CCR Groundwater Monitoring System Report

Antelope Valley Station
Beulah, North Dakota

Basin Electric Power Cooperative

Project number: 60495311

October 17, 2017

Quality information

Prepared by	Checked by	Verified by	Approved by
Ryan Klute Technical Manager	Dennis Connair Principal Geologist	Michael Thomas Associate Vice President	Jason Lach Project Manager

Revision History

Revision	Revision date	Details	Authorized	Name	Position

Distribution List

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3		Mr. Kevin Solie / Basin Electric Power Cooperative

Prepared for:

Basin Electric Power Cooperative
Bismarck, North Dakota

Prepared by:

AECOM
1000 E Calgary Avenue, Suite 1
Bismarck, ND 58503
aecom.com

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List of Acronyms

amsl	above mean sea level
ANOVA	analysis of variance
AVS	Antelope Valley Station
Basin	Basin Electric Power Cooperative
bgs	below ground surface
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
cm/sec	centimeters per second
EPA	United States Environmental Protection Agency
FGD	Flue Gas Desulfurization
ft	feet
gpm	gallons per minute
GWPS	Groundwater Protection Standards
MW	megawatt
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act

Monitoring System Certification

Basin Electric Power Cooperative Antelope Valley Station CCR Unit: Ash Landfill

AECOM (“Consultant”) has been retained by Basin Electric Power Cooperative to prepare the following assessment to determine whether the groundwater monitoring system at the coal combustion residuals (“CCR”) landfill at the Antelope Valley Station has been designed and constructed to meet the requirements set out in 40 Code of Federal $Regulations (CFR) § 257.91.

BACKGROUND

Pursuant to 40 CFR § 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. 40 CFR § 257.91 requires owners and operators of a CCR unit to install a groundwater monitoring system that, relying on site-specific technical information, consists 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 CFR § 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 CFR § 257.91, including the performance standards specified in 40 CFR § 257.91(a), based on the site-specific information specified in 40 CFR § 257.91(b). If the groundwater monitoring system includes only the minimum number of downgradient monitoring wells specified in 40 CFR § 257.91(c)(1) (three wells), the certification must document the basis supporting this determination.

In support of Consultant’s assessment, Consultant evaluated the groundwater monitoring system for the above-referenced CCR units to determine that sufficient information is available to make the certification required under 40 CFR § 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, Daryl R. Beck, PE, being a Registered Professional Engineer in the State of North Dakota, certify to the best of my knowledge, information, and belief, that the groundwater monitoring system(s) for the CCR unit(s) that is the subject of this certification has been designed and constructed to meet the requirements of 40 CFR § 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
Daryl R. Beck, PE-10696
Senior Project Engineer

Statistical Method Certification

Basin Electric Power Cooperative Antelope Valley Station CCR Unit: Ash Landfill

AECOM ("Consultant") has been retained by Basin Electric Power Cooperative to prepare the following assessment of whether the statistical method(s) selected for the evaluation of groundwater monitoring data for the above-referenced coal combustion residuals ("CCR") surface impoundments and landfill meets the requirements set out in 40 Code of Federal Regulations (CFR) § 257.93(f)(6).

BACKGROUND

Pursuant to 40 CFR § 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 the groundwater monitoring system. 40 CFR § 257.91 requires owners and operators of a CCR unit to install a groundwater monitoring system that, relying on site-specific technical information, consists 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 CFR § 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 CFR § 257.93(g). Per 40 CFR § 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 CFR § 257.93(f)(6), including the performance standards specified in 40 CFR § 257.91(a), based on the site-specific information specified in 40 CFR § 257.91(b).

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, Daryl R. Beck, PE, being a Registered Professional Engineer in the State of North Dakota, certify to the best of my knowledge, information, and belief, that the statistical method selected for the evaluation of groundwater monitoring data for the groundwater monitoring system for the CCR units that are the subject of this certification is appropriate for evaluating the groundwater monitoring data for the CCR management area comply with the performance standards specified in 40 CFR § 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

Daryl R. Beck, PE-10696
Senior Project Engineer

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 Antelope Valley Station (AVS) located in Beulah, North Dakota (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 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 AVS, as well as the results of groundwater samples collected from 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 AVS and associated CCR units;
- Chapter 3 describes the geological and hydrogeological setting of AVS;
- Chapter 4 describes selection and installation of the AVS CCR monitoring well network for all CCR units at AVS, including the drilling and installation of monitoring wells to supplement existing monitoring wells at AVS;
- Chapter 5 presents an evaluation of the AVS 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 in the Monitoring Well Certification Section.

