						52.0	4446.0	
55	SONIC 8	100		ML		SILT, with fine-grained sand, low to no plasticity, crumbles when crushed with hands, no odor or staining; moist, brown		3/8" Bentonite Chips (50' - 55' bgs); 10/20 Silica Sandpack (55' - 79' bgs)
						59.0	4439.0	
60				SP		SAND, fine-grained, little silt; wet (may be due to drilling waters)		0.010 Slotted Pipe (58.5' - 78.5' bgs)
						60.0	4438.0	
				SM		SILTY SAND, fine-grained sand, hard sand nodules interbedded; moist to wet (water in and around sand), brown increasing silt with depth		
	SONIC 9	100				64.0	4434.0	
65				ML		SILT, minor fine-grained sand, little clay, crumbles in hand; moderately stiff, moist, brown decreasing sand with depth		

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/11/16 12:29 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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AECOM

WELL NUMBER MW-43B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
				ML		SILT, minor fine-grained sand, little clay, crumbles in hand; moderately stiff, moist, brown decreasing sand with depth		
						69.0 ▽	4429.0	
				SP		SAND, fine-grained, minor silt; wet, tan		10/20 Silica Sandpack (55' - 79' bgs)
70						70.0	4428.0	
	SONIC 10	100		SP		S.A.A., brown		0.010 Slotted Pipe (58.5' - 78.5' bgs)
						74.0	4424.0	
75				ML		SILT, with fine-grained sand, crumbles; wet in fractures and sand zones, brown		
						76.0	4422.0	
				ML		S.A.A., decreasing sand with depth; moist		
						79.0	4419.0	Total Depth of Well 78.5' bgs

Bottom of borehole at 79.0 feet.

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/11/16 12:30 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-44B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 8/4/2016 **COMPLETED** 8/5/2016 **GROUND ELEVATION** 4527.324 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic ▽ **AT TIME OF DRILLING** 74.00 ft / Elev 4453.32 ft

LOGGED BY Chris Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 589659.8 N 731518.4 E **AFTER DRILLING** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0							Casing Top Elev: 2.065 (ft) Casing Type: 2" PVC Pipe Top of Casing (2.065' ags)
	SONIC 1	100		FILL		SAND (FILL), fine to coarse-grained, with round gravel, no odor or staining; loose, moist, brown	
5							
						@9' bgs: rock prevented 3.6' of recovery	Grout (0' - 67.11' bgs)
10	SONIC 2	28					PVC Pipe (2.065' ags - 92.1' bgs)
				SW-GP		14.0 4513.3 SAND, very fine to coarse-grained, with subangular gravel, no odor or staining; loose, wet, grayish brown (10YR 5/2)	
15						15.0 4512.3	
	SONIC 3	100		SW		S.A.A., no gravel; moist, very pale brown (10YR 7/3)	
						18.0 4509.3	
20				SW		S.A.A., little subangular gravel	

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:09 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
20				SW		SAND, very fine to coarse-grained, little subangular gravel, no odor or staining; loose, moist, very pale brown (10YR 7/3)	
	SONIC 4	94				21.6 4505.7	
				SW		21.9 S.A.A., light gray (10YR 7/1) 4505.4	
				SW		S.A.A., little silt; light brownish gray (10YR 6/2)	
25	SONIC 5	100	1.5	SM		25.7 4501.6 SILTY SAND, very fine to fine-grained, no odor staining; stiff, moist, gray (10YR 5/1)	
				SP-SM		26.9 4500.4 SAND, very fine to fine-grained, with silt; stiff, moist, gray (10YR 6/1)	Grout (0' - 67.11' bgs)
30						30.4 4496.9	
				SP-SM		S.A.A., wet	PVC Pipe (2.065' ags - 92.1' bgs)
						33.4 4493.9	
	SONIC 6	99		SP-SM		34.0 S.A.A., moist 4493.3	
35				SP-SM		S.A.A., moist to wet, light brownish gray (10YR 6/2)	
						36.5 4490.8	
				SP-SM		36.7 S.A.A., medium stiff, moist 4490.6	
				SP-SM		S.A.A., loose, decreasing moisture	
40						40.0 4487.3	
	SONIC 7	90		SM		SILTY SAND, very fine to medium-grained, no odor or staining; loose (broken up by rig), moist, light yellowish brown (10YR 6/4)	

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:09 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
						SILTY SAND, very fine to medium-grained, no odor or staining; loose (broken up by rig), moist, light yellowish brown (10YR 6/4)	
45	SONIC 8	98		SM		47.4 4479.9	
				CALICHE		CALICHE, 1" thick, with sand; hard, dry, white 48.3 4479.0	
				SM		SILTY SAND, very fine-grained; loose (broken up by rig), moist, light yellowish brown (10YR 6/4)	Grout (0' - 67.11' bgs)
50	SONIC 9	86		SP-SM		50.5 4476.8 SAND, very fine to fine-grained, with silt, no odor or staining; loose, moist, brown (10YR 5/3)	PVC Pipe (2.065' ags - 92.1' bgs)
55	SONIC 10	96		SM		59.0 4468.3 SILTY SAND, very fine to fine-grained, no odor staining; medium dense, moist, brown (10YR 4/3)	
60				SM		61.8 4465.5	
				SM		62.0 4465.3 S.A.A., wet	
				SM		S.A.A., moist	
	SONIC 11	97	>4.0			64.0 4463.3	
65				SM		SILTY SAND, very fine to fine-grained; hard, moist, brown (10YR 4/3)	

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:09 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
				SM		SILTY SAND, very fine to fine-grained; hard, moist, brown (10YR 4/3)		Grout (0' - 67.11' bgs)
						66.5	4460.8	
				SM		S.A.A., medium dense, moist		PVC Pipe (2.065' ags - 92.1' bgs)
						68.8	4458.5	3/8" Bentonite Chips (67.11' - 69.11' bgs)
				SM		69.0 S.A.A., soft, moist	4458.3	
70						No recovery due to rock		10/20 Silica Sandpack (69.11' - 92.1' bgs)
	SONIC 12	50						0.010 Slotted Pipe (72.1' - 92.1' bgs)
						74.0 ▽	4453.3	
75				SM		SILTY SAND, very fine to fine-grained; loose, wet, grayish brown (10YR 5/2)		
						77.6	4449.7	
				SM		S.A.A., decreasing moisture		
						79.0	4448.3	
80				ML		SILT, with sand, noncohesive, nonplastic, no odor or staining; medium dense, moist to wet, dark graish brown (10YR 4/2)		
	SONIC 13	60						
						84.0	4443.3	
85				SP		SAND, very fine to fine-grained; loose, moist to wet, brown		
	SONIC 14	98						
						88.0	4439.3	
				SP		S.A.A., fine to medium-grained		

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:09 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-44B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
				SP		89.0 4438.3 SILTY SAND, very fine to fine-grained; loose, wet, brown (10YR 4/3)	10/20 Silica Sandpack (69.11' - 92.1' bgs)
90							0.010 Slotted Pipe (72.1' - 92.1' bgs)
	SONIC 15	80		SM			Total Depth of Well 92.1' bgs
95							Native Clay Below Well - Natural Collapse
						99.0 4428.3	

Bottom of borehole at 99.0 feet.

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:09 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-45B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 8/6/2016 **COMPLETED** 8/7/2016 **GROUND ELEVATION** 4528.664 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic **AT TIME OF DRILLING** ---

LOGGED BY Chris Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 589851.3 N 732581.2 E **AFTER DRILLING** 73.85 ft / Elev 4454.81 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
0								Casing Top Elev: 2.257 (ft) Casing Type: 2" PVC Pipe Top of Casing (2.257' ags)
	SONIC 1	100		SW-GP		SAND, very fine to medium-grained, with gravel, little silt, little organic material; loose, moist, brown		
5								
							6.0 / 4522.7	
				SP-SM		S.A.A., with silt, less gravel		
							9.0 / 4519.7	
10				ML		SILT, with gravel and sand, noncohesive, nonplastic; soft, wet (due to drilling waters), grayish brown (10YR 5/2)		Grout (0' - 60' bgs)
							10.9 / 4517.8	
				SW-GP		SAND, fine to coarse-grained, with subround gravel, little silt; loose, moist, brown	11.8 / 4516.9	
				SW-GP		S.A.A., some silt	12.6 / 4516.1	PVC Pipe (2.065' ags - 89' bgs)
	SONIC 2	53				S.A.A., no silt		
15				SW-GP				
							19.0 / 4509.7	
20				SM		SILTY SAND, very fine-grained, no odor or staining; soft, moist, light brownish gray (10YR 6/2)		
	SONIC 3	100	>4.0				23.0 / 4505.7	
				SM		S.A.A., hard	24.0 / 4504.7	
25				SM		S.A.A., medium		

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:10 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
25	SONIC 4	88	2.0	SM		SILTY SAND, very fine-grained, no odor or staining; medium dense, moist, light brownish gray (10YR 6/2)		
							29.0 4499.7	
30				SP-SM		SAND, very fine to medium-grained, with silt, little gravel; loose, wet (perhed aquifer), brown (10YR 5/3)		
							32.0 4496.7	
				SP-SM		S.A.A., stiff, moist, dark gray (10YR 4/1)		
							33.5 4495.2	
35	SONIC 5	79		SP-SM		S.A.A., loose, light brownish gray (10YR 6/2)		Grout (0' - 60' bgs)
								PVC Pipe (2.065' ags - 89' bgs)
40	SONIC 6	100					43.0 4485.7	
				SM		SILTY SAND, very fine-grained, little fine-grained sand; stiff, moist, light brownish gray (10YR 6/2)	44.0 4484.7	
				SM		S.A.A., dark gray (10YR 4/1)	45.0 4483.7	
45				SM		S.A.A., light brownish gray (10YR 6/2)	46.0 4482.7	
	SONIC 7	100		SP-SM		SAND, very fine to fine-grained, with silt, no odor or staining; loose, moist, pale brown (10YR 6/3)	47.2 4481.5	
			1.0	SP-SM		S.A.A., grayish brown (10YR 5/2)	48.5 4480.2	
50				SP-SM		S.A.A., stiff	50.7 4478.0	
	SONIC 8	100		SP-SM		S.A.A., loose, light brownish gray (10YR 6/2)	53.0 4475.7	
						S.A.A., stiff, grayish brown (110YR 5/3)		

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:10 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
				SP-SM		54.0 4474.7 SILTY SAND, very fine-grained, little fine-grained sand; medium dense, moist, light brownish gray (10YR 6/2)	Grout (0' - 60' bgs)
55	SONIC 9	84		SM			PVC Pipe (2.065' ags - 89' bgs)
				SM		58.5 4470.2 59.0 4469.7 S.A.A., blocky; very stiff	
60	SONIC 10	100	1.75	SP-SM		SAND, very fine to fine-grained, with silt; stiff, moist, grayish brown (10YR 5/2) 60.4 4468.3 S.A.A., loose, pale brown (10YR 6/3)	3/8" Bentonite Chips (60' - 64.9' bgs)
65	SONIC 11	86	1.5	SP-SM		65.7 4463.0 S.A.A., loose, moist, light brownish gray (10YR 6/2)	10/20 Silica Sandpack (64.9' - 89' bgs)
70	SONIC 12	64		SM		69.0 4459.7 SILTY SAND, very fine to medium-grained; soft, wet, dark grayish brown (10YR 4/2) 70.0 4458.7 S.A.A., slow dilatancy; medium stiff, wet	0.010 Slotted Pipe (69' - 89' bgs)
75				SM		78.0 4450.7 S.A.A., moist	
				SM		79.0 4449.7 SILTY SAND; soft, wet, dark yellowish brown (10YR 4/4)	
80				SM		81.5 4447.2 S.A.A, mottled dark yellowish brown and gray (10YR 5/1)	

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:10 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-45B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
85	SONIC 13	32				82.5 4446.2 No recovery	10/20 Silica Sandpack (64.9' - 89' bgs); 0.010 Slotted Pipe (69' - 89' bgs)
						89.0 4439.7 Bottom of borehole at 89.0 feet.	Total Depth of Well 89' bgs

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:10 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

AECOM

WELL NUMBER MW-46B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 8/7/2016 **COMPLETED** 8/8/2016 **GROUND ELEVATION** 4525.334 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic ▽ **AT TIME OF DRILLING** 82.00 ft / Elev 4443.33 ft

LOGGED BY Chris Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 590022.2 N 733532.2 E **AFTER DRILLING** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
0								Casing Top Elev: 2.383 (ft) Casing Type: 2" PVC Pipe Top of Casing (2.383' ags)
						SAND, very fine to medium-grained, with gravel and silt, no odor or staining; loose, dry to moist, brown @0-3' bgs: organic material (roots, etc)		
5	1	100		SP				
10								Grout (0' - 66' bgs)
	2	100				11.5	4513.8	
				SM		SILTY SAND, very fine to fine-grained; loose, moist, yellowish brown		PVC Pipe (2.383' ags - 93' bgs)
						14.0	4511.3	
15				SW-GP		SAND, very fine to coarse-grained, with subround gravel (qtz, granite); loose, brown		
	3	100				17.4	4507.9	
				ML		SILT, noncohesive, nonplastic, blocky; stiff, moist, brown, mottled with gray		
						19.0	4506.3	
20				ML		SILT, some fine to medium-grained sand, little white qtz fragments, noncohesive, nonplastic, blocky; medium stiff, moist, grayish brown (10YR 5/2)		
	4	100				21.4	4503.9	
				ML		SILT, some fine to coarse-grained sand, little angular gravel, noncohesive, nonplastic, blocky; medium stiff, wet, grayish brown (10YR 5/2)		
						23.0	4502.3	
				ML		S.A.A., moist		
25								

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:10 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
25				ML		SILT, some fine to coarse-grained sand, little angular gravel, noncohesive, nonplastic, blocky; medium, moist, grayish brown (10YR 5/2)		
	5	100				26.5	4498.8	
				SM		SILTY SAND, very fine to fine-grained; loose, moist, yellowish brown		
						29.0	4496.3	
30				SM		SILTY SAND, very fine-grained; loose, moist, gray (10YR 5/1)		
						31.0	4494.3	
				SM		S.A.A., very loose		
			3.5			32.8	4492.5	
				SM		33.1 S.A.A., very stiff	4492.2	
				SM		S.A.A., very loose		
	6	97				34.0	4491.3	Grout (0' - 66' bgs)
35				SP-SM		SAND, poorly graded, with silt; loose, moist, grayish brown (10YR 5/2)		
						35.8	4489.5	
				CALICHE		CALICHE, laminated; hard, dry, white		PVC Pipe (2.383' ags - 93' bgs)
						36.6	4488.7	
				ML		SANDY SILT, noncohesive, nonplastic; medium stiff, moist, brown		
						41.0	4484.3	
40				ML		S.A.A., increasing sand content		
						42.9	4482.4	
	7	100		SP-SM		SAND, very fine to fine-grained, with silt, no odor or staining; loose, moist, light brownish gray (10YR 6/2)		
45						47.5	4477.8	
	8	100		CALICHE		48.1 CALICHE; hard, moist, white	4477.2	
				SP-GP		48.5 SAND, poorly graded, with gravel	4476.8	
						48.7	4476.6	
				CALICHE		49.0 CALICHE; hard, moist, white	4476.3	
				SP-GP		SAND, poorly graded, with gravel; moist		
50						SAND, poorly graded, with silt; loose, brown (10YR 5/3)		
						50.4	4474.9	
				SP-SM		SAND, very fine to medium-grained, with gravel and silt; loose, brown		
	9	62		SP				

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 20:25 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
				SP		54.0	4471.3	
				SP-SM		54.3 SAND, very fine to medium-grained, with silt, trace angular gravel; very dense, moist, grayish brown (10YR 5/2)	4471.0	
55						S.A.A., loose		
				SP-SM				
	10	96	>4.0			57.0	4468.3	
				SP-SM		57.5 S.A.A., increasing moisture	4467.8	
						S.A.A., wet		
				SP-SM				
60						60.0	4465.3	Grout (0' - 66' bgs)
						SAND, very fine to medium-grained, with silt, trace angular gravel; very dense, moist to wet, light brownish gray (10YR 6/2)		
	11	83		SP-SM				PVC Pipe (2.383' ags - 93' bgs)
65						65.0	4460.3	
				SM		SILTY SAND, very fine to fine-grained, no odor or staining; loose, moist, gray		
						66.0	4459.3	
						SAND, very fine to fine-grained, with silt; loose, moist, light brown		
	12	100		SP-SM				3/8" Bentonite Chips (66' - 70.5' bgs)
						69.0	4456.3	
						S.A.A., wet		
70								
				SP-SM				
						72.5	4452.8	
				ML		72.8 SILT, with fine sand, noncohesive, nonplastic; very soft, wet, dark gray (10YR 4/1)	4452.5	
				SP-SM		74.0 SAND, very fine to fine-grained, with silt; loose, moist to wet, brown	4451.3	
	13	47	3.0			SILTY SAND; very stiff, moist, grayish brown		
75				SM				
						76.0	4449.3	0.010 Slotted Pipe (73' - 93' bgs)
						S.A.A., dry		
				SM				
						78.3	4447.0	
				SP-GP		79.0 SAND, very fine to fine-grained, with gravel; stiff, dry, light gray	4446.3	
						S.A.A., medium stiff, moist		
80								
				SP-GP				
						82.0 ▽	4443.3	10/20 Silica

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 20:25 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

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AECOM

WELL NUMBER MW-46B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
85	14	30				No recovery	Sandpack (70.5' - 93' bgs) 0.010 Slotted Pipe (73' - 93' bgs)
						89.0 4436.3	
90	15	100		SP		SAND, very fine to fine-grained, trace silt, compact but breaks in hand; wet, brown @93.5' bgs: <1 inch of CALICHE; hard, dry, light gray	Total Depth of Well 93' bgs Native Clay Below Well - Natural Collapse
						94.0 4431.3	

Bottom of borehole at 94.0 feet.

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:11 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

WELL NUMBER MW-47B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DATE STARTED 8/8/2016 **COMPLETED** 8/9/2016 **GROUND ELEVATION** 4520.426 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Major Drilling, Inc **GROUND WATER LEVELS:**

DRILLING METHOD Rotary Sonic **AT TIME OF DRILLING** ---

LOGGED BY Jeremy Hurshman **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 590358.4 N 734848.3 E **AFTER DRILLING** 69.00 ft / Elev 4451.43 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
0								Casing Top Elev: 2.169 (ft) Casing Type: 2" PVC Pipe Top of Casing (2.169' ags)
				ML		SILT, trace gravel, rootlets near surface, topsoil; dry, dark brown		
							3.0 / 4517.4	
				SP		SILT, with very fine-grained sand; dry, tan		
5	1	100					6.0 / 4514.4	
				SW-GP		SAND, well graded, with 30% round gravel and cobbles (max 3"), no odor or staining; dry, tan		
							9.0 / 4511.4	
10				SP		SAND, poorly graded, with 25% subround gravel and 15% silt, few cobbles, no odor or staining; dry, light tan Material very hot from core barrel		Grout (0' - 62' bgs)
	2	100						PVC Pipe (2.169' ags - 89' bgs)
15							16.0 / 4504.4	
				SP		SAND, fine-grained; loose, slightly moist, light tan @17' bgs: .5" thick cemented zone		
	3	100						
20							20.0 / 4500.4	
				CALICHE		CALICHE, sandy, breaks into discs, broken from drilling; hard, wet (due to drilling waters), white		
	4	100					22.0 / 4498.4	
				ML		SILT, little sand, trace clay, low plasticity, crumbles; moist, light tan to white		
							24.0 / 4496.4	
25				SM		SILTY SAND, fine-grained, trace clay; dry, light tan to white		

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LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:11 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
25				SM		SILTY SAND, fine-grained, trace clay; dry, light tan to white @25.4-26.5' bgs: caliche modules		
	5	100				26.5	4493.9	
				SM		SILTY SAND, fine-grained, no odor or staining; dry to moist, medium tan		
						29.0	4491.4	
30				SP		SAND, fine grained, few hard cemented sand nodules, trace fines; hard, wet (due to drilling waters)		
						30.3	4490.1	
				ML		SILT, minor fine-grained sand, few white caliche nodules; moist to dry		
	6	100				31.7	4488.7	
				ML		SILT, with very fine-grained sand, crumbles; medium tan to brown		
						34.0	4486.4	Grout (0' - 62' bgs)
35				SM		SILTY SAND, fine-grained; soft, wet (due to drilling waters)		
						35.0	4485.4	
				SP		SAND, fine-grained, with sandstone lenses, water in fractures, minor silt, no odor; stiff to very stiff		PVC Pipe (2.169' ags - 89' bgs)
	7	100				36.7	4483.7	
				SM		SILTY SAND, fine-grained, no odor or staining, crumbles; light tan to brown could be siltstone		
						39.0	4481.4	
40				SANDSTONE		SILTY SANDSTONE, very fine-grained; hard, wet in fractures, dry in macro core, light tan		
						40.5	4479.9	
	8	100		SP-SM		SAND, fine-grained, with silt; loost, moist to wet (water in borehole), medium to dark brown		
						44.0	4476.4	
				SP		SAND, fine-grained, subround to round, minor silt; loose, moist to wet, tan to light tan		
45						45.0	4475.4	
				SP		S.A.A., dry		
	9	100				@49-50' bgs: wet (due to drilling waters)		
						@50-53' bgs: moist, grayish brown		
50								
	10	100				53.5	4466.9	

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
				SP		54.0 SAND, fine-grained, minor medium-grained sand, compact and hard lenses of gray clay/silt; tan 4466.4	
55						SILTY SAND, fine-grained, no odor or staining; loose, dry to moist @54-55' bgs: moist (due to drilling waters)	
	11	100		SM			
60						60.0 4460.4	
	12	50		SM		SILTY SAND, fine-grained, sloppy; very wet (due to drilling waters) mainly sluff	
						64.0 4456.4	
65						SILTY SAND, fine-grained; loose, dry (moist to wet at top of core due to drilling water), light tan	
	13	100		SM			
						69.0 ▽ 4451.4	
70						SILTY SAND; moist to wet (slightly compact in wet zone), light brownish tan	
	14	100		SM			
						74.0 4446.4	
75						S.A.A., slightly stiff @75-76' bgs: moist, gray	
	15	100		SM			
80						80.0 4440.4	
				SM		SILTY SAND, breaks with hands; wet, brown	

Grout (0' - 62' bgs)
PVC Pipe (2.169' ags - 89' bgs)
3/8" Bentonite Chips (62' - 67' bgs)
10/20 Silica Sandpack (67' - 89' bgs)
0.010 Slotted Pipe (69' - 89' bgs)

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AECOM

WELL NUMBER MW-47B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
85	16	100		SM		SILTY SAND, breaks with hands; wet, brown	10/20 Silica Sandpack (67' - 89' bgs); 0.010 Slotted Pipe (69' - 89' bgs); Total Depth of Well 89' bgs
						89.0 4431.4 Bottom of borehole at 89.0 feet.	