2. Background

AVS is a coal-based generating station located in Mercer County near the city of Beulah, North Dakota. It has a total power output capacity of 669 megawatts (MW) from two coal-based units:

- Unit 1, with a rating of 450 net MW, which began operating in 1984; and
- Unit 2, with a rating of 450 net MW, which began operating in 1986.

CCR from these units is disposed at AVS in the Section 7 Landfill 0160 located approximately 1 mile northeast of the generating units and office complex (**Figure 1-1**). This CCR landfill was permitted for solid waste disposal in 1995. Construction was completed in 1996, with ash placement beginning the same year. The landfill is situated in an area mine spoils identified as the Couteau Properties Freedom Mine. Documentation provided by Basin reports that in 2014, the landfill received 812,304 tons of waste including fly ash, flue gas desulfurization (FGD) waste and a minor contribution of solid debris (~702 tons). 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 AVS landfill is 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 AVS. The geology underlying the site includes mine spoils underlain by the Sentinel Butte Formation. This formation is comprised of continental deposits in excess of 1,000 feet of dense clay, weakly cemented sandstone, mudstone and lignite.

Precipitation supplies surface water to perennial and ephemeral streams that flow generally east toward the Beulah Trench then draining north towards Lake Sakakawea. Groundwater is recharged primarily through regional infiltration of melt water in the spring.

The base of the AVS CCR Landfill is underlain by 115 to 200 feet (approximately) of clay rich mine spoil that overlies the Lower Sentinel Butte Formation. The Sentinel Butte is comprised primarily of dense clay with trace very fine sand and beds of lignite typically ranging from 6- to 9-feet thick at the site. The 2016 AECOM drilling investigation did not penetrate to depths great enough to expose the lower portions of the Sentinel Butte.

Water precipitated in this environment is anticipated to move primarily as surface water runoff with infiltration typically limited to the upper few feet. The uppermost aquifer is found within the 6- to 9-foot unmined lignite bed located at depths ranging roughly from 180 to 260 feet below ground surface (ft, bgs). The potentiometric surface of the uppermost groundwater present within the lignite is approximately 1893 feet above mean sea level (ft, amsl) in the western portion of the Landfill facility sloping generally east to 1880 ft., amsl on the eastern side of the landfill. The hydraulic gradient for the uppermost aquifer is locally controlled by site-specific composition of the lignite with hydraulic conductivity typically ranging from 10^{-5} centimeters per second (cm/s) to 10^{-9} cm/s.

4. Monitoring Well System Selection and Installation

A monitoring well system has been established at AVS to comply with the requirements of the EPA CCR Rule published in the Federal Register on April 17, 2015.

Monitoring Well Installation in 2016

Seven monitoring wells were installed at AVS during the summer and winter of 2016 to target the uppermost aquifer in the vicinity of the AVS CCR units. Monitoring wells MW-14(S) through MW-19(S) were completed between May 18, 2016 and June 7, 2016. After the first baseline sampling event, MW-14(S) was not yielding significant water and MW-20(S) was installed to supplement the downgradient wells (**Figure 4-1)**. The monitoring well locations were selected to evaluate the direction of groundwater flow in the vicinity of the AVS CCR units, and provide a minimum of three downgradient monitoring wells and one background monitoring well to satisfy the CCR Rule requirements.

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

Drilling and Well Construction

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

Monitoring well drilling and construction occurred in two phases between May 17, 2016 through June 7, 2016 and November 7 through November 17, 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 approximately 5 feet below the base of the lignite or roughly equivalent to 10 to 15 feet below the elevation at which groundwater was anticipated.