LGE GHENT SOIL-WELL LOG - GHENT.GDT - 10/10/16 15:11 - C:\BISMARK GINT\LRS - 60506860 2.01\LRS_091516.GPJ

WELL NUMBER MW-22B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DATE STARTED 8/18/1982 **COMPLETED** 8/18/1982 **GROUND ELEVATION** 4565.87 ft **HAMMER TYPE**

DRILLING CONTRACTOR Northern Testing Laboratories **GROUND WATER LEVELS:**

DRILLING METHOD B-53 Rock Bit **AT TIME OF DRILLING** ---

LOGGED BY **CHECKED BY** **AT END OF DRILLING** ---

COORDINATES 587159.1 N 729587.2 E **AFTER DRILLING** 77.60 ft / Elev 4488.27 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0						SILTY SAND, with gravel	Casing Top Elev: 0 (ft) Casing Type: 4" PVC Pipe Top of Casing (estimated 3' ags)
10							ASTM C-33 Concrete Fines (0' - 60' bgs) 4" Sch. 40 PVC Pipe (3' ags - 96' bgs)
				SM			
20							
30							
						36.0 4529.9	
						SANDSTONE	
40							
			SANDSTONE				
50							

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AECOM

WELL NUMBER MW-22B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
50						SANDSTONE	ASTM C-33 Concrete Fines (0' - 60' bgs)
60							
70						SANDSTONE	
80							Sandpack (60' - 96' bgs)
90							#12 Pipe (66.3' - 96' bgs)
						96.0 4469.9 Bottom of borehole at 96.0 feet.	Total Depth of Well 96' bgs

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WELL NUMBER MW-23B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DATE STARTED 8/21/1982 **COMPLETED** 8/21/1982 **GROUND ELEVATION** 4565.07 ft **HAMMER TYPE**

DRILLING CONTRACTOR Northern Testing Laboratories **GROUND WATER LEVELS:**

DRILLING METHOD B-53 Rock Bit **AT TIME OF DRILLING** ---

LOGGED BY **CHECKED BY** **AT END OF DRILLING** ---

COORDINATES 587179.9 N 728811.2 E **AFTER DRILLING** 36.00 ft / Elev 4529.07 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0							Casing Top Elev: 0 (ft) Casing Type: 4" PVC Pipe Top of Casing (estimated 4' ags)
						SILTY SAND, with gravel	
10							ASTM C-33 Concrete Fines (0' - 55' bgs) 4" Sch. 40 PVC Pipe (4' ags - 90' bgs)
				SM			
20							
30							
						34.0 4531.1	
						SANDSTONE	
40							
						SANDSTONE	
50							

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AECOM

WELL NUMBER MW-23B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
50						SANDSTONE	ASTM C-33 Concrete Fines (0' - 55' bgs)
60							
70				SANDSTONE			Sandpack (55' - 90' bgs)
							#12 Pipe (60.2' - 90' bgs)
80							
90					90.0	4475.1	Total Depth of Well 90' bgs
						Bottom of borehole at 90.0 feet.	

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AECOM

WELL NUMBER MW-48B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DATE STARTED 7/8/2017 **COMPLETED** 7/8/2017 **GROUND ELEVATION** 4571.27 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR O'Keefe Drilling **GROUND WATER LEVELS:**

DRILLING METHOD Sonic Track Rig **AT TIME OF DRILLING** ---

LOGGED BY C. Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 587197.1 N 728402.3 E **AFTER DRILLING** 80.21 ft / Elev 4491.06 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0							Casing Top Elev: 0 (ft) Casing Type: 2" PVC Pipe WELL DIAGRAM Top of Casing (estimated 2.5' ags)
				ML		SANDY SILT, with gravel, nonplastic, noncohesive; hard (>4.0 qu tsf), moist, brown	
5	SONIC	100					
						7.0 4564.3	
				SM		SILTY SAND, very fine to medium sand, with subrounded gravel; hard, moist, brown	
10						10.0 4561.3	Neat Cement (0' - 71' bgs)
				ML		SANDY SILT, with gravel, nonplastic; hard, moist, brown	2" Sch. 40 PVC Pipe (2.5' ags - 100' bgs)
15	SONIC	100					
						16.0 4555.3	
				SM		SILTY SAND, very fine to medium sand, with subrounded gravel; hard, moist, brown	
20						20.0 4551.3	
				ML		SANDY SILT, very fine to fine sand, with gravel, nonplastic, noncohesive; hard, moist, brown	
						22.0 4549.3	
				SM		SILTY SAND, very fine to fine sand, with subrounded gravel; hard, moist, brown	
25	SONIC	100					
						27.0 4544.3	
				GW		WELL GRADED GRAVEL, subrounded gravel, with very fine to medium sand; loose, moist, gray	
30							
						33.0 4538.3	
				ML		SILT, with sand, nonplastic, noncohesive; hard, wet (due to drilling), brown	
35	SONIC	100					
40						40.0 4531.3	

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
40				QUARTZITE		41.0 QUARTZITE; hard, moist, brown	4530.3	
				ML		SANDY SILT, nonplastic, noncohesive; soft, moist, brownish gray		
45	SONIC	100				45.0 SANDSTONE, thinly bedded, sand grains visible; hard, moist, brown	4526.3	
50				SANDSTONE				
55	SONIC	100				54.5 SILTY SAND, very fine to fine sand; loose, moist, brown	4516.8	
				SM				
60						60.0 WELL GRADED SAND, very fine to fine sand, with some silt; loose, moist, brown	4511.3	
65	SONIC	100						Neat Cement (0' - 71' bgs)
						S.A.A., .5" layers of sandstone		
70				SW		S.A.A., .5" lenses of quartzite		
75	SONIC	100				S.A.A., no quartzite or sandstone		3/8" Bentonite Chips (71'-75' bgs) 2" Sch. 40 PVC Pipe (2.5' ags - 100' bgs)
80						80.0 ▼	4491.3	
				SW		80.5 WELL GRADED SAND; medium stiff, moist to wet, brown	4490.8	
				GW-GM		81.0 WELL GRADED GRAVEL, with silt and very fine to fine sand; loose, wet, brownish gray	4490.3	1020 Silica Sandpack (75' - 100' bgs)
				SW-SM		WELL GRADED SAND, very fine to fine sand, with silt, some .5" interbedded lenses of sandstone; medium stiff, wet, brown		0.010 Slotted Pipe (80' - 100' bgs)
85	SONIC	100						

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AECOM

WELL NUMBER MW-48B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
90						WELL GRADED SAND, very fine to fine sand, with silt, some .5" interbedded lenses of sandstone; medium stiff, wet, brown	1020 Silica Sandpack (75' - 100' bgs)
				SW-SM			0.010 Slotted Pipe (80' - 100' bgs)
95	SONIC	100					
100						100.0 4471.3	Total Depth of Well 100' BGS

EOB = 100' bgs, no refusal

Bottom of borehole at 100.0 feet.

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AECOM

WELL NUMBER MW-49B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DATE STARTED 7/9/2017 **COMPLETED** 7/13/2017 **GROUND ELEVATION** 4566.97 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR O'Keefe Drilling **GROUND WATER LEVELS:**

DRILLING METHOD Sonic Track Rig **AT TIME OF DRILLING** ---

LOGGED BY C. Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 587153.4 N 729978.4 E **AFTER DRILLING** 79.22 ft / Elev 4487.75 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
0								Casing Top Elev: 0 (ft) Casing Type: 2" PVC Pipe Top of Casing (flush mount)
				SW-SC		WELL GRADED SAND, very fine to fine sand, with clay and gravel; medium stiff, moist, brown		
							3.0 4564.0	
				ML		SILT, with very fine to fine sand, nonplastic, noncohesive; medium stiff, moist, brown		
5	SONIC	100					5.0 4562.0	
				SW-SC		WELL GRADED SAND, very fine sand, with clay; medium stiff, moist, brown		
10								Neat Cement (0' - 74' bgs)
						S.A.A., little gravel		2" Sch. 40 PVC Pipe (0' bgs - 100' bgs)
							12.0 4555.0	
15	SONIC	100		ML		SILT, with very fine to fine sand, little gravel; hard, moist, grayish brown @17-17.4' bgs: S.A.A., organic-like odor, dark gray		
						S.A.A., no odor		
20						S.A.A., with gravel		
							24.0 4543.0	
25	SONIC	100		SW-SM		WELL GRADED SAND, very fine to fine sand, with silt; hard, moist, brownish gray	26.0 4541.0	
				ML		SILT, with sand, nonplastic, noncohesive; hard, moist, brownish gray		
30								
							32.0 4535.0	
				SW-SM		WELL GRADED SAND, very fine to fine sand, with silt, no gravel; hard, moist, brownish gray		
35	SONIC	100						
							38.0 4529.0	
				GW		WELL GRADED GRAVEL, some very fine to fine sand, trace fines; loose, moist, brown	39.0 4528.0	
40				ML			40.0 4527.0	

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
40								
						SILT, with sand, nonplastic, noncohesive; hard, moist, light brown		
						WELL GRADED SAND, very fine to fine sand, with silt; dense, moist, brown		
45	SONIC	70		SW-SM				
50						50.0	4517.0	
						WELL GRADED SAND, very fine to fine sand, little silt; loose, moist, brown		
55	SONIC	100		SW		S.A.A., .5" interbedded quartzite		
60								
						63.0	4504.0	
				SANDSTONE		63.5 SANDSTONE, horizontal fractures, trace sand; hard, dry, white brown	4503.5	
						WELL GRADED SAND, very fine to fine; loose, moist, brown		
65	SONIC	100						
70				SW				Neat Cement (0' - 74' bgs)
75	SONIC	100				75.0	4492.0	
				SANDSTONE		76.0 SANDSTONE, horizontal fractures; hard, moist, whitish brown	4491.0	3/8" Bentonite Chips (74'-78' bgs)
						WELL GRADED SAND, very fine to fine sand, little silt; medium dense, moist, brown		2" Sch. 40 PVC Pipe (0' bgs - 100' bgs)
				SW				
80						80.0	4487.0	
				SW		81.0 WELL GRADED SAND, very fine to fine sand; stiff, moist, brown	4486.0	
						SANDSTONE, massive, platey; hard, wet, brown		1020 Silica Sandpack (78' - 100' bgs)
				SANDSTONE				0.010 Slotted Pipe (80' - 100' bgs)
85	SONIC	100						

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AECOM

WELL NUMBER MW-49B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
90				SANDSTONE		SANDSTONE, massive, platey; hard, wet, brown		1020 Silica Sandpack (78' - 100' bgs) 0.010 Slotted Pipe (80' - 100' bgs)
						91.0	4476.0	
				SANDSTONE		92.0 SANDSTONE, weathered, with very fine to fine sand; stiff, wet, brown	4475.0	
95	SONIC	100		SW		WELL GRADED SAND, very fine to fine sand, some silt, trace gravel; medium stiff, wet, brown		
100						100.0	4467.0	Total Depth of Well 100' bgs
						EOB = 100' bgs, no refusal Bottom of borehole at 100.0 feet.		

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AECOM

WELL NUMBER MW-50B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DATE STARTED 7/6/2017 **COMPLETED** 7/6/2017 **GROUND ELEVATION** 4590.95 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR O'Keefe Drilling **GROUND WATER LEVELS:**

DRILLING METHOD Sonic Track Rig **AT TIME OF DRILLING** ---

LOGGED BY C. Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 586231.9 N 728742.5 E **AFTER DRILLING** 93.61 ft / Elev 4497.34 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0							Casing Top Elev: 0 (ft) Casing Type: 2" PVC Pipe Top of Casing (flush mount)
						SILT, with sand, little gravel, nonplastic, noncohesive; stiff, moist (wet due to drilling), light brownish gray	
5	SONIC	80		ML		S.A.A., increasing gravel	
10						10.0 4581.0	Neat Cement (0' - 86.5' bgs)
				GW		WELL GRADED GRAVEL, rounded gravel, with silt and very fine to fine sand; loose, moist, light brownish gray	2" Sch. 40 PVC Pipe (0' bgs - 120' bgs)
						11.0 4580.0	
				ML		SILT, with very fine sand, nonplastic, noncohesive; stiff, moist (wet due to drilling), light brownish gray	
15	SONIC	100					
						16.0 4575.0	
						SANDY SILT, very fine sand, nonplastic, noncohesive; stiff, moist, light brownish gray	
20							
				ML			
25	SONIC	100					
						27.0 4564.0	
						GRAVELLY SILT, nonplastic, noncohesive; stiff, moist, brown	
				ML			
30						30.0 4561.0	
						SANDY SILT, with gravel, nonplastic, noncohesive; stiff, moist, light brown	
35	SONIC	100		ML			
40						40.0 4551.0	

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
40								
				SW		WELL GRADED SAND, very fine to medium sand; medium stiff, moist, brown		
						44.0	4547.0	
45	SONIC	100		ML		SILT, with very fine sand, trace rounded gravel, nonplastic, noncohesive; medium stiff, moist, light brown	4546.0	
						45.0		
						WELL GRADED SAND, very fine to medium sand; loose, moist, brown, no oxidation		
				SW				
50						50.5	4540.5	
						SANDSTONE; very stiff, dry, brown		
55	SONIC	100		SANDSTONE				
						59.0	4532.0	
60				SW		WELL GRADED SAND, very fine to medium sand, little silt, trace gravel; loose, moist, brown	4531.0	
						60.0		
						WELL GRADED SAND, very fine to fine sand, with <1" interbedded sandstone lenses, some silt; loose, moist, brown		
65	SONIC	100						
								Neat Cement (0' - 86.5' bgs)
70				SW		S.A.A., with fine silt and .5-1" sandstone lenses		2" Sch. 40 PVC Pipe (0' bgs - 120' bgs)
75	SONIC	100						
80								
						81.0	4510.0	
				SANDSTONE		SANDSTONE, blocky, with little sand; ahrd, dry, brown	4509.0	
						82.0		
						WELL GRADED SAND, very fine to fine sand, some silt, no gravel; loose, moist, brown		
				SW				
85	SONIC	100						

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AECOM

WELL NUMBER MW-50B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
90						WELL GRADED SAND, very fine to fine sand, some silt, no gravel; loose, moist, brown		3/8" Bentonite Chips (86.5'-89.5' bgs)
								2" Sch. 40 PVC Pipe (0' bgs - 120' bgs)
				SW		S.A.A., medium dense		Natural Cave In
95	SONIC	100						
						S.A.A., wet		
100						100.0	4491.0	
				QUARTZITE		101.0 QUARTZITE, cleavage planes; very hard, moist, brown	4490.0	
						SILTY SAND, very fine to fine sand; medium stiff, wet, brown, no oxidation or staining		
105	SONIC	100		SM				1020 Silica Sandpack (97' - 120' bgs)
110						111.0	4480.0	0.010 Slotted Pipe (100' - 120' bgs)
						WELL GRADED SAND, very fine to fine sand, with silt; medium dense, wet, brown		
115	SONIC	100		SW		S.A.A., .5" sandstone lenses		
120						120.0	4471.0	Total Depth of Well 120' bgs
						EOB = 120' bgs, no refusal Bottom of borehole at 120.0 feet.		

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AECOM

WELL NUMBER MW-51B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DATE STARTED 6/29/2017 **COMPLETED** 7/1/2017 **GROUND ELEVATION** 4591.51 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR O'Keefe Drilling **GROUND WATER LEVELS:**

DRILLING METHOD Sonic Track Rig **AT TIME OF DRILLING** ---

LOGGED BY C. Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 586215.1 N 729312.9 E **AFTER DRILLING** 95.22 ft / Elev 4496.29 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0							Casing Top Elev: 0 (ft) Casing Type: 2" PVC Pipe Top of Casing (flush mount)
						GRAVELLY CLAY, lean, with sand, nonplastic, noncohesive, massive, no odor or staining; hard (>4.0 qu tsf), moist, grayish brown	
5	SONIC	100					
10				CL		10.0 4581.5	Neat Cement (0' - 93.5' bgs)
						S.A.A., decreasing gravel	2" Sch. 40 PVC Pipe (0' bgs - 120' bgs)
15	SONIC	100				15.0 4576.5	
						S.A.A., increasing gravel	
20						20.0 4571.5	
				GW-GC		WELL GRADED GRAVEL, rounded gravel, with very fine to coarse sand and clay; dense, moist, light brownish gray	
						22.0 4569.5	
						WELL GRADED SAND, very fine to medium sand, with clay; hard, moist, light brown	
25	SONIC	100					
30						30.0 4561.5	
				SW-SC		S.A.A., with rounded gravel	
35	SONIC	100				35.0 4556.5	
						S.A.A., little gravel	
40						40.0 4551.5	

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
40						SILT, with very fine sand, nonplastic, noncohesive; hard, moist, light brown		
						43.0	4548.5	
45	SONIC	100		SW-SM		WELL GRADED SAND, very fine to medium sand, with silt; loose, moist, light brown, mottled gray and orange		
						48.0	4543.5	
				SW		WELL GRADED SAND, fine to coarse sand, little silt; loose, moist, dark gray		
50						49.5	4542.0	
						S.A.A., with rounded gravel		
						51.0	4540.5	
						SILT, trace very fine sand, nonplastic, noncohesive, soft; loose, moist, light brown		
55	SONIC	100				55.0	4536.5	
						S.A.A., hard, moist		
60						60.0	4531.5	
				ML		S.A.A., hard		
65	SONIC	100						
								Neat Cement (0' - 93.5' bgs)
70						70.0	4521.5	2" Sch. 40 PVC Pipe (0' bgs - 120' bgs)
				ML		SANDY SILT, very fine sand, nonplastic, noncohesive; medium stiff, moist, light brown		
						74.5	4517.0	
75	SONIC	100		SANDSTONE		75.0 SANDSTONE; hard, moist, brown	4516.5	
						SILTY SAND, fine sand; medium dense, moist, light brown		
80						80.0	4511.5	
				SM		S.A.A., little gravel		
85	SONIC	70						

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AECOM

WELL NUMBER MW-51B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
				SM		SILTY SAND, fine sand, little gravel; medium dense, moist, light brown		
						89.0	4502.5	
90			SANDSTONE			90.0 SANDSTONE, thinly bedded; hard, moist, brown	4501.5	
				ML		SILT, nonplastic, noncohesive, massive; very stiff, moist, light grayish brown		
95	SONIC	40				▼		3/8" Bentonite Chips (93.5'-96.0' bgs) 2" Sch. 40 PVC Pipe (0' bgs - 120' bgs)
100						100.0	4491.5	
	SONIC	100				SILTY SAND, very fine sand, little sandstone fragments; medium stiff, wet, brown, no oxidation (100-105' bgs: expansive soil, expanded 10%)		
105				SM		105.0	4486.5	
	SONIC	100				S.A.A., stiff (105-110' bgs: expansive soil, expanded 10%)		
110						110.0	4481.5	1020 Silica Sandpack (96' - 120' bgs)
	SONIC	100		SW		WELL GRADED SAND, very fine to fine, with sandstone; very stiff, wet, light brown (110-115' bgs: expansive soil, expanded 10%)		0.010 Slotted Pipe (100' - 120' bgs)
						113.0	4478.5	
115			MUDSTONE			MUDSTONE, with very fine to fine sand, layered, thinly bedded, platey; very stiff, moist, light brown (115-120' bgs: expansive soil, expanded 10%) 115.0	4476.5	
	SONIC	100		ML		SILT, with sand, very fine sand, nonplastic, noncohesive; medium stiff, moist, light brown		
120						120.0	4471.5	Total Depth of Well 120' bgs

EOB = 120' bgs, no refusal

Bottom of borehole at 120.0 feet.

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AECOM

WELL NUMBER MW-52B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DATE STARTED 6/23/2017 **COMPLETED** 6/27/2017 **GROUND ELEVATION** 4592.21 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR O'Keefe Drilling **GROUND WATER LEVELS:**

DRILLING METHOD Sonic Track Rig **AT TIME OF DRILLING** ---

LOGGED BY C. Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 586198 N 729809.7 E **AFTER DRILLING** 96.75 ft / Elev 4495.46 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		Casing Top Elev: 0 (ft) Casing Type: 2" PVC Pipe WELL DIAGRAM
0								Top of Casing (flush mount)
				CL		0.8 Top .75" road bed	4591.5	
				ML		SANDY SILT, very fine sand, nonplastic, noncohesive; soft, moist, grayish brown		
5	SONIC	80						
10						10.0	4582.2	Neat Cement (0' - 98.6' bgs)
				ML		SILT, with sand, nonplastic, noncohesive; very stiff (3.0 qu tsf), moist, brownish gray		2" Sch. 40 PVC Pipe (0' bgs - 125' bgs)
						12.0	4580.2	
	SONIC	90		ML		SANDY SILT, trace gravel, nonplastic, noncohesive, no odor or staining; medium dense, moist, brownish grat		
15						14.0	4578.2	
				CL		SANDY CLAY, lean, subrounded gravel, nonplastic, noncohesive, no oxidation or staining; soft, moist (wet due to drilling), light grayish brown		
	SONIC	90				S.A.A., decreasing gravel; stiff		
20						20.0	4572.2	
				CL		SANDY CLAY, lean; hard (>4.0 qu tsf), moist, light brownish gray		
25	SONIC	95				S.A.A., increasing sand, little subangular gravel; moist		
30						30.0	4562.2	
				GW		31.0 WELL GRADED GRAVEL, subrounded gravel; loose, moist (wet due to drillering), gray	4561.2	
				CL		SANDY CLAY, with gravel; very stiff, moist, grayish brown		
35	SONIC	80				35.0	4557.2	
				SW		WELL GRADED SAND, very fine to fine sand, with white deposits (calcite); medium stiff, moist, brown, no oxidation		
40								

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
40				SW		42.0 4550.2 S.A.A., dark brown	
						SILTY SAND; loose, moist (wet due to drilling), light brownish gray	
45	SONIC	80					
						S.A.A., very fine sand; hard, brown, no oxidation	
50				SM			
						S.A.A., thin lenses of 1-2 mm of calcite deposits	
55	SONIC	100				S.A.A., light olive green with brown oxidation spots	
						58.5 4533.7 S.A.A., trace gravel; light brown	
60			SANDSTONE			60.0 4532.2 SANDSTONE, very fine to medium sand, thinly bedded; hard, moist, light brown	
			QUARTZITE			60.3 4532.0 3" of quartzite, hard, laminated, visible sand	
						SAND, with silt; loose, moist, light brown	
						S.A.A., blocky lenses of sand with silt, very fine to fine sand; moist	
65	SONIC	100		SW-SM		S.A.A., hard	
						S.A.A., very fine to fine sand, soft; loose	
							Neat Cement (0' - 98.6' bgs)
70						S.A.A., with little gravel	
			QUARTZITE			70.3 4522.0 3" of quartzite, hard, laminated, visible sand	2" Sch. 40 PVC Pipe (0' bgs - 125' bgs)
						SAND, with silt, very fine to fine sand, no odor or stain; loose, moist (wet due to drilling), brown	
75	SONIC	30		SP-SM			
80						80.0 4512.2	
						SANDY SILT, very fine sand, nonplastic, noncohesive; soft, moist, brown	
				ML			
85	SONIC	100					

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AECOM

WELL NUMBER MW-52B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
				ML		SANDY SILT, very fine sand, nonplastic, noncohesive; soft, moist, brown		
90						90.0	4502.2	
				ML		SANDY SILT, with 1" sandstone lenses, nonplastic, noncohesive; loose, moist, brown		
						91.0	4501.2	
				QUARTZITE		QUARTZITE, layered; hard, moist, gray		
						92.0	4500.2	
				SILTSTONE		SILTSTONE, little very fine sand; hard, moist, brown		
						93.0	4499.2	
						SILTY SAND, very fine sand; medium stiff, moist, brown, no oxidation		
95	SONIC	30		SM				
						98.0	4494.2	
				QUARTZITE		QUARTZITE, fractured; hard, wet, white gray		
						98.5	4493.7	
100						SILT, with very fine sand, nonplastic, noncohesive; medium stiff, moist		3/8" Bentonite Chips (98.6'-101' bgs)
				ML				2" Sch. 40 PVC Pipe (0' bgs - 125' bgs)
						102.0	4490.2	
	SONIC	85		QUARTZITE		QUARTZITE; hard, moist, white gray		
105						105.0	4487.2	
				ML		SILT, with very fine sand and thin lenses of interbedded sandstone, nonplastic, noncohesive; medium stiff, moist, brown		
	SONIC	0						
110								
						113.0	4479.2	1020 Silica Sandpack (96' - 125' bgs)
				ML		GRAVELLY SILT, angular gravel, with very fine sand, nonplastic, noncohesive; soft, wet, light brown		0.010 Slotted Pipe (105' - 125' bgs)
115	SONIC	0						
120								
						120.5	4471.7	
	SONIC	100		SW-SM		WELL GRADED SAND, very fine sand, with silt; hard, wet, brown		
125						125.0	4467.2	Total Depth of Well 125' bgs

EOB = 125' bgs, no refusal

Bottom of borehole at 125.0 feet.

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AECOM

WELL NUMBER MW-53B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DATE STARTED 6/20/2017 **COMPLETED** 6/28/2017 **GROUND ELEVATION** 4591.84 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR O'Keefe Drilling **GROUND WATER LEVELS:**

DRILLING METHOD Sonic Track Rig **AT TIME OF DRILLING** ---

LOGGED BY C. Ahrendt **CHECKED BY** A. Lanning **AT END OF DRILLING** ---

COORDINATES 586189 N 730213.8 E **AFTER DRILLING** 97.06 ft / Elev 4494.78 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION		WELL DIAGRAM
0				GW		0.5 WELL GRADED GRAVEL (road bed), with sand; loose, dry, gray	4591.3	Top of Casing (flush mount)
				ML		1.0 SILT, with sand, bedded, nonplastic, noncohesive; stiff, dry, brown	4590.8	
						No recovery		
5	SONIC	10						
10						10.0	4581.8	Neat Cement (0' - 95' bgs)
				ML		SILT, with sand, bedded, nonplastic, noncohesive; soft, moist, light brown @10-12' bgs: with WHITE SPOTS		2" Sch. 40 PVC Pipe (0' bgs - 120' bgs)
15	SONIC	100				16.5	4575.3	
						WELL GRADED SAND, very fine to fine, with silt; hard (>4.0 qu tsf), moist, brown, no oxidation or staining		
20						S.A.A., medium dense, light brown		
25	SONIC	100		SW-SM		S.A.A., very dense blocky, white calcite deposits, no odor or staining		
30								
35	SONIC	60				36.5 S.A.A., decreasing fines	4555.3	
				MUDSTONE		37.5 MUDSTONE, blocky, bedded; hard (>4.0 qu tsf), moist, brown (10YR 4/3)	4554.3	
				SANDSTONE		SANDSTONE, little silt and sand; dense, moist, light brown		
40						40.0	4551.8	

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CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
40						No recovery	
45	SONIC	30					
						47.0 4544.8	
50						SANDSTONE, some very fine sand, thinly bedded; dense, moist, light brown	
			SANDSTONE				
55	SONIC	30					
						57.0 4534.8	
60				SW		WELL GRADED SAND, very fine to fine sand, trace silt; medium dense, moist, grayish brown S.A.A., dense, moist, light brown	
						60.0 4531.8	
65	SONIC	50		ML		GRAVELLY SILT, subrounded gravel, with very fine to fine sand, nonplastic, noncohesive; soft, moist, light brown	
							Neat Cement (0' - 95' bgs)
70						70.0 4521.8	2" Sch. 40 PVC Pipe (0' bgs - 120' bgs)
						WELL GRADED SAND, very fine sand, with silt; loose, moist, light brown, no oxidation or staining	
75	SONIC	100					
				SW-SM			
80						S.A.A., medium stiff, light brown	
	SONIC	100					
85							

(Continued Next Page)

AECOM

WELL NUMBER MW-53B

CLIENT Basin Electric **PROJECT NAME** Laramie River Station

PROJECT NUMBER 60506860 **PROJECT LOCATION** Wheatland, Wyoming

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
						87.0 4504.8	
90	SONIC	100				SILT, with sand, nonplastic, noncohesive; medium stiff, moist, light brown	
95	SONIC	100		ML			
						97.0 4494.8	3/8" Bentonite Chips (95'-98' bgs)
100	SONIC	0				No recovery	2" Sch. 40 PVC Pipe (0' bgs - 120' bgs)
						100.0 4491.8	
				GW-GM		100.5 4491.3 WELL GRADED GRAVEL, rounded gravel, with silt; medium dense, wet, light brown	
105	SONIC	100		ML		SANDY SILT, slow dilatency, nonplastic, noncohesive; stiff (1.5 qu tsf), wet, grayish brown	
110						110.0 4481.8	1020 Silica Sandpack (98' - 120' bgs)
						SANDSTONE, fractured, layered, with very fine to coarse sand; hard, wet, brown	0.010 Slotted Pipe (100' - 120' bgs)
115	SONIC	25	SANDSTONE				
120						120.0 4471.8	Total Depth of Well 120' bgs
						EOB = 120' bgs, no refusal Bottom of borehole at 120.0 feet.	

WELL LOG - .GDT - 9/21/17 11:28 - C:\BASIN ELECTRIC SEPT 2017\BASINELECTRIC_091917.GPJ

Appendix B

Aquifer Test Procedures, Data and Analysis

PUMPING TEST DATA FORM (Slug Test)

Well ID	MW-33B	Personnel	Hershman
Location	Basin Electric LRS	Static Water Level	~~66.8~~ JH 69.88
Type of Well	Monitoring well	Extraction Well Distance	—
Test Date	8/22/16	Total Casing Depth	86.90
Measuring Point Elevation	TOC - TBD	Borehole Diameter	6 inch
Type of Test	Slug Test	Casing Diameter	2 inch
Step Number	—	Screened Interval	
Data logger Test Run No.	1	Sand Pack Interval	
Pumping Rate	—	Lithology Tested	
Test Start Time		Test End Time	

Slug = 64 x 1 inch

Time	Elapsed Time (min)	Water Depth (ft)	Time	Elapsed Time (min)	Water Depth (ft)
1321	0	69.80			
1322	Start Test	NM			
1323	Slug In	NM			
1325	4 min	69.77			
1336	15 min	69.88			
1337	16 min	Slug out			
1339	18 min	70.09			
1345	24 min	69.91			
1349	28 min	69.90			
1356	35 min	69.89			
1358	37 min	Stopped test			

See transducer data for details on Test.

PUMPING TEST DATA FORM (Slug Test)

Well ID	MW-35B	Personnel	Hurshman
Location	Basin Electric LRS	Static Water Level	66.43
Type of Well	Monitoring well	Extraction Well Distance	—
Test Date	8/22/16	Total Casing Depth	88.31
Measuring Point Elevation	TOC - TBD	Borehole Diameter	6 inch
Type of Test	Slug Test	Casing Diameter	2 inch
Step Number	NA	Screened Interval	
Data logger Test Run No.	1	Sand Pack Interval	
Pumping Rate	—	Lithology Tested	
Test Start Time	1055	Test End Time	1126

Slug = 6 ft x 1 inch

Time	Elapsed Time (min)	Water Depth (ft)	Time	Elapsed Time (min)	Water Depth (ft)
1054	Ø	66.42			
1055	Start Slug Test	NM			
1102	7 min	66.41			
1111	16 min	66.42			
1112	17 min	removed slug			
1114	19 min	66.59			
1122	27 min	66.43			
1124	29 min	66.43			
1126	31 min	stopped Test.			

see transducer data for details

PUMPING TEST DATA FORM

Well ID	MW-373	Personnel	Hirshman
Location	Basin Electric LRS	Static Water Level	62.32
Type of Well	Monitoring Well	Extraction Well Distance	—
Test Date	8/19/16	Total Casing Depth	78.53
Measuring Point Elevation	TOC - TBD	Borehole Diameter	6 inch
Type of Test	Slug Test	Casing Diameter	2 inch
Step Number	—	Screened Interval	
Data logger Test Run No.	1	Sand Pack Interval	
Pumping Rate	NA (slug)	Lithology Tested	
Test Start Time	1118	Test End Time	1143

Slug = 6 ft x 1 inch

Time	Elapsed Time (min)	Water Depth (ft)	Time	Elapsed Time (min)	Water Depth (ft)
1117	0	62.36			
1118	Start slug Test	—			
1123	5 min	62.35			
1128	10 min	62.36			
1129	Slug out	NM			
1139	21 min	62.37			
1141	23 min	62.37			
1143	Stopped slug Test				

See transducer data for details.

PUMPING TEST DATA FORM (Slug Test)

Well ID	MW-38B	Personnel	Hunsman
Location	Basin Electric LES	Static Water Level	60.05
Type of Well	Monitoring Well	Extraction Well Distance	—
Test Date	8/22/16	Total Casing Depth	77.75
Measuring Point Elevation	TOC - TBD	Borehole Diameter	6 inch
Type of Test	Slug Test	Casing Diameter	2 inch
Step Number	—	Screened Interval	
Data logger Test Run No.	1	Sand Pack Interval	
Pumping Rate	—	Lithology Tested	
Test Start Time		Test End Time	

Slug = 6 ft x 1 inch.

Time	Elapsed Time (min)	Water Depth (ft)
1637	0	60.08
1638	1 min	Slug in well
1639	2 min	59.76
1644	7 min	59.97
1651	14 min	60.05
1653	16 min	60.07
1659	22 min	60.04 - transducer may have bumped slightly
1700	23 min	Slug out
1703	26 min	60.40
1706	29 min	60.23
1709	32 min	60.15
1712	35 min	60.12
1715	38 min	60.11
1719	42 min	60.10
1722	45 min	60.09
1723	46 min	Stopped Test.

Time	Elapsed Time (min)	Water Depth (ft)

See Transducer for details.

PUMPING TEST DATA FORM (Slug Test)

Well ID	MW-39B	Personnel	Hardman, Alzaidt
Location	Basin Electric LRS	Static Water Level	81.69
Type of Well	Monitoring Well	Extraction Well Distance	—
Test Date	8/23/16	Total Casing Depth	110.71
Measuring Point Elevation	TOC - TBD	Borehole Diameter	6 inch
Type of Test	Slug Test	Casing Diameter	2 inch
Step Number	—	Screened Interval	
Data logger Test Run No.	1	Sand Pack Interval	
Pumping Rate	—	Lithology Tested	
Test Start Time		Test End Time	

Slug - 6 ft x 1 inch

Time	Elapsed Time (min)	Water Depth (ft)	Time	Elapsed Time (min)	Water Depth (ft)
0737	0	81.69			
0738	1 min	Start Test slug in			
0739	2 min	80.78			
0743	6 min	81.54			
0747	10 min	81.67			
0751	14 min	81.69			
0752	15 min	slug out			
0754	17 min	82.42			
0758	21 min	81.75			
0802	25 min	81.72			
0804	27 min	81.71			
0813	36 min	81.71			
0815	58 min	Stopped Test.			

See transducer data for details.

PUMPING TEST DATA FORM (Slug test)

Well ID	MW-42B	Personnel	Hershman
Location	Basin Electric LRS	Static Water Level	46.37
Type of Well	Monitoring Well	Extraction Well Distance	—
Test Date	8/12/16	Total Casing Depth	70.07
Measuring Point Elevation	TOC - TBD	Borehole Diameter	6 inch
Type of Test	Slug test	Casing Diameter	2 inch
Step Number	—	Screened Interval	
Data logger Test Run No.	1	Sand Pack Interval	
Pumping Rate	—	Lithology Tested	
Test Start Time	0844	Test End Time	0907

Slug = 6 ft x 1 inch

Time	Elapsed Time (min)	Water Depth (ft)	Time	Elapsed Time (min)	Water Depth (ft)
0843	Ø	46.36			
0844	start test, slug in well.				
0852	9 min	46.35			
0856	13 min	46.36			
0857	slug out	NM			
0859	16 min	46.56			
0904	21 min	46.36			
0907	Stop test	NM			

See transducer data for details

PUMPING TEST DATA FORM (Slug Test)

Well ID	MW-453	Personnel	Hrubman
Location	Basin Electric LRS	Static Water Level	76.59
Type of Well	Monitoring Well	Extraction Well Distance	—
Test Date	8/18/16	Total Casing Depth	91.18
Measuring Point Elevation	TOC	Borehole Diameter	6 inch
Type of Test	Slug test	Casing Diameter	2 inch
Step Number	—	Screened Interval	
Data logger Test Run No.	Slug test 1	Sand Pack Interval	
Pumping Rate	NA	Lithology Tested	
Test Start Time	13:43	Test End Time	

Slug dimensions: 6 ft x 1 inch diameter

	Time	Elapsed Time (min)	Water Depth (ft)	Time	Elapsed Time (min)	Water Depth (ft)
Slug test 1	1343	0	76.59			
	1345	Slug in	—			
Note: Slug may not have been fully submerged.	1348	5	76.55			
	1352	Slug out				
	1356	13	76.63			
	1401	18	76.63			
	1402	Stop test				
Slug Test 2	1405	0	76.62			
	1406	start test	NM			
	1408	Slug in	NM			
	1418	13	76.57			
	1423	18	76.60			
	1425	Slug out	NM			
	1432	27	76.69			
	1435	30	76.65			
	1438	33	76.64			
	1439	Stopped Test				

See transducer data for details.

PUMPING TEST DATA FORM (Slug Test)

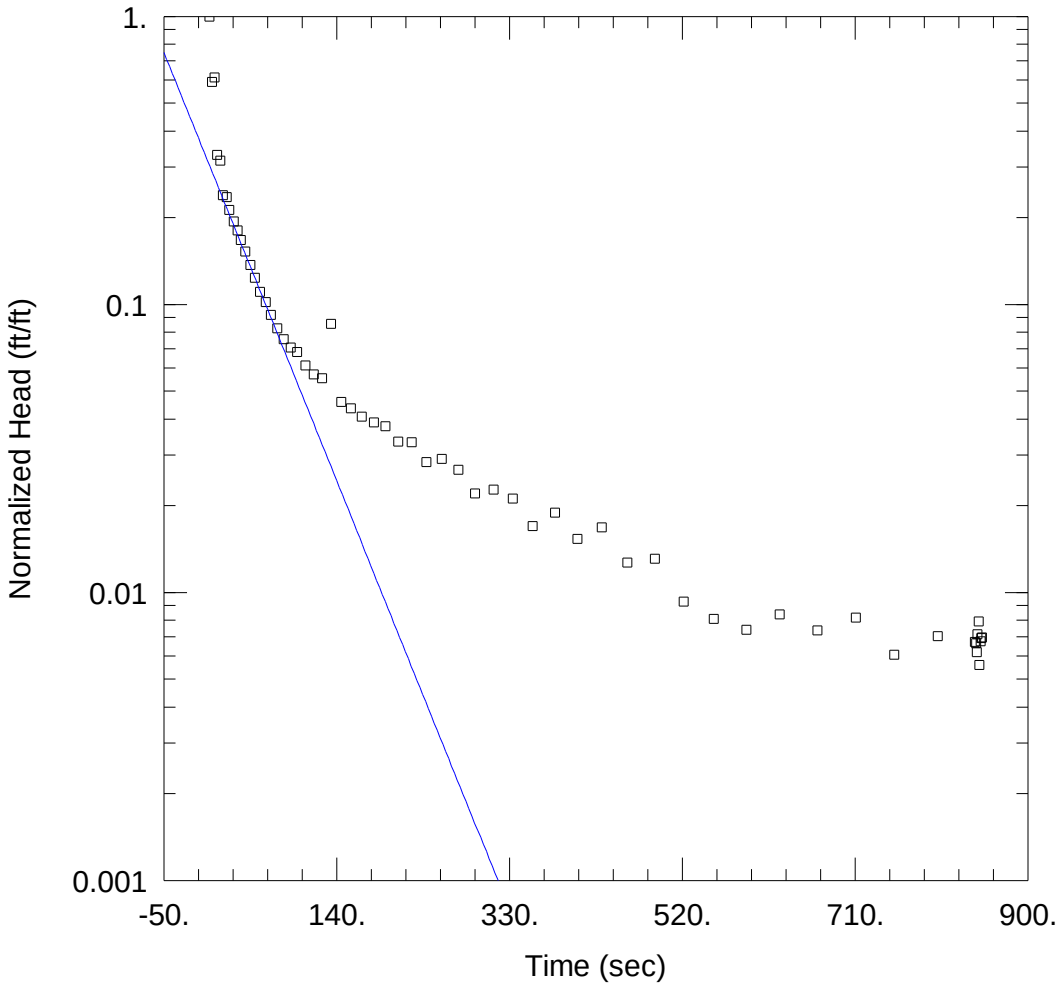
Well ID	MW-473	Personnel	Hurshman
Location	Basin Electric LRS	Static Water Level	75.86 btoc
Type of Well	Monitoring well	Extraction Well Distance	—
Test Date	8/18/16	Total Casing Depth	90.76 bTOC
Measuring Point Elevation	TOC	Borehole Diameter	6 inch
Type of Test	—	Casing Diameter	2 inch
Step Number	—	Screened Interval	
Data logger Test Run No.	1	Sand Pack Interval	
Pumping Rate	NA (slug)	Lithology Tested	
Test Start Time	1525	Test End Time	1610

Test 1

Time	Elapsed Time (min)	Water Depth (ft)
1524	0	75.86
1525	test started	NM
1526	slug in	NM
1533	9 min	75.73
1538	14 min	75.81
1546	22 min	75.84
1549	25 min	75.85
1551	slug out	NM
1555	31 min	76.05
1600	36 min	75.92
1604	40 min	75.89
1609	45 min	75.89
1610	stop test	NM

Time	Elapsed Time (min)	Water Depth (ft)

see transducer data for details



WELL TEST ANALYSIS

Data Set: C:\...\MW-33B_Slug_in.aqt
Date: 09/21/16 Time: 13:27:20

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 33B
Test Date: 8/22/16

AQUIFER DATA

Saturated Thickness: 16.36 ft Anisotropy Ratio (Kz/Kr): 1.

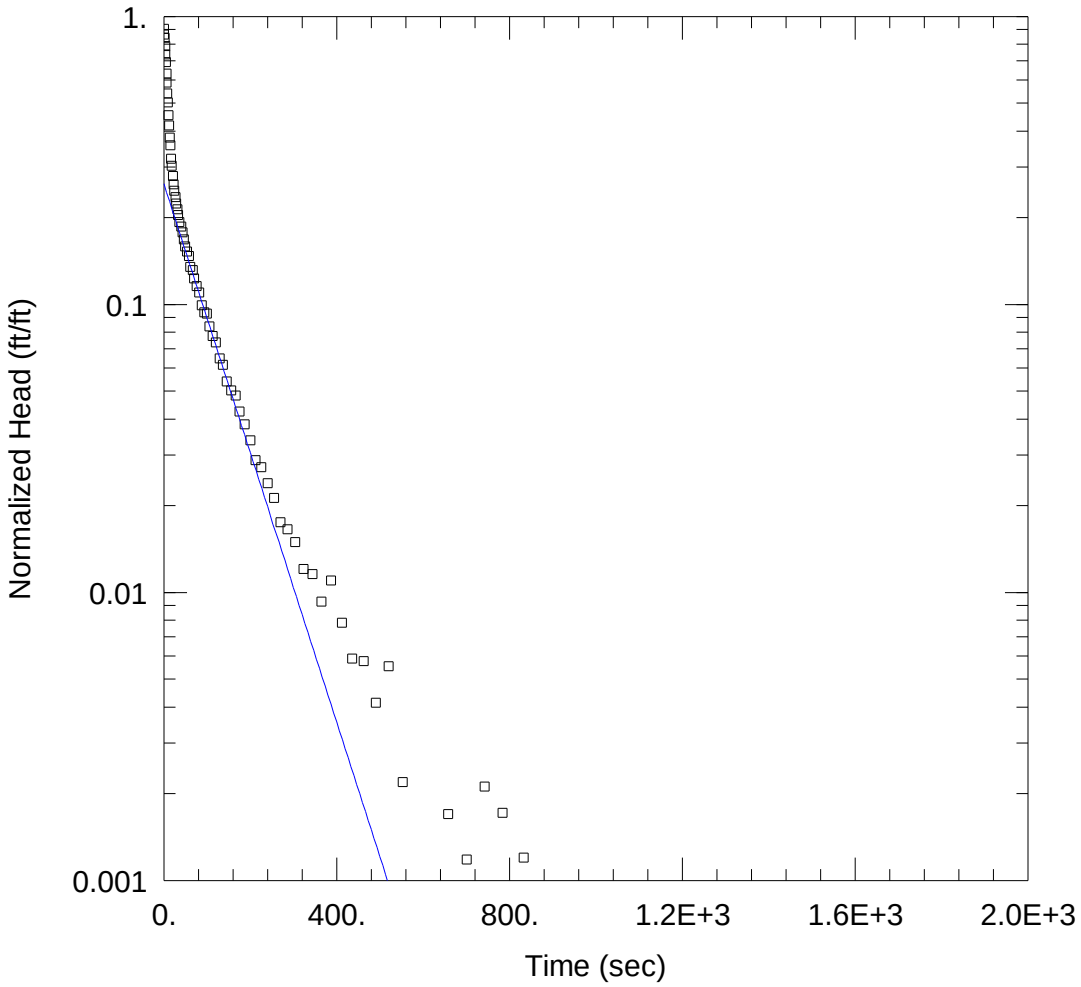
WELL DATA (33B)

Initial Displacement: 2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 16.36 ft
Screen Length: 20. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 3.801 ft/day y0 = 0.7403 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-33B_Slug_out.aqt
Date: 09/15/16 Time: 18:00:51

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 33B
Test Date: 8/22/16

AQUIFER DATA

Saturated Thickness: 16.36 ft Anisotropy Ratio (Kz/Kr): 1.

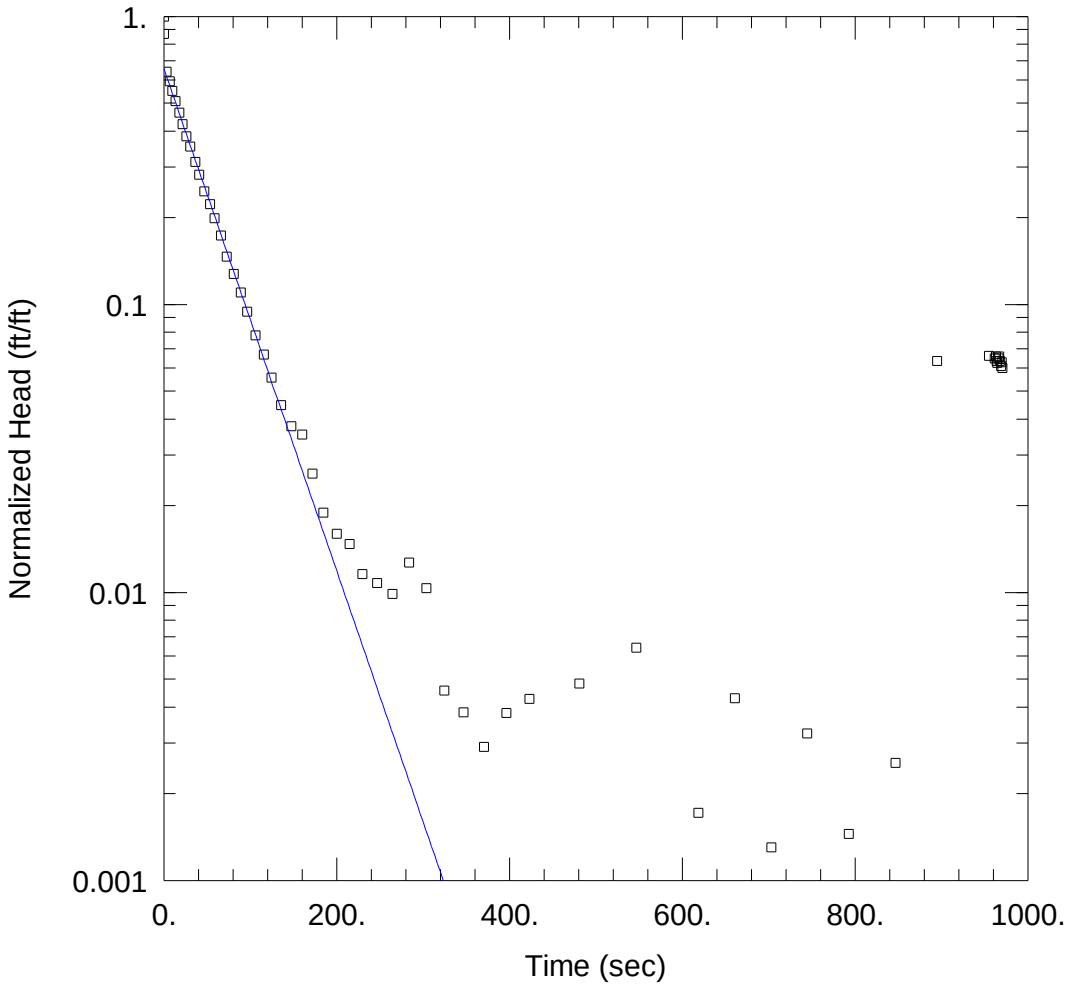
WELL DATA (33B)

Initial Displacement: -2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 16.36 ft
Screen Length: 20. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 2.268 ft/day y0 = -0.6358 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-35B_Slug_in.aqt
Date: 09/15/16 Time: 18:01:23

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 35B
Test Date: 8/22/16

AQUIFER DATA

Saturated Thickness: 19.96 ft Anisotropy Ratio (Kz/Kr): 1.

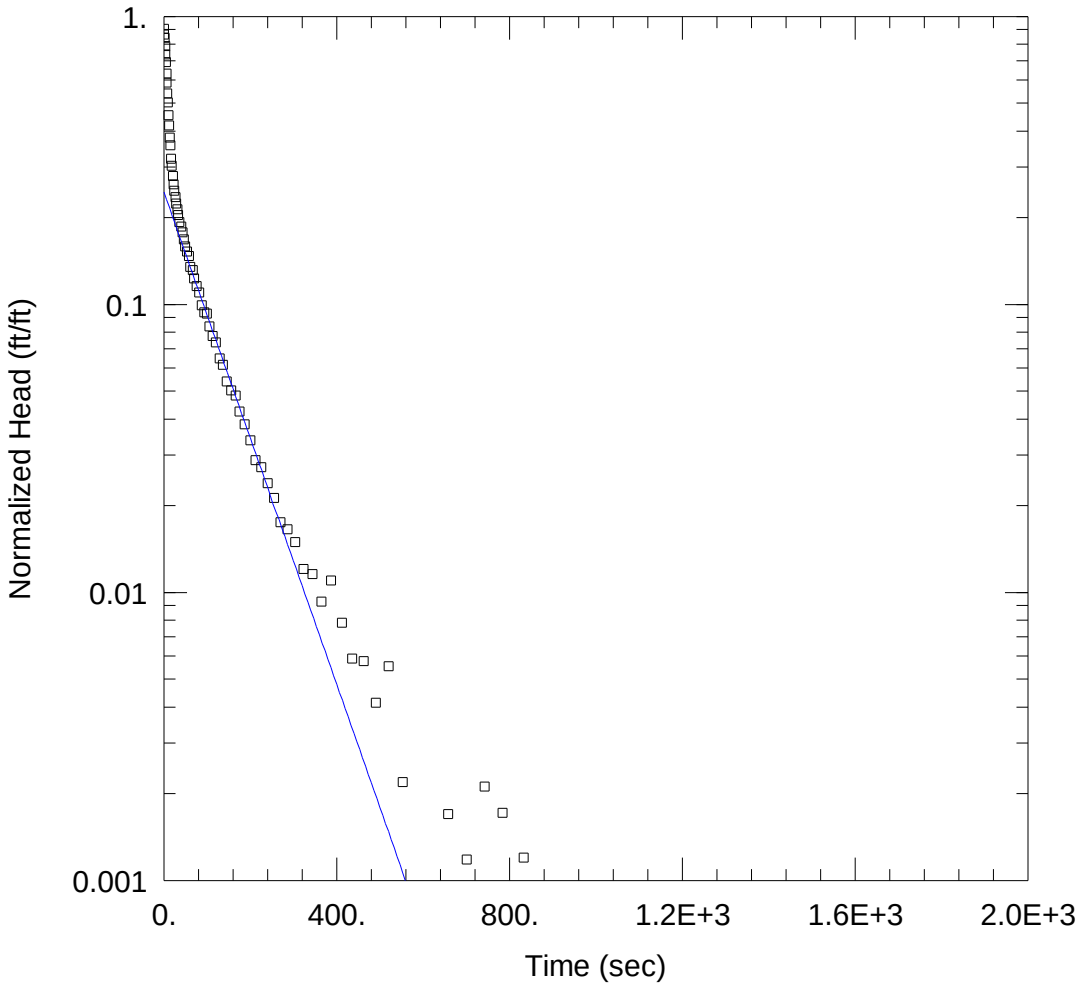
WELL DATA (35B)

Initial Displacement: 2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 19.96 ft
Screen Length: 20. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 3.502 ft/day y0 = 1.6 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-35B_Slug_out.aqt
Date: 09/15/16 Time: 18:01:50

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 35B
Test Date: 8/22/16

AQUIFER DATA

Saturated Thickness: 19.96 ft Anisotropy Ratio (Kz/Kr): 1.

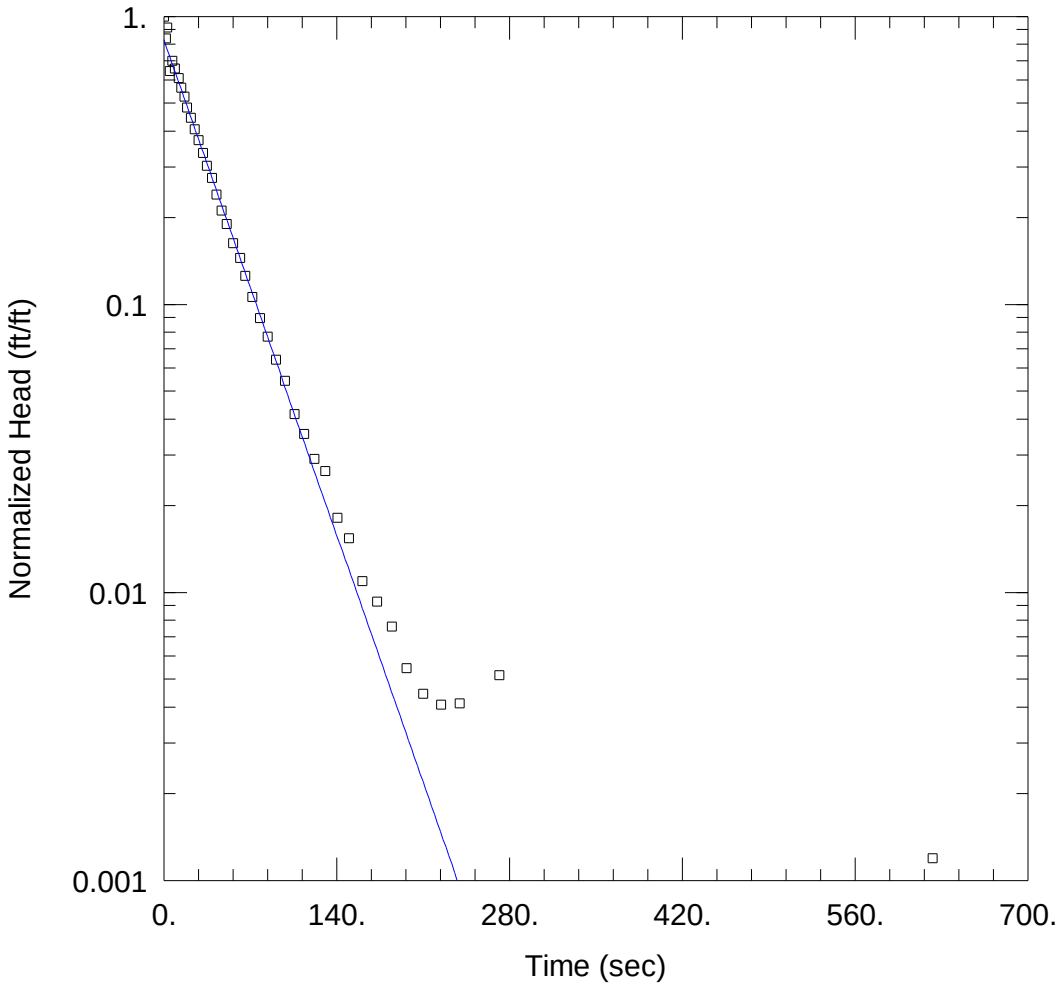
WELL DATA (35B)

Initial Displacement: -2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 19.96 ft
Screen Length: 20. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.717 ft/day y0 = -0.5973 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-37B_Slug_in.aqt
Date: 09/21/16 Time: 13:36:01

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 37B
Test Date: 8/19/16

AQUIFER DATA

Saturated Thickness: 16.14 ft Anisotropy Ratio (Kz/Kr): 1.

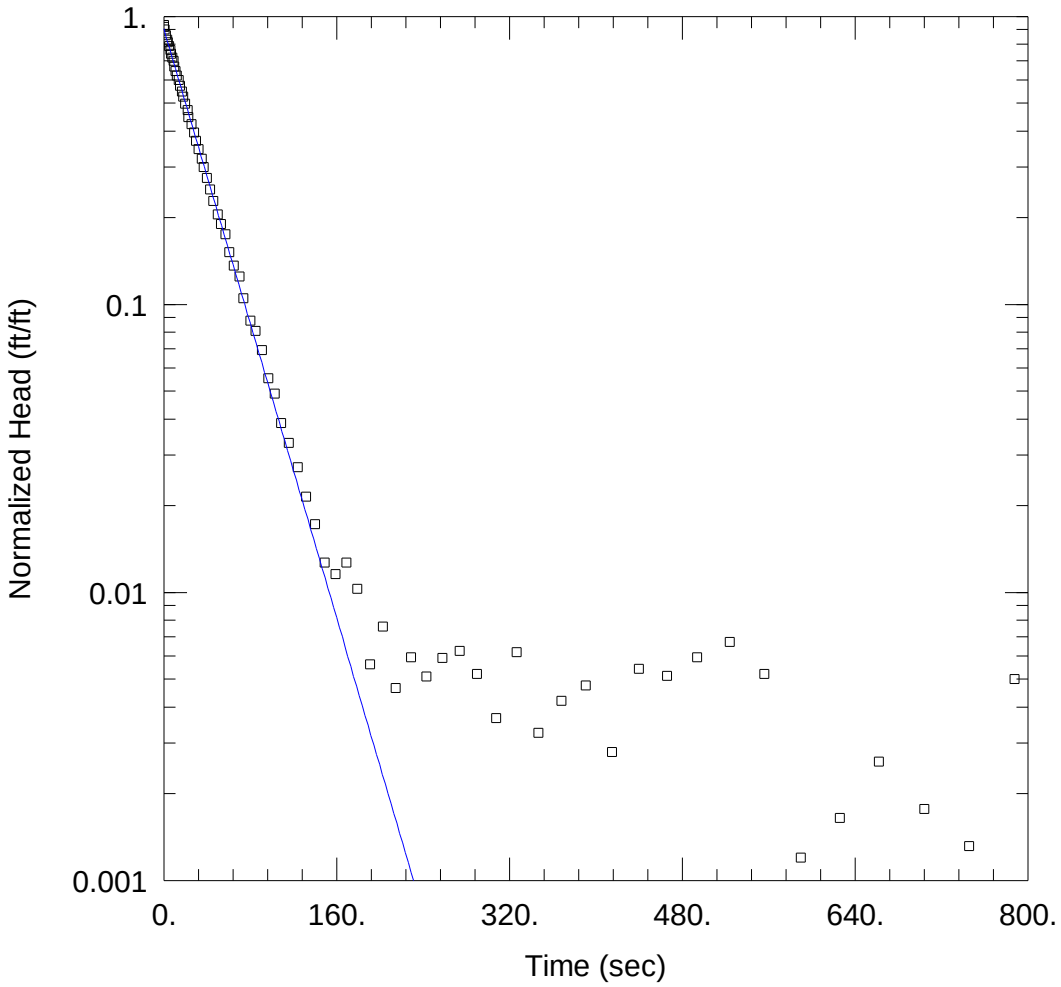
WELL DATA (37B)

Initial Displacement: 2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 16.14 ft
Screen Length: 20. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 6.039 ft/day y0 = 2.014 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-37B_Slug_out.aqt
Date: 09/21/16 Time: 13:37:13

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 37B
Test Date: 8/19/16

AQUIFER DATA

Saturated Thickness: 16.14 ft Anisotropy Ratio (Kz/Kr): 1.

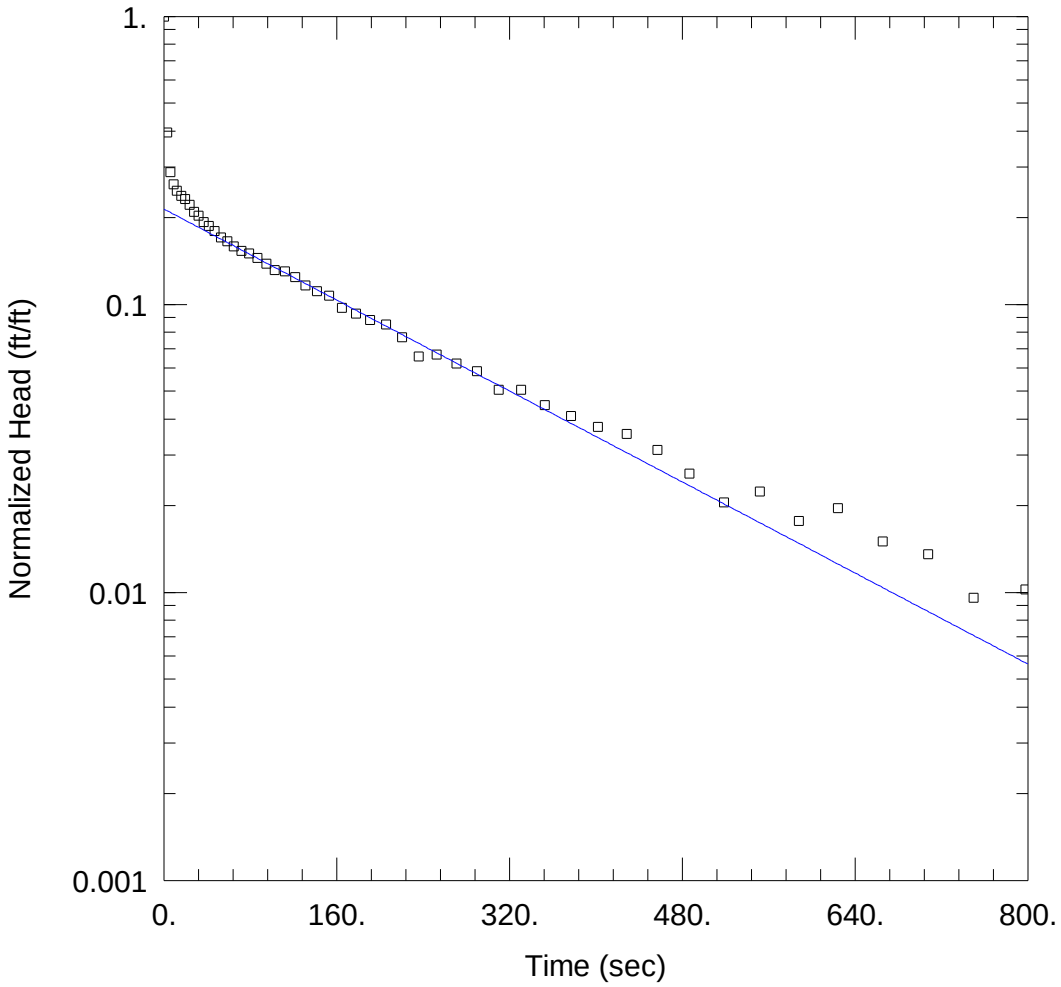
WELL DATA (37B)

Initial Displacement: -2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 16.14 ft
Screen Length: 20. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 6.284 ft/day y0 = -2.192 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-38B_Slug_in.aqt
Date: 09/15/16 Time: 17:10:28

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 38B
Test Date: 8/22/16

AQUIFER DATA

Saturated Thickness: 15.83 ft Anisotropy Ratio (Kz/Kr): 1.

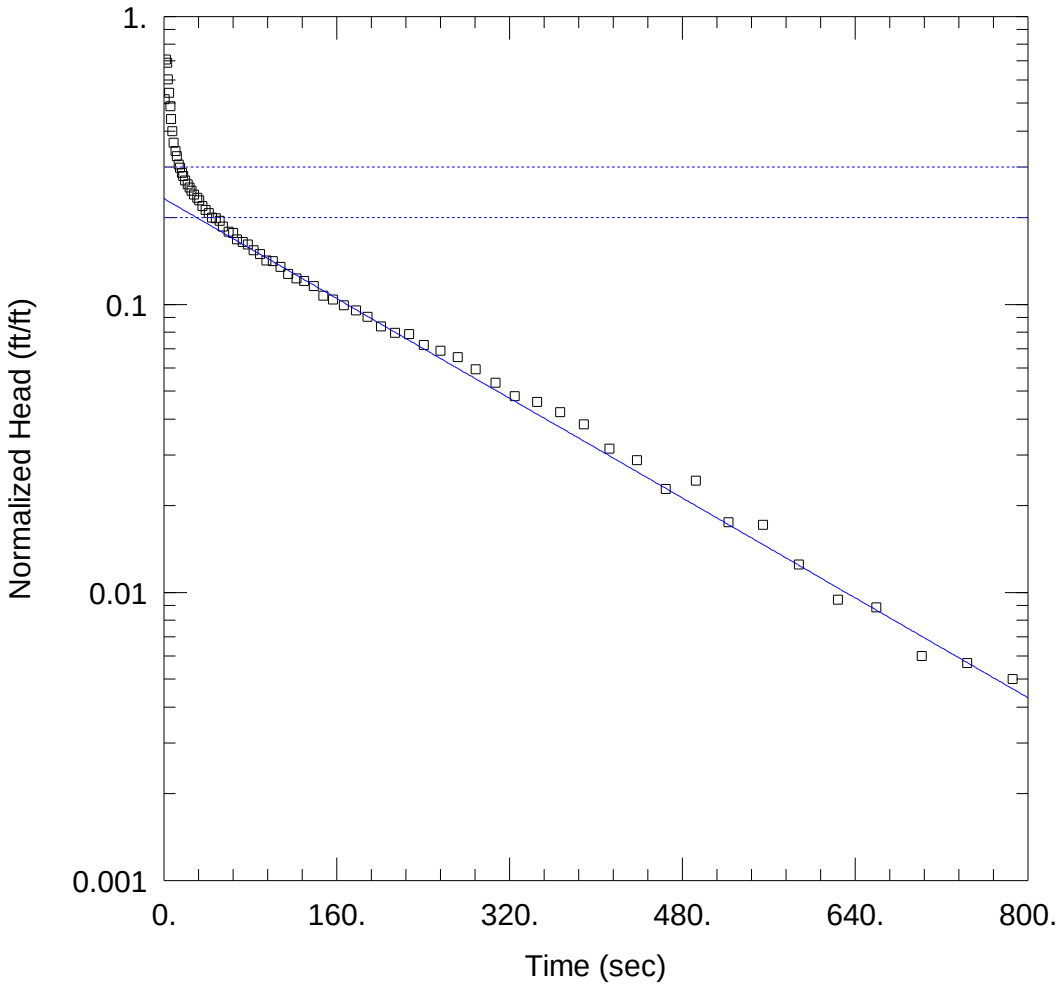
WELL DATA (38B)

Initial Displacement: 2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 15.83 ft
Screen Length: 20. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.99 ft/day y0 = 0.5201 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-38B_Slug_out.aqt
Date: 09/15/16 Time: 17:09:06

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 38B
Test Date: 8/22/16

AQUIFER DATA

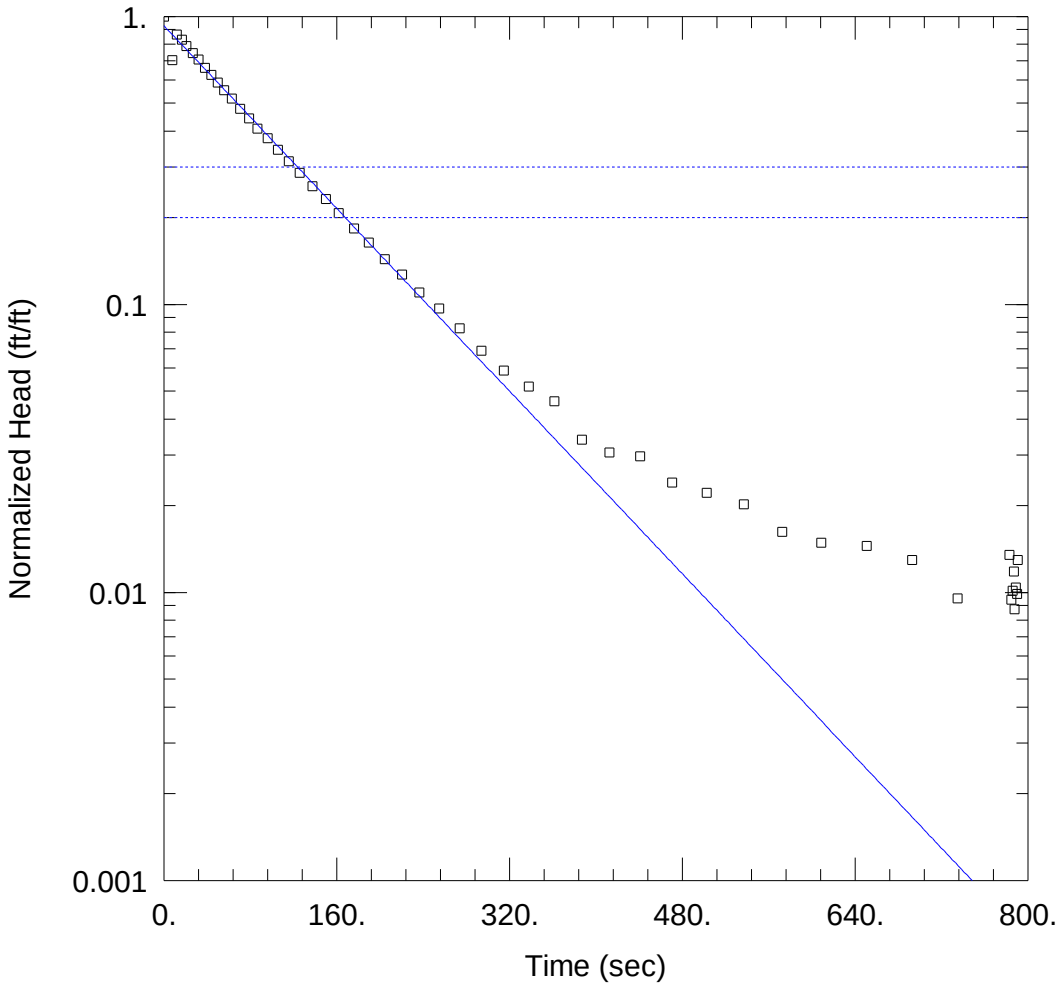
Saturated Thickness: 15.83 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (38B)

Initial Displacement: -2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 15.83 ft
Screen Length: 20. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.086 ft/day
y0 = -0.5652 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-39B_Slug_in.aqt
Date: 09/15/16 Time: 17:42:17

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 39B
Test Date: 8/23/16

AQUIFER DATA

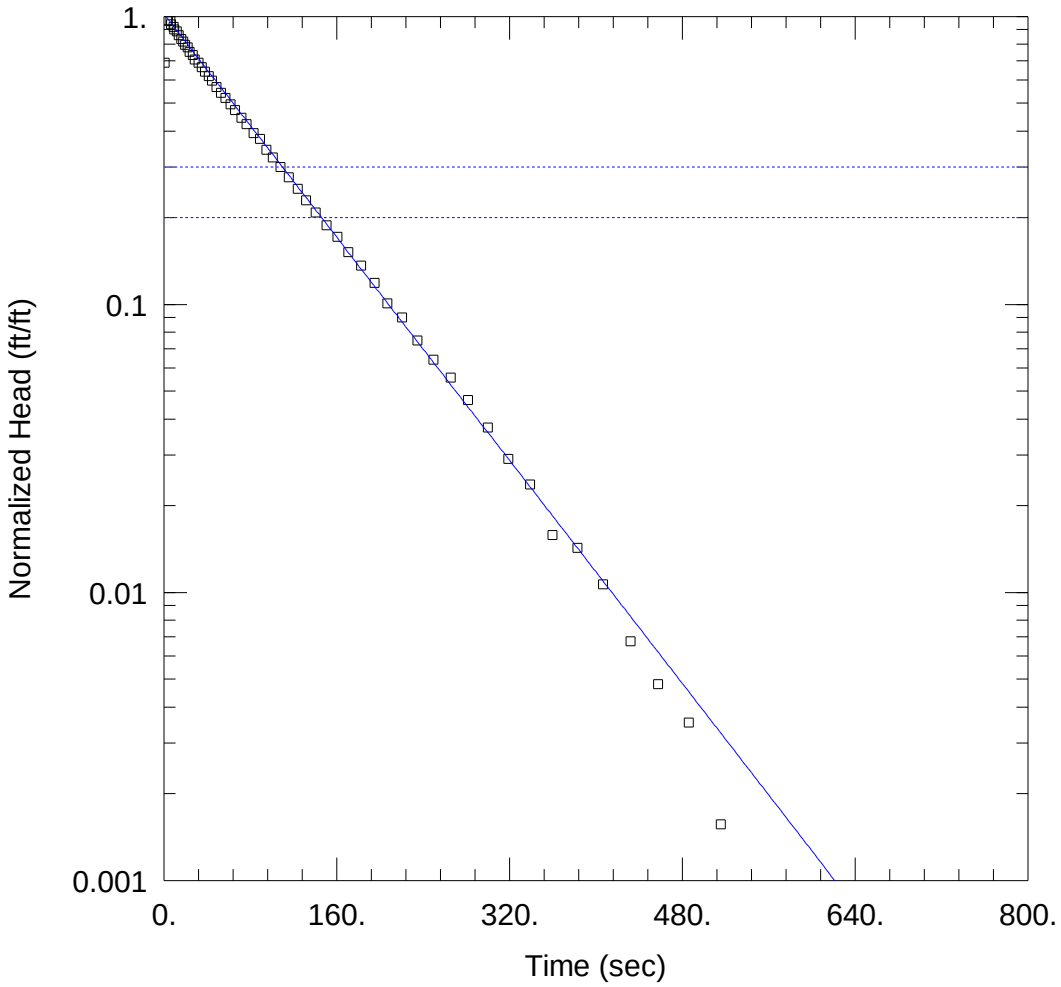
Saturated Thickness: 25.17 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (39B)

Initial Displacement: 2.428 ft Static Water Column Height: 25.17 ft
Total Well Penetration Depth: 20. ft Screen Length: 20. ft
Casing Radius: 0.08612 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
K = 0.4514 ft/day y0 = 2.254 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-39B_Slug_out.aqt
Date: 09/15/16 Time: 17:43:53

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 39B
Test Date: 8/23/16

AQUIFER DATA

Saturated Thickness: 25.17 ft Anisotropy Ratio (Kz/Kr): 1.

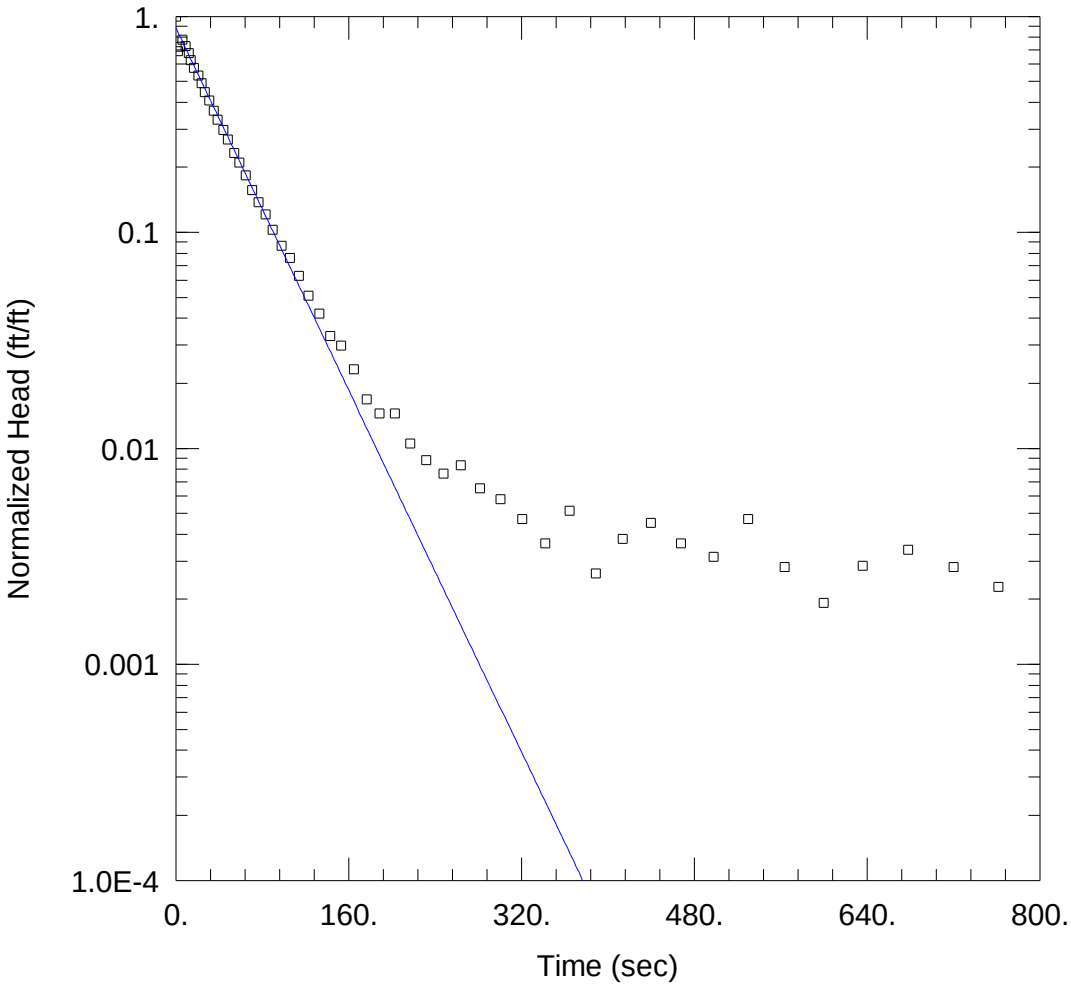
WELL DATA (39B)

Initial Displacement: -2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 25.17 ft
Screen Length: 20. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.5514 ft/day
y0 = -2.477 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-42B_Slug_in.aqt
Date: 09/15/16 Time: 17:46:50

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 42B
Test Date: 8/19/16

AQUIFER DATA

Saturated Thickness: 21.62 ft Anisotropy Ratio (Kz/Kr): 1.

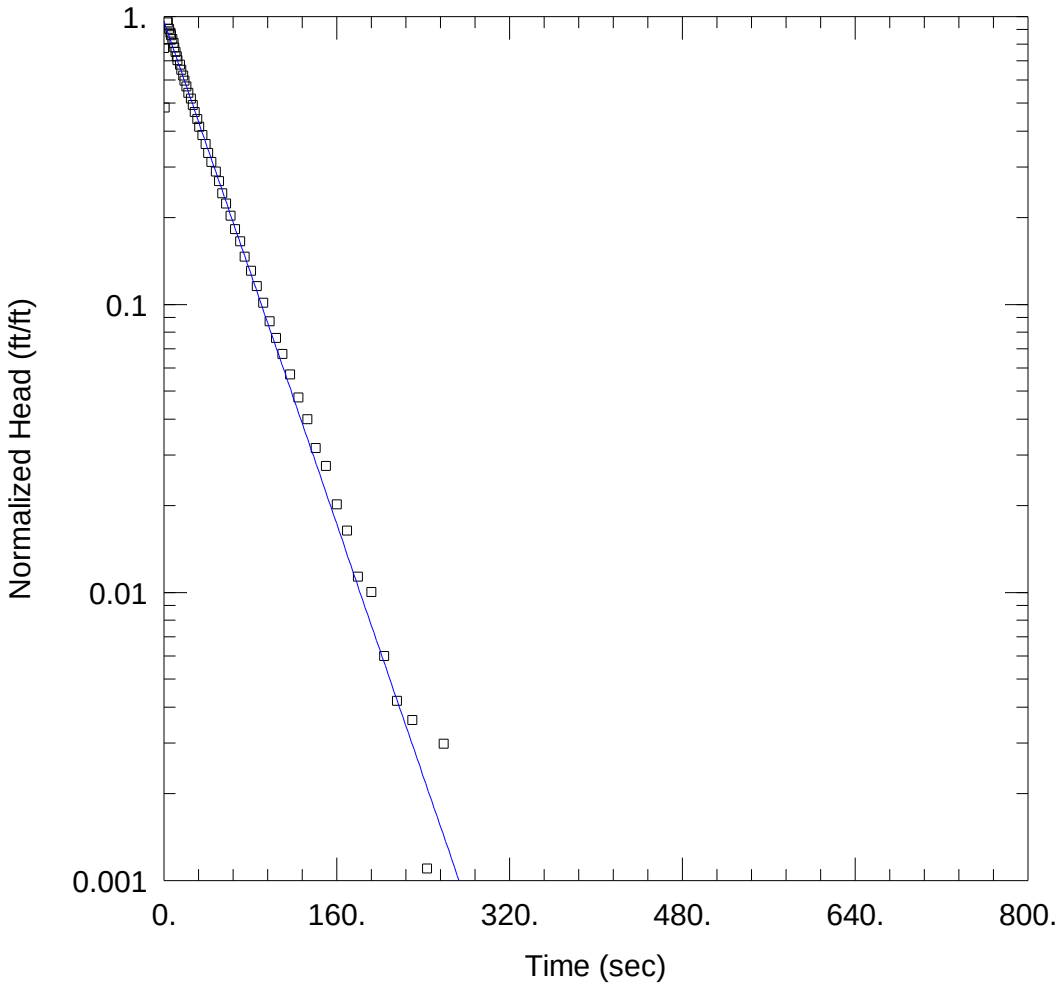
WELL DATA (42B)

Initial Displacement: 2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 21.62 ft
Screen Length: 20. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.227 ft/day
y0 = 2.148 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-42B_Slug_out.aqt
Date: 09/15/16 Time: 17:49:00

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 42B
Test Date: 8/19/16

AQUIFER DATA

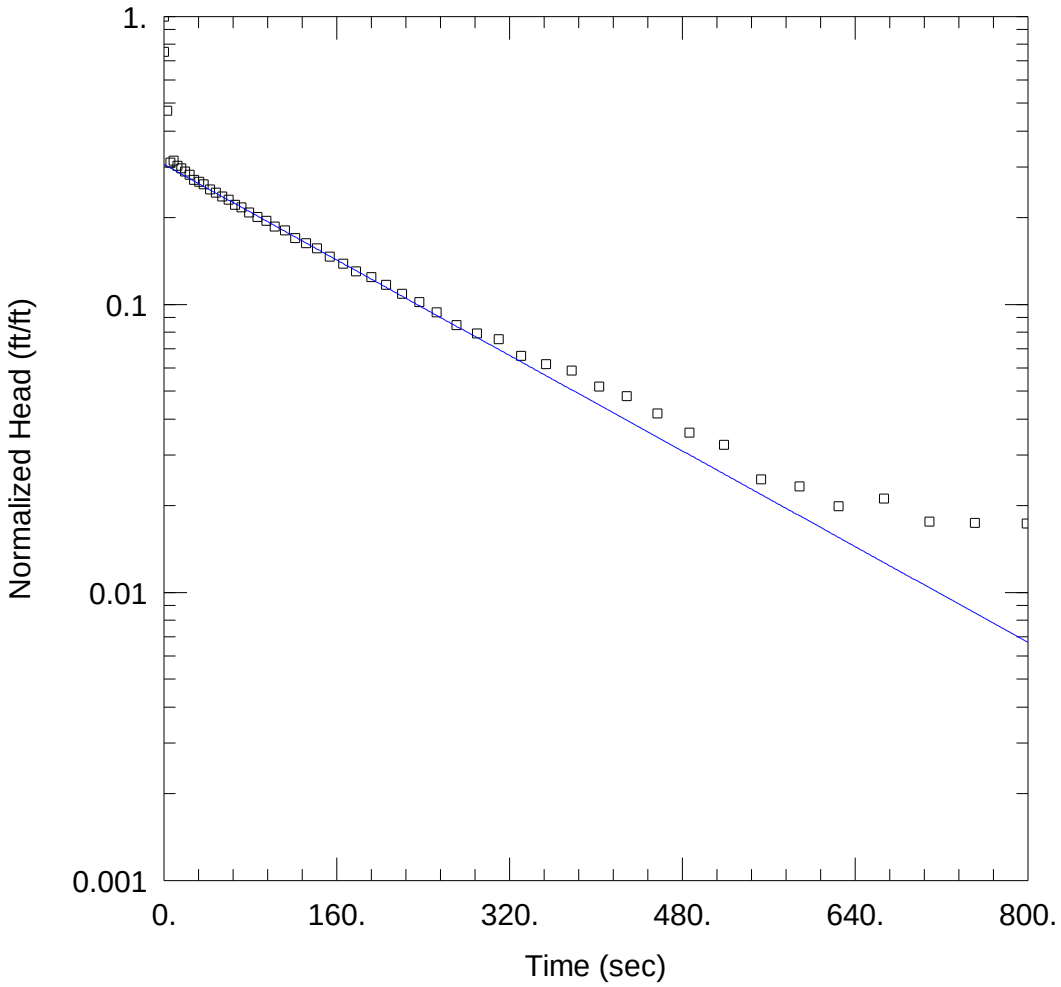
Saturated Thickness: 21.62 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (42B)

Initial Displacement: -2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 21.62 ft
Screen Length: 20. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.278 ft/day
y0 = -2.342 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-45B_Slug_in.aqt
Date: 09/15/16 Time: 17:51:45

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 45B
Test Date: 8/18/16

AQUIFER DATA

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

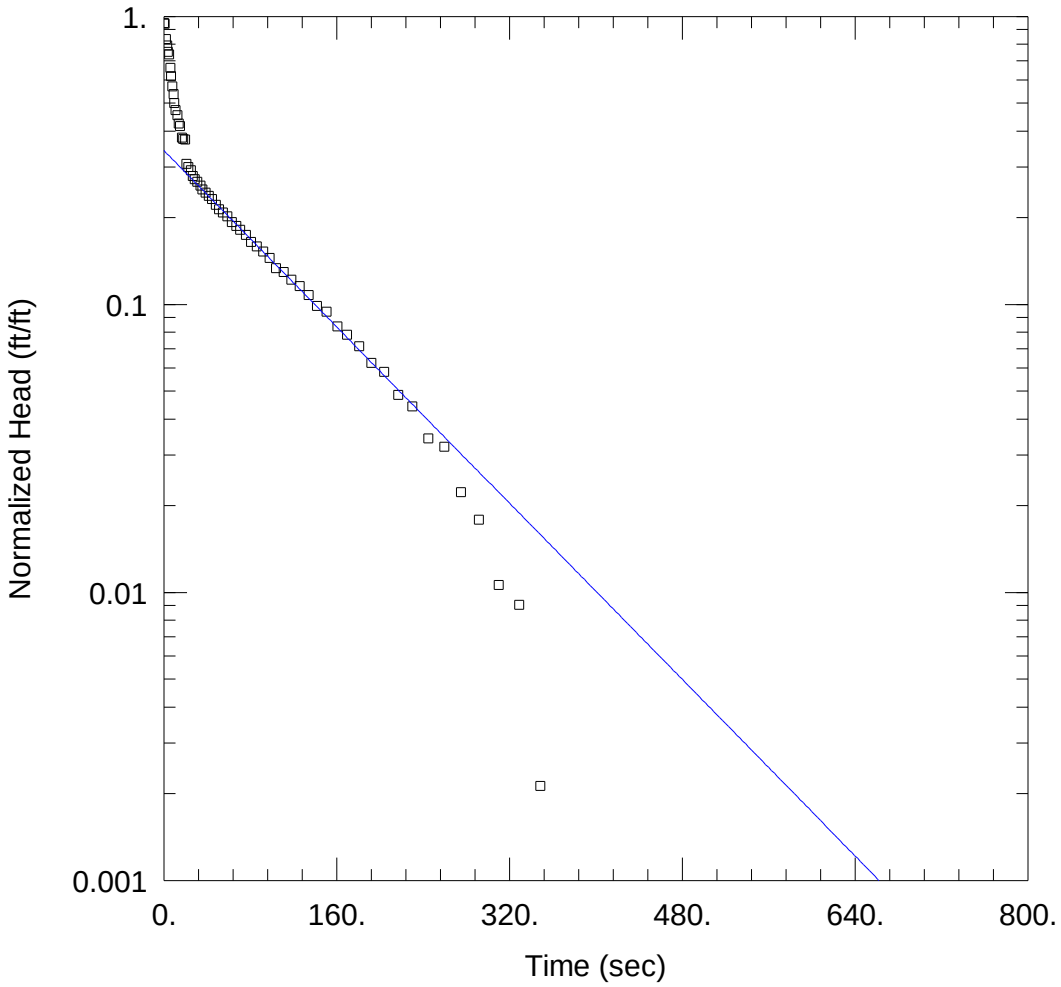
WELL DATA (45B)

Initial Displacement: 2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 12.8 ft
Screen Length: 20. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.272 ft/day y0 = 0.7434 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-45B_Slug_out.aqt
Date: 09/15/16 Time: 17:55:35

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 45B
Test Date: 8/18/16

AQUIFER DATA

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

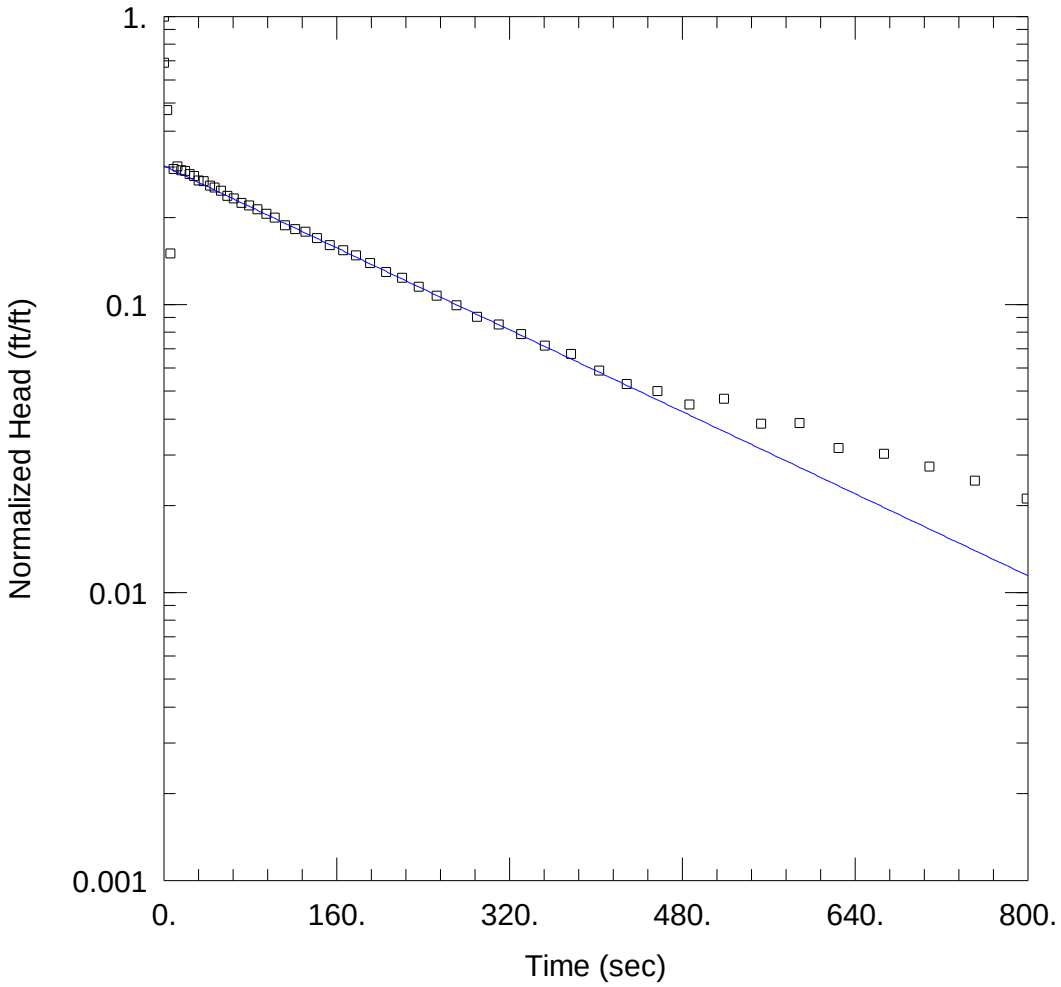
WELL DATA (45B)

Initial Displacement: -2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 12.8 ft
Screen Length: 20. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 2.347 ft/day y0 = -0.8308 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-47B_Slug_in.aqt
Date: 09/15/16 Time: 17:58:04

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 47B
Test Date: 8/18/16

AQUIFER DATA

Saturated Thickness: 12.53 ft Anisotropy Ratio (Kz/Kr): 1.

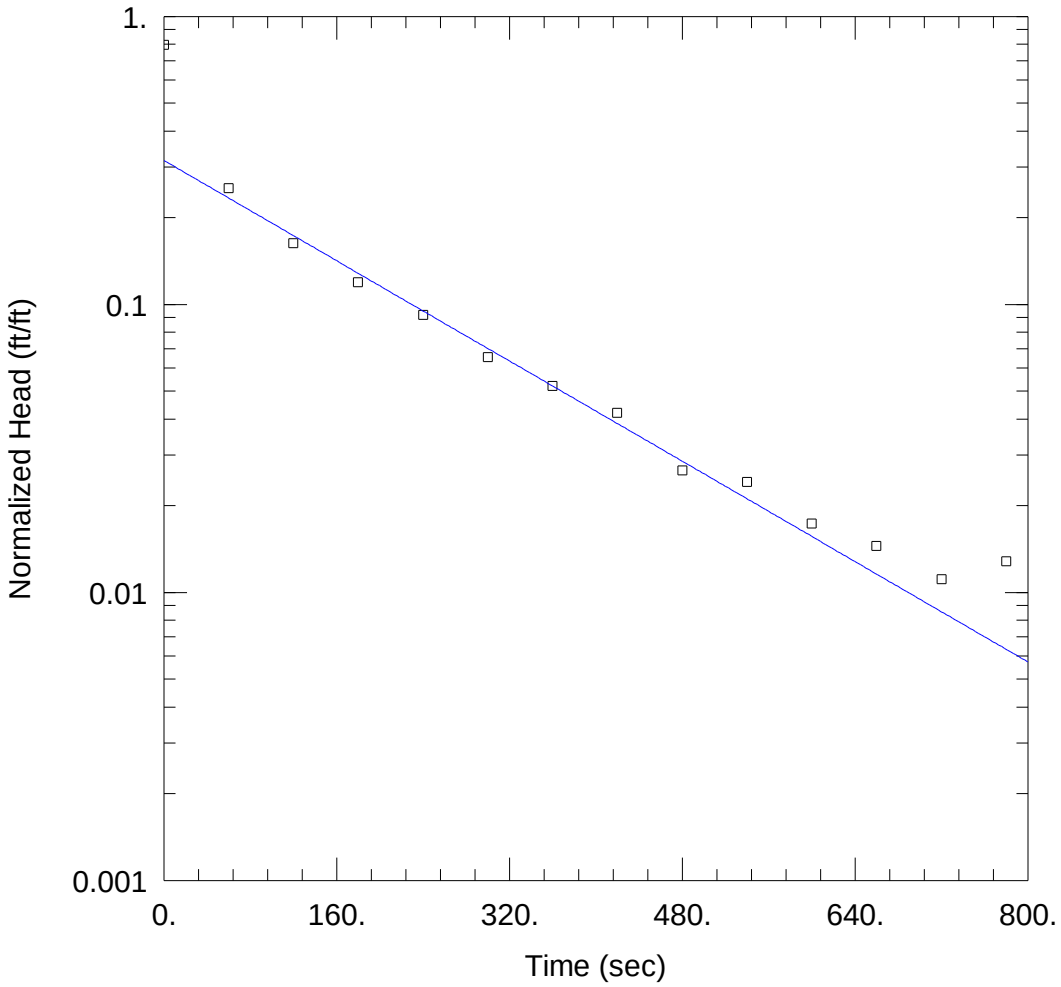
WELL DATA (45B)

Initial Displacement: 2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 12.53 ft
Screen Length: 20. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.112 ft/day y0 = 0.7345 ft



WELL TEST ANALYSIS

Data Set: C:\...\MW-47B_Slug_out.aqt
Date: 09/15/16 Time: 17:59:43

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 47B
Test Date: 8/18/16

AQUIFER DATA

Saturated Thickness: 12.53 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (45B)

Initial Displacement: -2.428 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.08612 ft
Static Water Column Height: 12.53 ft
Screen Length: 20. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.361 ft/day y0 = -0.7672 ft

PUMPING TEST DATA FORM

Well ID	MW-32B	Personnel	Chris Ahrendt & Jeremy Hurshman
Location	Basin Electric LB	Static Water Level	60.43
Type of Well	PVC Schedule 40	Extraction Well Distance	—
Test Date	8/22/2016	Total Casing Depth	76.74
Measuring Point Elevation	Top of Inner Casing	Borehole Diameter	6"
Type of Test	Recovery	Casing Diameter	2"
Step Number	—	Screened Interval	
Data logger Test Run No.	1	Sand Pack Interval	
Pumping Rate	0.8 gpm	Lithology Tested	
Test Start Time	1606	Test End Time	1830

1604 PM Start ~~1543~~

Time	Elapsed Time (min)	Water Depth (ft)	Time	Elapsed Time (min)	Water Depth (ft)
1604	0	60.30			
1620	14	10gal / 7.76			
1631	25	20gal / 7.62			
1644	38	30gal / 7.54			
1657	51	40gal / 7.51			
1709	63	50gal / 7.47			
1722	76	60gal / 7.48			
1735	89	70gal / 7.47			
pump off: 1735 1740	94	cl. 22			
1748	102	Co.45			
1755	109	60.56			
1759	113	Co.51			
1804	118	Co.49			
1814	128	60.45			
1819	133	60.45			
1824	135	60.43			

PUMPING TEST DATA FORM

Well ID	MW-34B	Personnel	Chris Arendt & Jeremy Hughman
Location	Basin Electric	Static Water Level	66.54
Type of Well	PVC, Schedule 40	Extraction Well Distance	
Test Date	8/22/2016	Total Casing Depth	88.78
Measuring Point Elevation	Top of Inner Casing	Borehole Diameter	6"
Type of Test	Recovery	Casing Diameter	2"
Step Number		Screened Interval	
Data logger Test Run No.		Sand Pack Interval	
Pumping Rate	1 gpm	Lithology Tested	
Test Start Time	12:52 PM	Test End Time	

Time	Elapsed Time (min)	Water Depth (ft)	Time	Elapsed Time (min)	Water Depth (ft)
1251	0	66.56			
1304	12	10gal / 9.05			
1316	24	20gal / 7.67			
1327	35	30gal / 7.70			
1339	47	40gal / 7.72			
1350	58	50gal / 7.78			
1402	70	60gal / 7.71			
1409	79	70gal / 7.74			
1414	stopped pump	NM			
1416	86	72.40			
1423	93	67.22			
1432	102	66.69			
1439	109	66.67			
1452	122	66.63			
1502	132	66.61			
1509	139	66.62			

PUMPING TEST DATA FORM

Well ID	MW-36B	Personnel	Chris Albright & Jeremy Hurshm
Location	Basin Electric LRS	Static Water Level	61.21
Type of Well	PVC Schedule 40	Extraction Well Distance	NA
Test Date	8/22/2016	Total Casing Depth	80.25
Measuring Point Elevation	Top of PVC Casing	Borehole Diameter	6"
Type of Test		Casing Diameter	2"
Step Number		Screened Interval	
Data logger Test Run No.	-	Sand Pack Interval	
Pumping Rate	0.7gpm	Lithology Tested	
Test Start Time	10:17 AM	Test End Time	12:12 PM

Time	Elapsed Time (min)	Water Depth (ft) Height of H2O over probe	Time	Elapsed Time (min)	Water Depth (ft)
10:15 AM	0	61.22			
10:17 AM Start pump					
10:31	14	10gal / 12.90 ↓			
10:46	29	20gal / 12.85 ↓			
11:00	43	30gal / 12.87 ↑			
11:14	57	40gal / 12.84 ↓			
11:28	71	50gal / 12.84 -			
11:43	86	60gal / 12.85 ↑			
Stopped pump @ 11:51 pm	11:51	62.5gal / NR			
	12:04	61.23			
Stopped test	12:12 PM	61.22			

PUMPING TEST DATA FORM

Well ID	MW-40B	Personnel	Chris Ahrendt & Jeremy Hurshman
Location	Basin Electric	Static Water Level	94.89
Type of Well	PVC, Schedule 40	Extraction Well Distance	—
Test Date	8/23/2010	Total Casing Depth	111.10
Measuring Point Elevation	Top of Inner casing	Borehole Diameter	6"
Type of Test	Aquifer Test	Casing Diameter	2"
Step Number	—	Screened Interval	
Data logger Test Run No.	1	Sand Pack Interval	
Pumping Rate	~0.9 gpm	Lithology Tested	
Test Start Time		Test End Time	

Time	Elapsed Time (min)	Water Depth (ft)
0939	0	94.88
0948	1 min	Pump on
0951	12 min	10 gal / 3.10
1003	26 min	20 gal 2.72
1016	39 min	30 gal / 2.45
1029	52 min	40 gal / 2.61
1042	65 min	50 gal / 2.58
1054	77 min	60 gal / 2.55
1101	84 min	65 gal / 2.56
1104	pump off	NM
1106	89 min	98.58
1112	95 min	96.62
1118	104 min	95.69
1132	118 min	95.15
1138	126 min	95.10
1146	134 min	95.05
1157	145 min	95.03
1206	154 min	95.02

Time	Elapsed Time (min)	Water Depth (ft)

* See transducer data for details

PUMPING TEST DATA FORM

Well ID	MW-41B	Personnel	Chris Ahrendt
Location	Basin Electric	Static Water Level	56.71 1040 AM 8/19/2016 pre set-up
Type of Well	Schedule 40 PVC	Extraction Well Distance	—
Test Date	8/19/2016	Total Casing Depth	75.51
Measuring Point Elevation	Top of Inner Casing	Borehole Diameter	6"
Type of Test	Aquifer constant rate	Casing Diameter	2"
Step Number	—	Screened Interval	
Data logger Test Run No.	1	Sand Pack Interval	
Pumping Rate	1 gpm	Lithology Tested	
Test Start Time	1049	Test End Time	

Time	Elapsed Time (min)	Water Depth (ft)	Time	Elapsed Time (min)	Water Depth (ft)
1048	0	56.77			
1059	11	10gal / 12.81			
1107	19	20gal / 12.80			
1117	29	30gal / 12.79			
1128	40	40gal / 12.78			
1142	54	55gal / 12.76, 12.78			
1150	62	60gal 12.78			
1200	72	70gal /			
pump off 1201	73	71gal			
1224		56.81 ft			
1238		56.81 ft			

Temperature drop and wind increase occurred at 11:20 - 11:30 AM, strong wind gusts

PUMPING TEST DATA FORM

Well ID	MW-43B	Personnel	Chris Ahrendt & Jeremy Hurshman
Location	Basin Electric	Static Water Level	7:38A 8/9/16 24.48' Top of Inner Casing
Type of Well	PVC Sched 40	Extraction Well Distance	
Test Date	8/19/2016	Total Casing Depth	7:38A 8/16 79.15' Top of Inner Casing
Measuring Point Elevation	Top of PVC Casing	Borehole Diameter	6"
Type of Test	Constant Rate Recovery	Casing Diameter	2"
Step Number	–	Screened Interval	
Data logger Test Run No.		Sand Pack Interval	
Pumping Rate	~1 gpm start of test	Lithology Tested	
Test Start Time		Test End Time	

Time	Elapsed Time (min)	Water Depth (ft)	Time	Elapsed Time (min)	Water Depth (ft)
8:18 AM	0	24.49 static			
Start 8:19 AM test & pump 8:29	10	10gal / 43.95			
840	21	20 gal / 4380			
848	29	30gal / 43.77			
~1 gpm 0858	39	40gal / 43.77			
0908	49	50gal / 43.77			
0919	60	60gal / 43.81			
0930	71	70gal 43.79			
0942	83	80gal 43.78			
0947	88	85gal / 43.77			
0947	pump stopped - recovery				
0951	91	24.91' stec			
0959	99	24.56			
1002	102	24.54			
1007	107	24.52			
1011	111	24.52			

caution 85' bgs.

PUMPING TEST DATA FORM

Well ID	MW-44B	Personnel	Chris Ahrendt & Jeremy Hutchman
Location	Basin Electric LBS	Static Water Level	70.58' without equipment
Type of Well	2" PVC	Extraction Well Distance	
Test Date	8/18/2016	Total Casing Depth	94.06'
Measuring Point Elevation	Top of PVC Casing	Borehole Diameter	6"
Type of Test	Constant Rate	Casing Diameter	2"
Step Number	–	Screened Interval	
Data logger Test Run No.		Sand Pack Interval	
Pumping Rate		Lithology Tested	
Test Start Time		Test End Time	

	Time	Elapsed Time (min)	Water Depth (ft)	Time	Elapsed Time (min)	Water Depth (ft)
(Bond started) Test 1 (Trial) (1 gpm)	09:18	0	70.59 static			
	0937		71.34 recovery			
	0944		70.65			
	0946		70.64			
(Bond down) Test 2 (0.5 gpm)	0955	0	70.63 static			
	1009		70.64 recovery			

PUMPING TEST DATA FORM

Well ID	MW-44B	Personnel	Chris Ahrendt & Jeremy Hurshman
Location	Basin Electric LRS	Static Water Level	
Type of Well	2" PVC	Extraction Well Distance	
Test Date	8/18/2016	Total Casing Depth	94.06
Measuring Point Elevation	Top of inner PVC casing	Borehole Diameter	6"
Type of Test	Constant Rate	Casing Diameter	2"
Step Number	–	Screened Interval	
Data logger Test Run No.		Sand Pack Interval	
Pumping Rate	0.4 gpm	Lithology Tested	
Test Start Time		Test End Time	

44B (MW-44B) data

Time	Elapsed Time (min)	Water Depth (ft)	Time	Elapsed Time (min)	Water Depth (ft)
Test 3					
1044	Ø	70.58			
1045	1 start test				

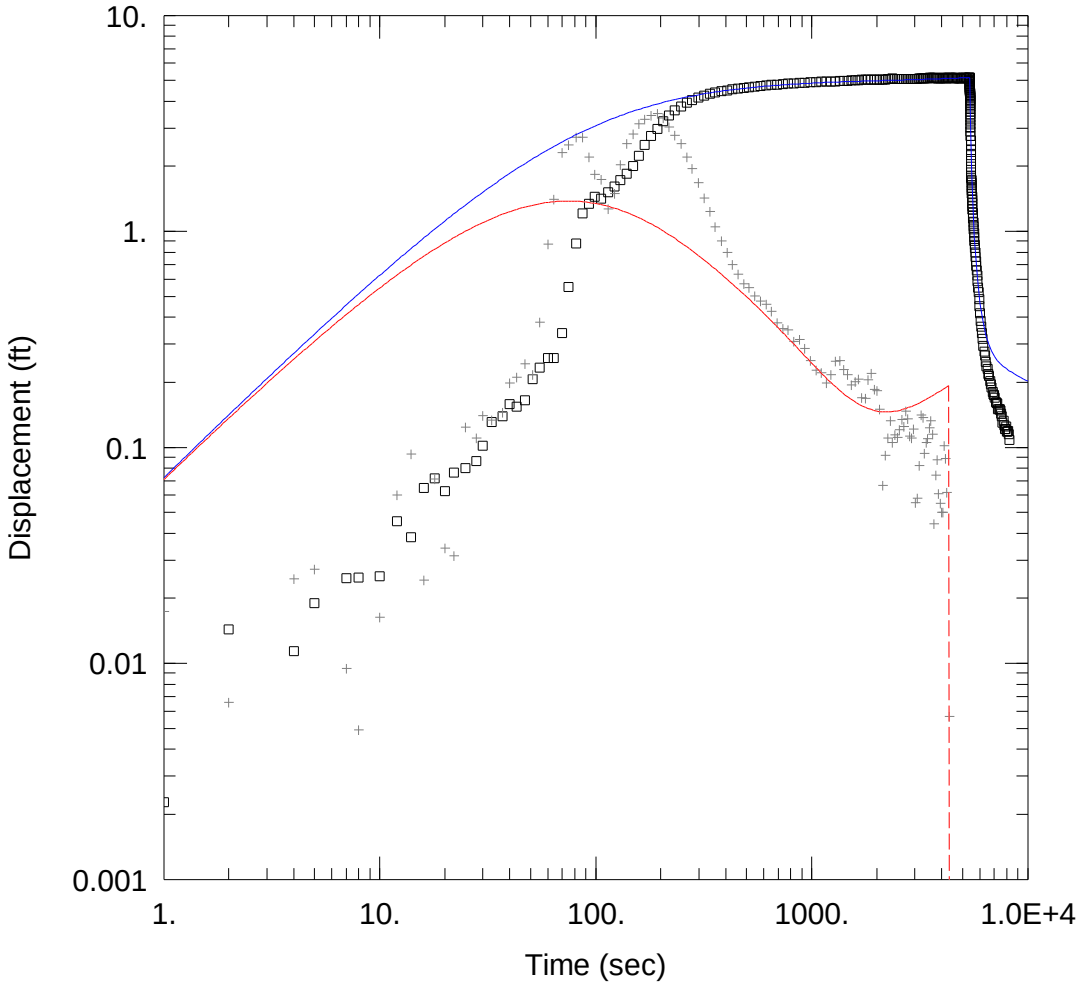
MW-44B Test 4 ~1.5 gpm (good data)

1121	Ø	70.59
1122	start test	NM
1130	10 gallons	NM
1137	20 gallons	NM
1144	30 gallons	NM
1151	40 gallons	NM
1158	50 gallons	NM
Stopped pump at 1158 – recovery time.		
1202		70.84
1205		70.68
1210		70.64
1213		70.63
1235		70.60
1236	Stopped test	

PUMPING TEST DATA FORM

Well ID	MW-46B	Personnel	Chris Pimentel & Jeremy Hutchinson
Location	Basin Electric LRS	Static Water Level	~~76.00~~ 76.00
Type of Well	PVC, Sch. 40	Extraction Well Distance	NA
Test Date	8/18/2016	Total Casing Depth	95.41
Measuring Point Elevation	Top of inner PVC casing	Borehole Diameter	6"
Type of Test	Recovery	Casing Diameter	2"
Step Number	–	Screened Interval	
Data logger Test Run No.	–	Sand Pack Interval	
Pumping Rate	~1.4 gpm	Lithology Tested	
Test Start Time	13:18	Test End Time	

Time	Elapsed Time (min)	Water Depth (ft) / ft above transducer	Time	Elapsed Time (min)	Water Depth (ft)
1317	∅	76.00			
1318	~~start test~~	NM			
1327	9	10 gal			
1335	17	20 gal / 7.97			
1344	26	30 gal / 7.59			
1353	35	40 gal / 7.44			
1.2 gpm 1401	43	50 gal / 7.39			
1410	52	60 gal / 7.36			
1419	61	70 gal / 7.34			
1427	69	80 gal / 7.32			
1435	77	90 gal / 7.32			
1444	86	100 gal / 7.24			
1454	96	110 gal / 7.25			
1505	107	1/2 122.5 / 7.28			
1.2 gpm 1511	113	130 / 7.31			
1519	121	140 gal / 7.30			
pump off @ 1520 PM		142.5 total gallons			
1526 PM		77.86' / 14.78'			
1531 PM		76.87' / 16.27'			
1536 PM		76.41' / 16.52'			
1541 PM		76.23' / 16.83'			
1546 PM	~~stopped test~~	76.16' / 16.92			



WELL TEST ANALYSIS

Data Set: C:\...\MW-32B_Pumping_Test.aqt
Date: 09/22/16 Time: 20:00:17

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 32B
Test Date: 8/22/16

AQUIFER DATA

Saturated Thickness: 12.59 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
32B	0	0

Observation Wells

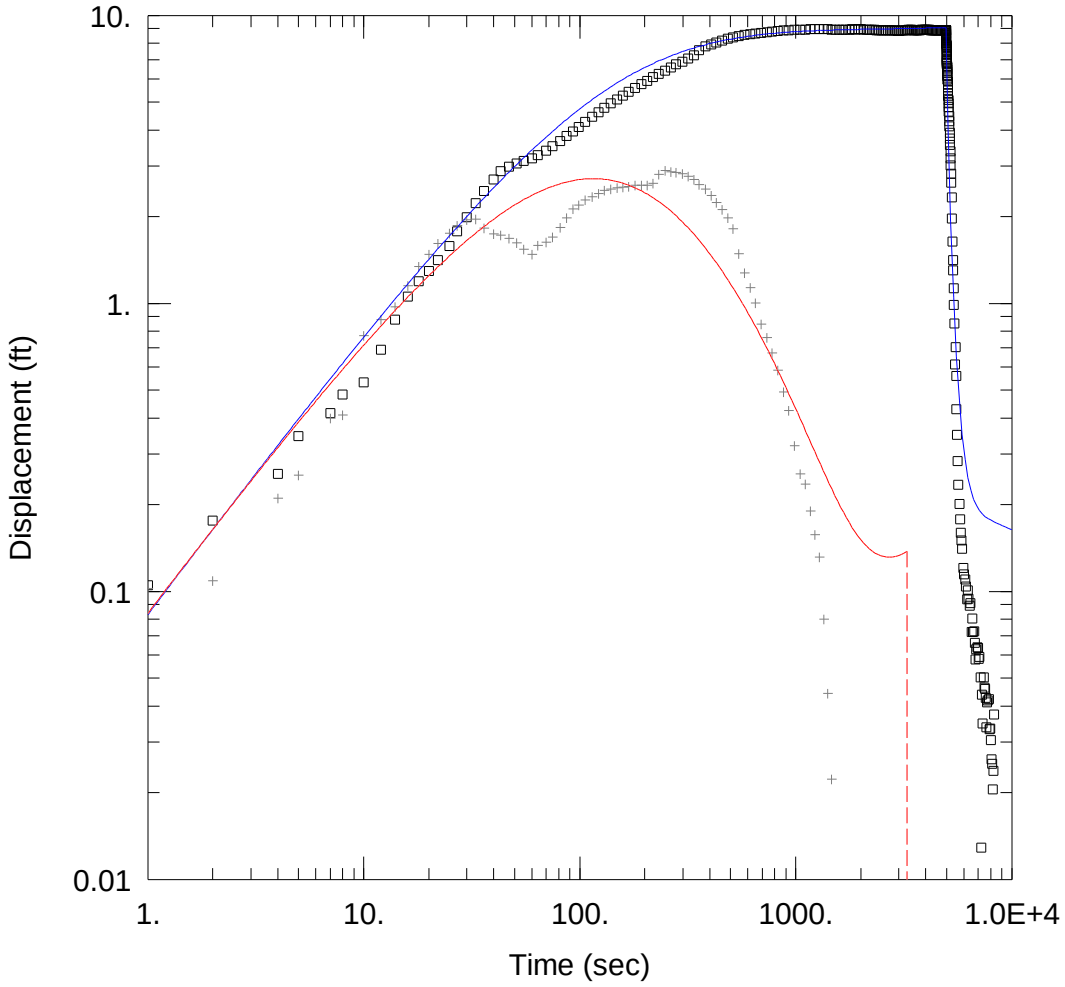
Well Name	X (ft)	Y (ft)
▫ 32B	0	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Moench

T = 16.21 ft^2/day
Sy = 0.1
Sw = 0.
r(c) = 0.08612 ft

S = 0.001872
ß = 0.0003941
r(w) = 0.25 ft
alpha = 1.0E+30 sec^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\MW-34B_Pumping_Test.aqt
Date: 09/22/16 Time: 20:02:29

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 34B
Test Date: 8/22/16

AQUIFER DATA

Saturated Thickness: 16.62 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
34B	0	0

Observation Wells

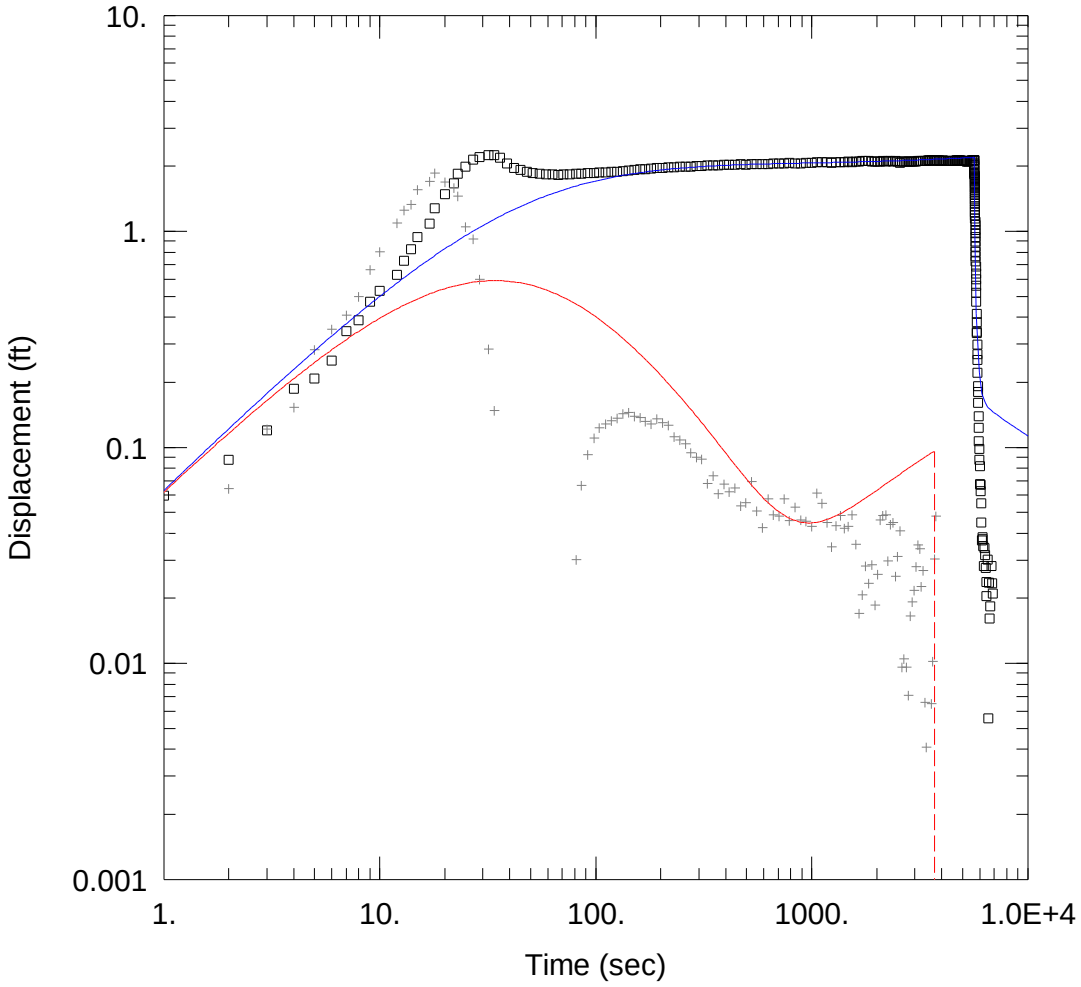
Well Name	X (ft)	Y (ft)
▫ 34B	0	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Moench

T = 10.88 ft^2/day
Sy = 0.1
Sw = 0.
r(c) = 0.08612 ft

S = 0.0006148
ß = 0.0002262
r(w) = 0.25 ft
alpha = 1.0E+30 sec^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\MW-36B_Pumping_Test.aqt
Date: 09/22/16 Time: 20:06:04

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 36B
Test Date: 8/22/16

AQUIFER DATA

Saturated Thickness: 14.97 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
36B	0	0

Observation Wells

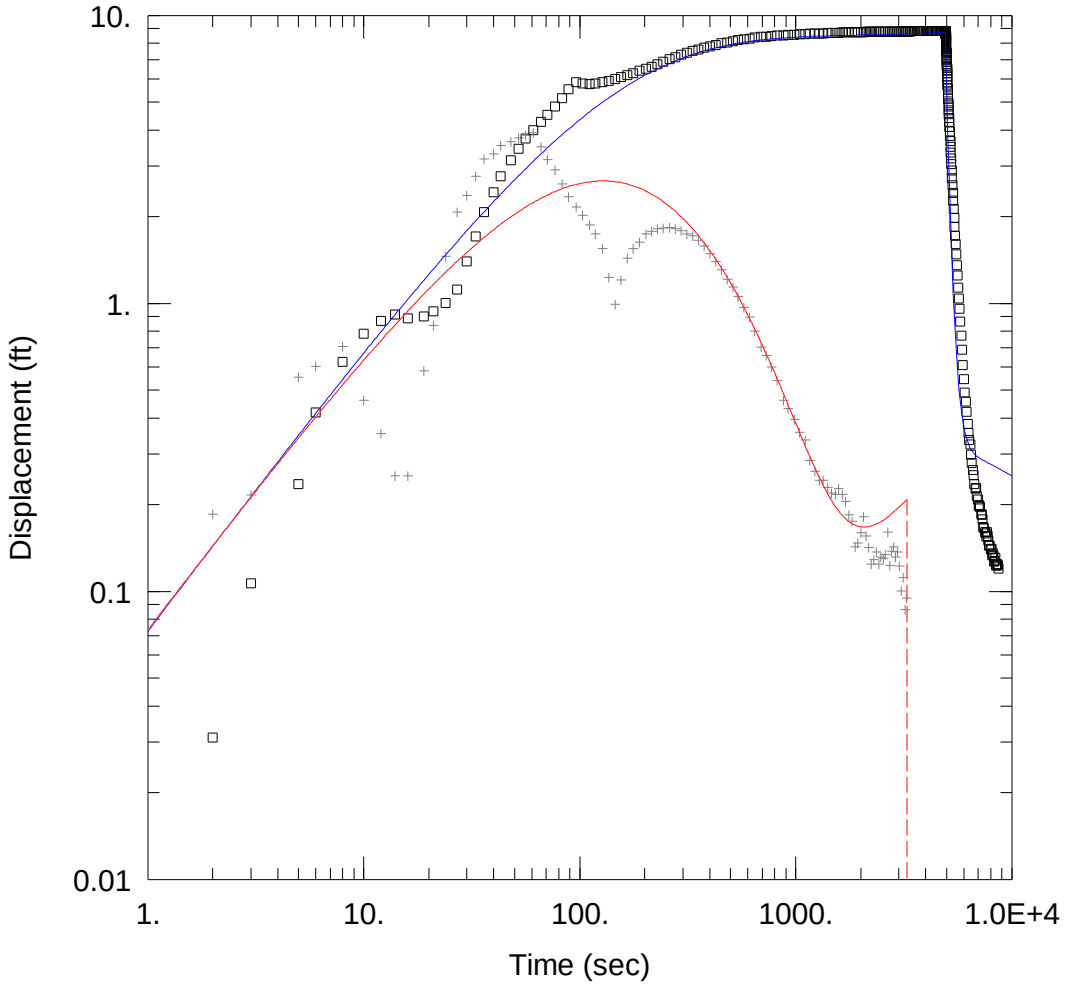
Well Name	X (ft)	Y (ft)
□ 36B	0	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Moench

T = 36.22 ft^2/day
Sy = 0.09859
Sw = 0.
r(c) = 0.08612 ft

S = 0.001105
ß = 0.000279
r(w) = 0.25 ft
alpha = 1.0E+30 sec^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\MW-40B_Pumping_Test.aqt
Date: 09/22/16 Time: 20:09:17

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 40B
Test Date: 8/23/16

AQUIFER DATA

Saturated Thickness: 11.39 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
40B	0	0

Observation Wells

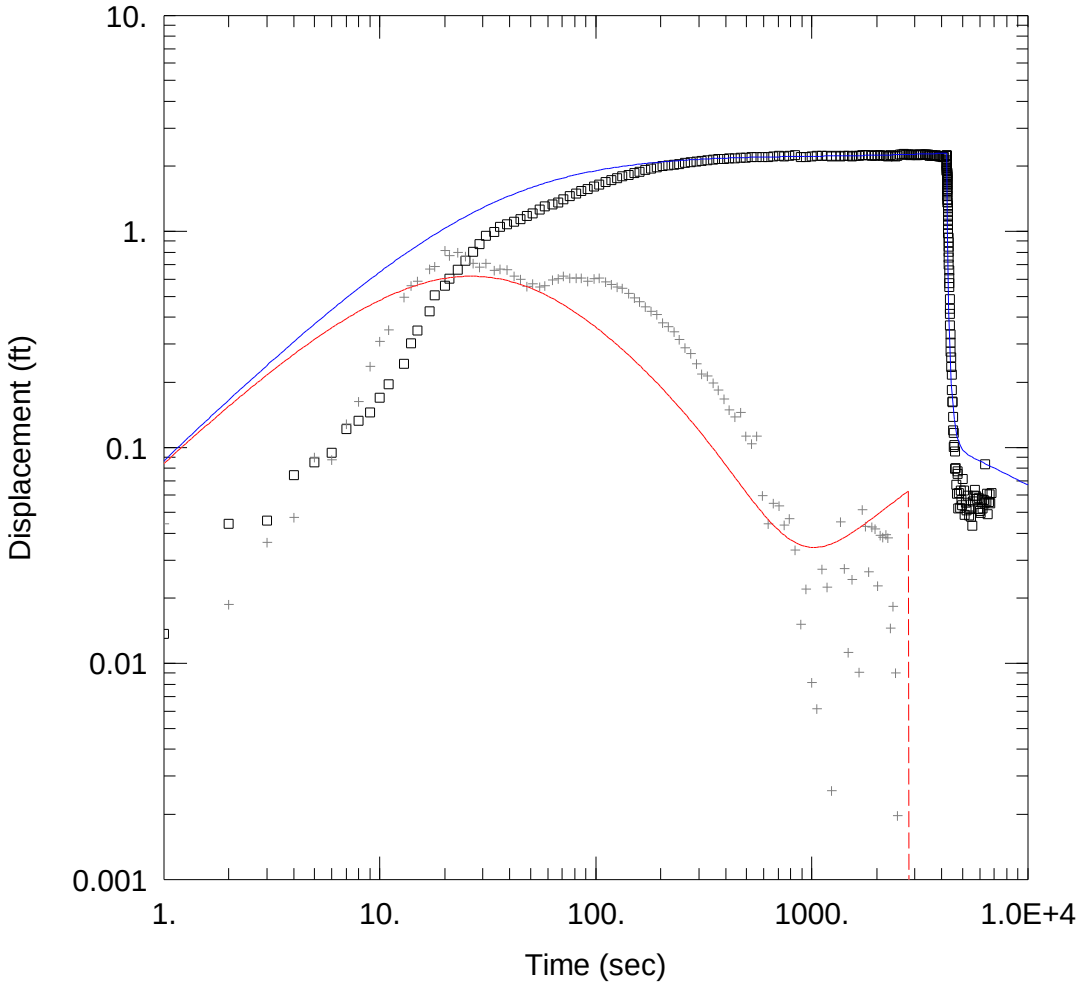
Well Name	X (ft)	Y (ft)
▫ 40B	0	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Moench

T = 8.988 ft^2/day
Sy = 0.09996
Sw = 0.
r(c) = 0.08612 ft

S = 0.0007605
ß = 0.0004818
r(w) = 0.25 ft
alpha = 1.0E+30 sec^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\MW-41B_Pumping_Test.aqt
Date: 09/22/16 Time: 20:09:57

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 41B
Test Date: 8/19/16

AQUIFER DATA

Saturated Thickness: 15.03 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
41B	0	0

Observation Wells

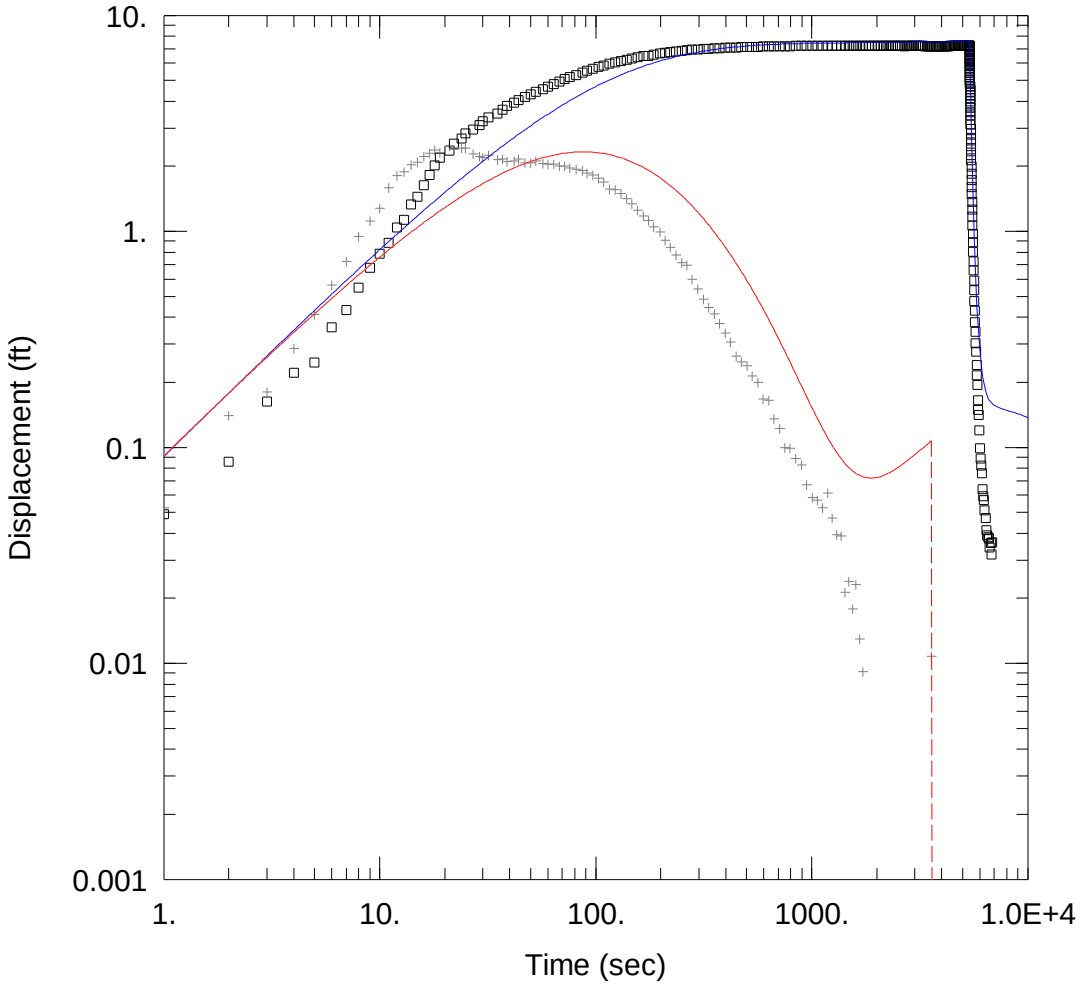
Well Name	X (ft)	Y (ft)
▫ 41B	0	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Moench

T = 46.84 ft^2/day
Sy = 0.1972
Sw = 0.
r(c) = 0.08612 ft

S = 0.001378
ß = 0.0002768
r(w) = 0.25 ft
alpha = 1.0E+30 sec^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\MW-43B_Pumping_Test.aqt
Date: 09/22/16 Time: 20:10:26

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 43B
Test Date: 8/19/16

AQUIFER DATA

Saturated Thickness: 20. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
43B	0	0

Observation Wells

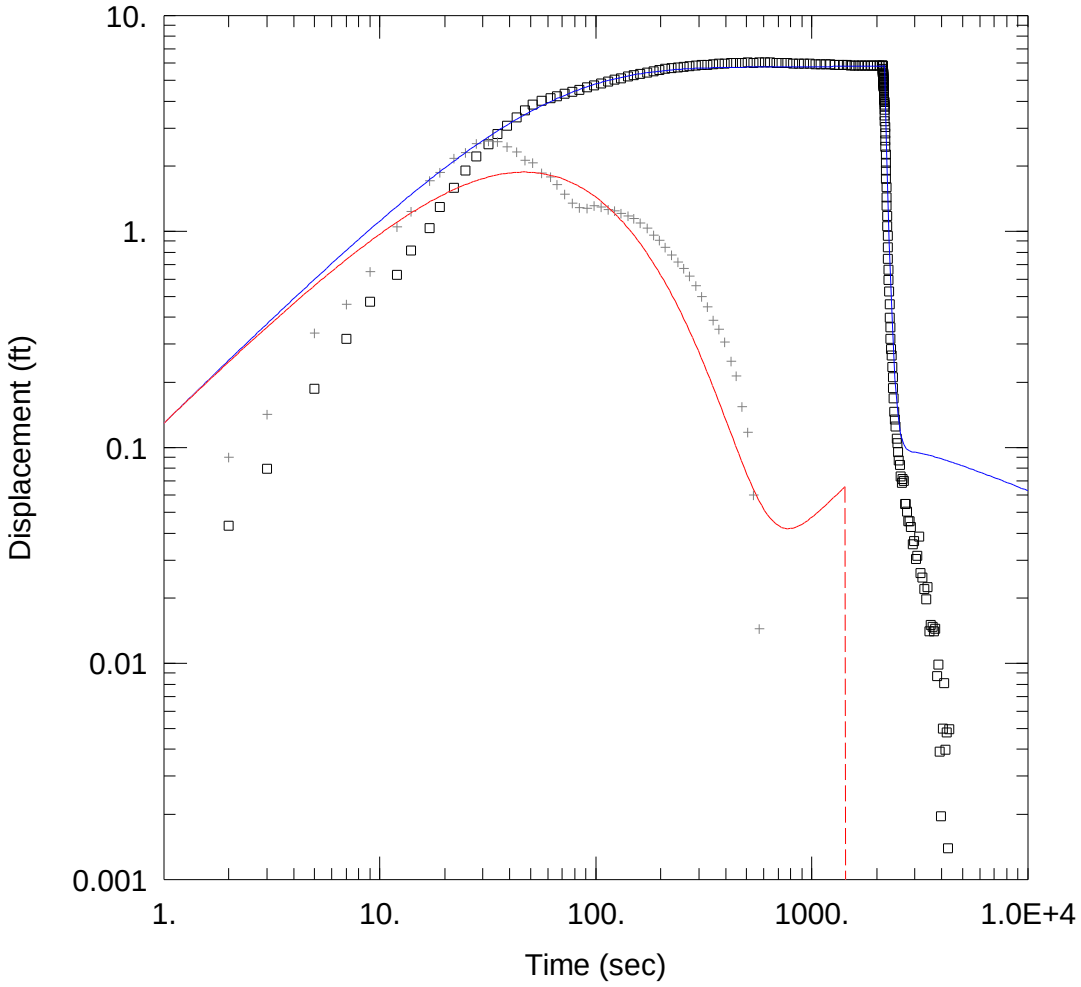
Well Name	X (ft)	Y (ft)
▫ 43B	0	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Moench

T = 14.9 ft^2/day
Sy = 0.1007
Sw = 0.
r(c) = 0.08612 ft

S = 0.0003493
ß = 0.0001563
r(w) = 0.25 ft
alpha = 1.0E+30 sec^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\MW-44B_Pumping_Test.aqt
Date: 09/22/16 Time: 20:11:01

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 44B
Test Date: 8/18/16

AQUIFER DATA

Saturated Thickness: 19.69 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
44B	0	0

Observation Wells

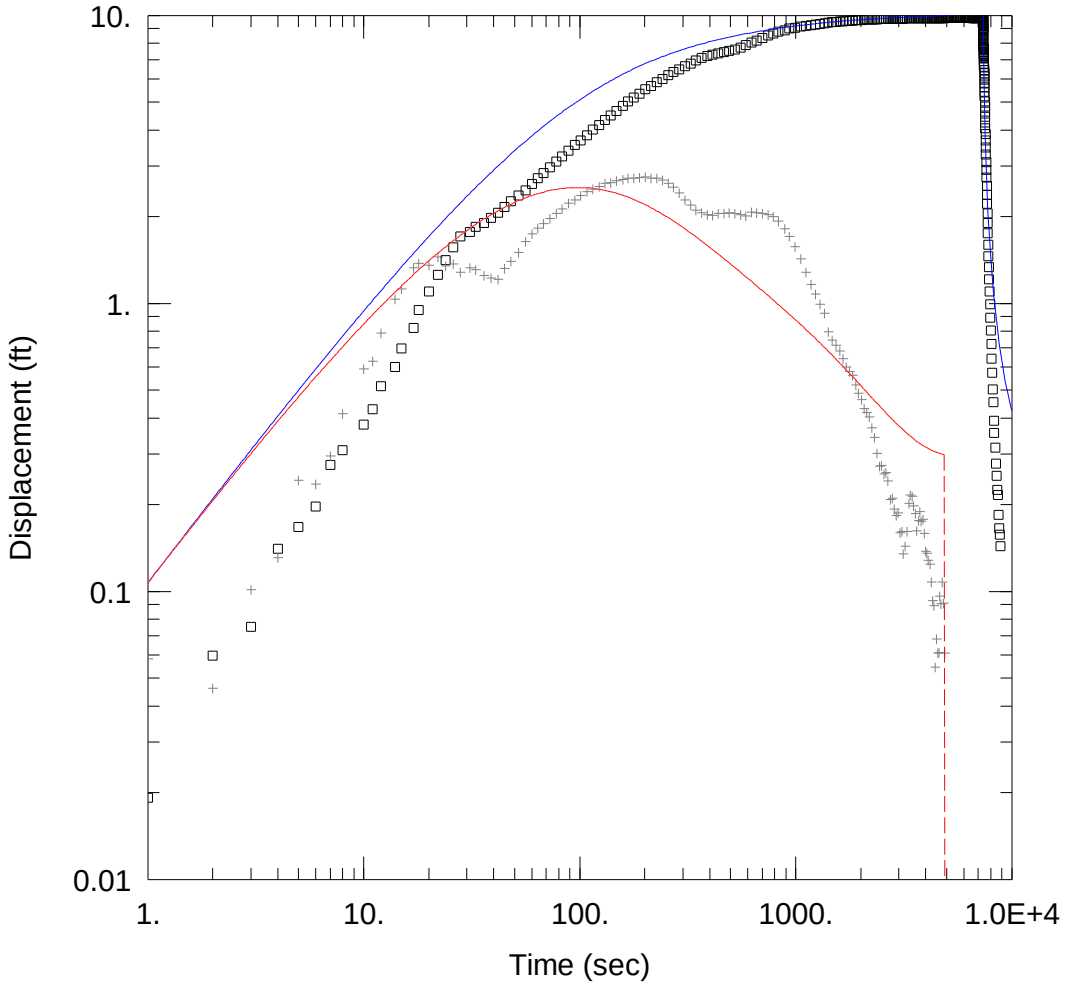
Well Name	X (ft)	Y (ft)
▫ 44B	0	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Moench

T = 27.59 ft^2/day
Sy = 0.1007
Sw = 0.
r(c) = 0.08612 ft

S = 0.0002211
ß = 0.0001612
r(w) = 0.25 ft
alpha = 1.0E+30 sec^{-1}



WELL TEST ANALYSIS

Data Set: C:\...\MW-46B_Pumping_Test.aqt
Date: 09/22/16 Time: 20:13:30

PROJECT INFORMATION

Company: AECOM
Client: Basin Electric
Project: 60506860
Test Well: 43B
Test Date: 8/19/16

AQUIFER DATA

Saturated Thickness: 17.1 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
46B	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ 46B	0	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Moench

T = 13. ft^2/day
Sy = 0.1007
Sw = 0.
r(c) = 0.08612 ft

S = 0.002151
ß = 0.0002138
r(w) = 0.25 ft
alpha = 1.0E+30 sec^{-1}

SOP NUMBER 18.0 Aquifer Pumping Tests

Attachment

SOP NUMBER 18.0 Aquifer Pumping Tests

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used for performing aquifer pumping tests on groundwater monitoring wells. Pumping tests are conducted to determine aquifer transmissivity, hydraulic conductivity, storativity (or specific yield), anisotropy, and assess aquifer hydraulic connectedness. This SOP provides procedures for a step-discharge test to estimate the optimum pumping rate for the extraction well(s); a constant-rate pumping test (conducted at the rate selected from the step-discharge test); and a recovery test. The pumping tests will be run consecutively to reuse the test/monitoring equipment.

This SOP will provide descriptions of equipment, field procedures and documentation necessary to estimate the above hydraulic properties from step, constant rate, and recovery tests.

All activities will be conducted in accordance with the site-specific Health and Safety Plan (HASP).

1.0 EQUIPMENT AND MATERIALS

General equipment and materials used when performing pumping tests include:

- Boring logs, well construction and development records
- Pressure transducers of appropriate range and data logger
- Laptop computer for data logger
- Weather station with thermometer and barometer
- Electric water level meter
- Pumping test data forms (Attachment 18-1)
- Pump capable of pumping variable rates
- Associated pump control box and suspension cable or rope
- Generator or other appropriate power source for the pump
- Appropriately sized polyethylene discharge pipe, ball/gate valves, and check valve
- In-line flow meter with totalizer and flow measurements in gpm range
- Calibrated measuring volume and stopwatch
- Purge water collection system, as needed
- Tool box, hand tools (pliers, screwdrivers, cutting tools, duct tape etc.)
- Keys to well locks
- Decontamination equipment
- Appropriate health and safety equipment as required by the HASP
- Paper towels

- Field log book

2.0 PUMPING TEST METHOD

An aquifer pumping test is a hydraulic well testing method in which groundwater is removed from an extraction (pumping) well to create a hydraulic stress on a water-bearing geologic unit, followed by monitoring of the changing hydraulic head in the pumping well and nearby observation wells. Pumping tests also commonly include a recovery phase where recharge is monitored in the test wells. Pumping tests are normally used to measure hydraulic conductivity as well as specific yield and other aquifer properties that are beyond the scope of less complicated slug tests.

Pumping tests may be performed on a single extraction well, however, only transmissivity and hydraulic conductivity values can be obtained from a single well test. The addition of one or more observation wells allows for the computation of specific yield or storativity of the aquifer and possibly for determination of anisotropy. Ideal testing conditions for determination of anisotropy include at least two pairs of in-line observation wells oriented perpendicularly to their radial offset from the extraction well. Constant-head or barrier boundaries within or close to the area affected by groundwater pumping can influence the drawdown and recovery observed in an aquifer pumping test, and may need to be addressed in the analysis.

Three types of aquifer tests may be conducted at each well selected for pumping. The three types of tests are step-drawdown, constant-rate, and recovery. Step-drawdown tests are conducted at successively greater discharges for relatively short periods to collect data that will be used to assess aquifer response at various pumping rates. These tests are usually conducted prior to constant-rate tests in order to estimate the maximum sustainable pumping rates.

Constant-rate tests involve pumping a well for a significant length of time at an approximately constant-rate. Constant rates are typically selected based on step-discharge testing results and/or well development information.

Recovery tests involve monitoring the recharge of groundwater to the test wells following the conclusion of the constant rate test. The following procedures will be implemented for conducting the aquifer tests.

2.1 PUMPING TEST PROCEDURES

2.1.1 Pre-Test Data Recording

A Pumping Test Data Form will be completed for each well and each test as described in Section 3.

2.1.2 Instrument Check

The flow meter, transducers, and electronic water level meters will be calibrated or checked to make sure they are working properly before commencement of the aquifer tests. Copies of instrument calibration documents will be filed with the records of the test data. The following checks and calibrations will be performed for pumping test equipment:

1) Pressure transducers are rated to specific pressure heads. When selecting pressure transducers, verify pressure head ranges and associated maximum water column heights. Select an appropriate transducer for the range of water level change anticipated in the aquifer test (see operations manual). Record any pertinent information that may have a bearing on test quality.
2) The in-line flow meter will be checked on-site using a calibrated volume and stopwatch.
3) The accuracy of the transducers will be checked by moving the transducer up and down in the well a known vertical distance and reading the pressure (or feet of water) values recorded at the data logger. The known amount that the transducer is moved up or down should match the value displayed on the data logger. Also, the sign of the value on the data logger will be checked to verify the direction of transducer movement.
4) The water level meter will be checked to make sure that there are no lengths of cable cut off, and that the footages are accurate. The probes will be submerged into water to verify that the tone and/or indicator light are functional.

2.1.3 General Setup

1) Adequate fuel will be kept on-site to maintain a generator, if used for power, for the duration of the test, and all refuel times will be noted in field notebook.
2) The oil level in the generator (if used for power) will be checked periodically (at least twice daily).
3) Locate, open, and vent all wells to be tested on that day, unless prohibited by access restrictions. This will allow the water level in the test well to equilibrate with the prevailing barometric pressure. Equilibration of static water levels should be measured with the electronic water level indicator and/or pressure transducer as appropriate. The test wells should equilibrate for at least 30 minutes prior to beginning an aquifer test, and may require more time depending on aquifer characteristics.
4) Measure the static water level and total depth of the well to the nearest 0.01 foot with an electronic water level indicator before the test begins. The measuring point shall be the survey point where the surface elevation was measured; otherwise the point of reference will be the rim of the top of casing on the north side of the well. The well must not be recovering or receding as a result of sampling, development, pumping of nearby wells, or related activities. The test wells will be allowed to recover from these activities for a minimum of 24 hours before the start of the aquifer test.
5) Install pump and discharge lines in pumping well. The pump will be equipped with a check valve on the discharge line to prevent water in the discharge pipe from reentering the well once pumping ceases. Connect the discharge lines to purge containers, and pump control box to pump cable. Allow the water level in the well equilibrate to static conditions.
6) Measure the static water level and total depth in pumping well and observation wells from the surveyed reference point with an electric water level meter.
7) Install pressure transducers in pumping well and observation wells at a depth below the maximum drawdown expected during the test. The pumping well transducer may be installed

inside a sounding tube to limit noise in the transducer readings from potential turbulence in the well. If a sounding tube is present, install pressure transducer approximately 6 inches from the bottom of the tube. Transducers are usually installed above the pump. Do not exceed the specified depth range of the transducer. The transducer should be secured so that it does not move during the test.

8) The transducers should equilibrate for 5 to 10 minutes before initiating the aquifer test.

9) The transducer cable will be connected to the data logger and the data logger turned on. The transducer probe pressure readout (reference level) will be set to zero while the probe is in the water. The depth interval from the static water level will be compared to the transducer probe readout on the data logger to verify that the transducer probe is working properly. The probe may then be referenced to the "appropriate datum" within the data logger. The appropriate datum may be the water level elevation as referenced to mean sea level or the depth of groundwater below the monitoring point.

10) A pre-run checkout test will be performed as specified in Section 2.1.2.

11) Care must be taken to ensure that the elevation of the transducer does not change once the test has begun. Readings from the transducer may be utilized to determine when the test should be stopped.

12) All water generated during the test shall be properly containerized or otherwise disposed of.

13) At the conclusion of any test, be sure to “stop”, “save”, and “download” all data from the transducers and/or data logger prior to removing a transducer from the well.

14) Remove the transducer and decontaminate all equipment.

15) Aquifer test data acquired from wells will be downloaded from the data logger onto a computer and backup copies created.

2.1.4 Conducting a Step-Discharge Test

A series of 2-hour step-discharge tests may be conducted at each selected test well at pre-selected rates based on well development records. The purpose of these tests is to estimate the optimum sustainable pumping rate for the constant-rate test, and to assess how specific capacity varies with increasing pumping rates. The step-discharge test will involve pumping the test well up to 4 successively increasing discharge rates. Each pumping rate (step) will continue for at least 2 hours, or until water levels generally stabilize.

1) Pumping rates for each step may be adjusted in the field.

2) Water-level data from select observation wells and the pumping well will be collected continuously on a logarithmic time schedule using a data logger. Water levels will be measured according to the following time schedule for each step:

   a) 0-10 minutes (min): 1 second (sec) intervals

   b) 10-15 min: 10 sec intervals

   c) 15-100 min: 2 min intervals

d) 100-120 min: 5 min intervals

e) >120 min: 10 min intervals

3) The start time of the data logger will be synchronized with that of the pump. This can easily be done with hand signals or with the delayed start feature on the data logger. Ensure that the pump does not start before the data logger so that the initial water level, H_o, is recorded.

4) Start the step test, recording the time the pump is started as test "zero time."

5) Monitor the pumping well discharge rate and maintain a constant flow rate by regulating the valve. Monitor the pumping rate approximately every 15 minutes during the step test. Record data on the Aquifer Test Data Forms, or in the field notebook.

6) Water levels in the pumping well and observation wells will be measured and recorded to back up the electronic data collected by the pressure transducers and data logger. Manual water-level measurements of the pumping well will be made at 5-minute intervals during the first hour, at 15 minute intervals through the remainder of the test. Measurements at the observation wells may be made every 30 minutes. Measurements will be recorded on the Pumping Test Data Forms.

7) At the end of a 2-hour interval (or sooner, if equilibrium conditions are reached early), the pump will be advanced to the next higher rate and the next step will begin. The water level measurement schedule will start over from time = 0.

8) The data logger will be downloaded to a laptop computer after step- testing is completed.

2.1.5 Conducting a Constant-Rate Test

A constant-rate test will be conducted to estimate aquifer parameters. The constant-rate test will begin only after the aquifer has recovered to within 95% of pre-step test static conditions. Water levels will be measured at least 3 times, approximately 10-15 minutes apart, to verify that static conditions have been re-established.

The constant-rate test will involve pumping the aquifer at a constant discharge rate for a specified duration and measuring water level drawdown. The pumping rate at which the constant-rate test is conducted will be determined from the results of step-discharge test or from previous site knowledge. Barometric pressure will be recorded several times daily to document changes that may influence groundwater elevations. A detailed list of activities to be performed during the constant-rate test follows:

1) Prior to starting the constant-rate test, static water level will be measured in the observation wells and in the test well (to nearest 0.01 foot). Measurements will be made from a surveyed reference point on the well.

2) The pumping well and observation wells located within 100 feet of the pumping well will be monitored with a data logger. The data logger will be programmed to record data logarithmically from the test well and observation wells in which transducers have been placed on the following schedule:

a) 0-10 min: 1 sec intervals

b) 10-15 min: 10 sec intervals

c) 15-100 min: 2 min intervals

d) 100-1,000 min: 30 min intervals

e) 1,000-10,000 min: 200 min intervals

3) Water levels may be monitored manually with an electric water level meter at observation wells located within 300 feet of the pumping well at the following approximate intervals:

   a) 0-10 min: 1 min intervals

   b) 10-100 min: 10 min intervals

   c) 100-1,000 min: 100 min intervals

   d) >1,000 min: 1,000 min intervals

   Observation wells greater than 300 feet from the test well may be monitored manually less frequently.

4) The start time of the data logger will be synchronized with that of the pump. This can easily be done with hand signals or with the delayed start feature on the data logger. Ensure that the pump does not start before the data logger so that the initial water level, H_o, is recorded.

5) Start the constant-rate test, recording the time the pump is started as test "zero time."

6) If the initial discharge rate exceeds the predetermined discharge rate, reduce flow by partially closing the valve on the discharge pipe and note the time in the field notebook.

7) Monitor the pumping well discharge rate and maintain a constant flow rate by regulating the valve. Monitor the pumping rate every 10 minutes during the first two hours. It is recommended to then monitor the pumping rate at 30-minute to 1-hour intervals, as appropriate, throughout the remainder of the test. Record data on the Pumping Test Data Forms, or in the field notebook.

8) During pumping, plot the data (time versus drawdown) on log-log and/or semi-log graph paper or with computer software to assess the progress of the test and to determine when sufficient data have been collected.

9) Water levels in the pumping well will be measured and recorded to back up the electronic data collected by the pressure transducers and data logger. Manual water-level measurements in the pumping well are recommended at approximately 5-minute intervals during the first hour, at 15 minute intervals from 1 to 4 hours, and at 1 hour intervals through the remainder of the test. Measurements will be recorded on the Aquifer Test Data Forms.

10) Manual water-level measurements in the observation wells are recommended at 15 minute intervals during the first 4 hours, and then at 2 hour intervals through the conclusion of the test. Measurements will be recorded on the Pumping Test Data Forms.

11) Samples of groundwater may be collected from the pumping well during the test.

12) The data logger will be downloaded to a laptop computer after the constant-rate test is completed.

There is generally no need to continue a test if water levels have sufficiently stabilized. This normally indicates that sufficient data have been collected. Additional useful information generally will not be gained by continued pumping. When the time versus drawdown data for the most distant observation well begins to plot as a straight line (constant slope) on the semi-log graph paper, the test can be terminated unless delayed yield conditions are anticipated.

Delayed yield conditions may be expected in unconfined aquifers. Pumping tests in unconfined aquifers should be continued until the effects of delayed yield are no longer present and a second Theis-type drawdown begins, if practical.

2.1.6 Conducting a Recovery Test

When the constant-rate test is terminated, the data logger cycle will be terminated and started again to record recovery data. The data logger will be programmed to collect recovery data in a logarithmic mode at the same intervals as those used for the constant-rate test. The start of the data recording will be timed precisely to the shutdown of the pump. The pump will be equipped with a check valve on the discharge line to prevent water in the discharge pipe from reentering the well once pumping ceases.

The recovery test will be terminated when water levels in the observation wells have recovered to within 90% of pre-test static levels or a specified duration. Recorded data will be downloaded from the data logger to a computer disk with file names that reflect the well name and test type (step-discharge, constant-rate, or recovery). Backup disks will also be created for contingency purposes.

2.2 PUMPING TEST DATA ANALYSIS

Data analyses and interpretations from the aquifer tests will be included in the investigation report. Drawdown and recovery data will be compiled and analyzed to:

- Determine hydraulic conductivity, transmissivity, and specific yield or storativity
- Estimate the radius of influence
- Assess whether any hydrogeologic boundaries were encountered (i.e., barrier or recharge boundaries)
- Assess whether any hydraulic communication between aquifer units exists
- Determine the nature and extent of aquifer anisotropy, if appropriate

All analyses will be performed using AQTESOLV® for Windows software (Duffield, 2007), Microsoft Excel®, or similar software. The aquifer test data will be analyzed using the appropriate analytical method(s). Methods may include, but are not limited to, Theis (1935) and Cooper-Jacob (1946). If the hydrogeologic conditions and pumping test data satisfy more than one method of analysis, then results will be presented for each method used.

If hydrogeologic conditions at the site prove to be more complicated than is appropriate for standard modeling methods, a more detailed numerical modeling approach may be undertaken. All numerical modeling results should contain an adequate description of the method or methods utilized.

2.3 REPORTING

Aquifer test data analyses and interpretations will be presented in the investigation report. At a minimum, this portion of the report will include:

- A description of the procedures implemented during testing
- Interpretations of pumping test data
- Tables containing well completion information (e.g., well elevations and screened intervals) and water level data (e.g., initial and final pumping water levels)
- Tables summarizing estimated aquifer property values and water quality parameters collected during the pumping tests
- AQTESOLV® reports and graphs, as well as any manually produced graphs and calculations

3.0 DOCUMENTATION

Documentation of the observations and data acquired in the field will provide information on the activities conducted and also provide a permanent record of field activities. Observations and data will be recorded on a Pumping Test Data Form (Attachment 18-1) and in the field logbook.

3.1 FIELD NOTES

The following aquifer test information will be recorded in a bound field logbook using indelible ink:

- Names of test personnel
- Weather conditions (including barometric pressure)
- Date and time of testing
- Test locations, specifying pumping wells and observation wells
- Start and stop time for each test or step conducted
- Equipment used
- Any other pertinent information that may have a bearing on test quality

3.2 FIELD FORMS

A Pumping Test Data Form (Attachment 18-1) will be completed for each well and each test. The following information will be recorded:

- Date of test
- Aquifer test personnel
- Pumping/extraction or observation well identification number
- Location and elevation (if known) of the reference point from which water depth measurements are made (i.e., top of PVC well casing) for each well

- Static water level
- Well depths, screened intervals, well casing diameters, borehole diameters, and filter pack intervals (from well construction logs)
- Aquifer or groundwater zone (lithology) being tested (from well construction logs)
- Start time of test or step
- End time of test or step
- Type of test (step test, constant-rate, or recovery). If a step test is run, specify which step in the series.
- Pumping rate
- Data logger test number
- Manual water level readings and associated times
- Data collected during the test will not be hand copied from the data logger, but will be downloaded onto a computer and backup copies created

4.0 REFERENCES

Cooper, H.H. and C.E. Jacob, 1946. A generalized graphical method for evaluating formation constants and summarizing well field history, Am. Geophys. Union Trans., vol. 27, pp. 526-534.

Duffield, Glenn M. 1996. AQTESOLV for Windows™, User's Guide. HydroSOLVE, Inc.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

Attachment 18-1
Example of Pumping Test Data Form

PUMPING TEST DATA FORM

Well ID		Personnel	
Location		Static Water Level	
Type of Well		Extraction Well Distance	
Test Date		Total Casing Depth	
Measuring Point Elevation		Borehole Diameter	
Type of Test		Casing Diameter	
Step Number		Screened Interval	
Data logger Test Run No.		Sand Pack Interval	
Pumping Rate		Lithology Tested	
Test Start Time		Test End Time	

Time	Elapsed Time (min)	Water Depth (ft)		Time	Elapsed Time (min)	Water Depth (ft)

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