Monitoring wells MW-14(s) through MW-19(s) were constructed of 2-inch-diameter, schedule 80 polyvinyl chloride (PVC) riser pipe and slotted screen. One additional monitoring well, identified as MW-20(s), was constructed of 4-inch-diameter, schedule 80 PVC riser pipe and slotted screen. The screen interval was constructed using 10 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. Two to 8 feet of 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 applied in lifts of approximately 30 feet and allowed to set for a minimum of 24 hours. Above-grade steel protective casings with lockable covers 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 were installed around wells located near traffic areas to enhance visibility and protect the wells. All bollards, protective casings and locking lids were painted yellow to help protect against corrosion and improve visibility. The location and elevation of the top of inner casing for each monitoring well was determined by Basin, North Dakota registered land surveyors. Well construction diagrams are included in **Appendix A**, and construction details, including survey information, are summarized in **Table 4-1**.

Well Development

Monitoring wells MW-14(s) through MW-19(s) were developed between June 4, 2016 and June 10, 2016. Development of MW-20(s) occurred November 17, 2016 through November 20, 2016. Well development activities included measuring the water level and total depth of the well, followed by surging and bailing of the well with a weighted bailer to remove initial influx of sediment into the well. After well measurements were taken, the weighted bailer was used as a surge block to surge water into and out of the screened portion of the well for a minimum of 10 to 15 minutes. Due to poor well yields and well depths, wells were bailed dry a minimum of three times during the course of development. Field parameters (pH, specific conductance and turbidity) were measured and recorded periodically during the development process. Water generated during well development was spread on the adjacent ground surface.

Aquifer Testing

A pump test and slug test were performed on background well MW-19(s) and downgradient well MW-16(s) respectively to assess the hydraulic characteristics of the geologic formation beneath the site. The tests were performed between October 6, 2017 and October 7, 2017. The test at MW-19(s) was allowed to proceed for approximately 30 minutes when it was determined that the water elevation in the well was approaching full recovery to pre-test levels, thereby concluding the test. The data from MW-16(s) was collected for over 23 hours after the start of the test. Water level measurements indicated that this well was recovering but had not yet reached pre-test elevation at the time the test was concluded. Manual measurements were recorded on field aquifer testing forms and electronic data was removed from the transducer and used for data evaluation.

Monitoring well MW-19(s) is located to the east of the landfill. After well measurements, a transducer was lowered to approximately 1 foot above the top of the dedicated pump. The water level was then allowed to stabilize before the test was started. After water level stabilization the transducer was turned on to allow the collection of a period of static water levels before the pump was turned on to a flow rate of 0.1 gallons per minute (gpm). The pumping rate was held constant during the test and drawdown in the well was recorded using periodic manual measurements using an electronic water level meter. The pump remained on until the water level in the well stabilized. 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.

The slug test was performed on MW-16(S) located to the east of the landfill. After well measurements, a transducer was lowered to approximately 1 foot above the top of the dedicated pump. The water level was then allowed to stabilize before the test was started. After water level stabilization the transducer was turned on to allow the collection of static water levels before the pump was turned on. The pump was turned on and 3 liters were removed before shutting off the pump. The water level was allowed to recover for approximately 24 hours before the test was stopped and the equipment removed from the well.

Pumping Test Analysis Process

Data from the test were processed and analyzed using the AQTESOLV software package (Duffield, 2007), which provides type curve solutions corresponding to various conceptual models, each with their own hydrologic assumptions. 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 recovery tests using the recovery solution for a pumping test in a non-leaky confined aquifer (Theis, 1935). The analysis involves matching a straight line to residual drawdown data collected after the termination of a pumping test. The Theis solution utilizes the following assumptions:

- Aquifer has infinite areal extent;
- Aquifer is homogeneous, isotropic and of uniform thickness;
- Control well is fully penetrating;
- Flow to control well is horizontal;
- Aquifer is non-leaky confined;
- Flow is unsteady;
- Water is released instantaneously from storage with decline of hydraulic head;

- Diameter of pumping well is very small so that storage in the well can be neglected;
- Values of *u′* are small (i.e., *r* is small and *t′* is large)

The AQTESOLV report of the constant rate pump test data for MW-19(S) is presented in **Appendix B**. The estimated hydraulic conductivity of the completed slug tests was 1.652 x 10^{-4} cm/sec.

Slug Test Analysis Process

Data from the test was 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 KGS Solution for Confined Aquifers (Bouwer & Rice 1976). This method uses a type curve fit to the observed water-level displacement and accounts for wellbore storage. Graphs of the slug test results are included in **Appendix B**. Due to the slow rate of recovery; wellbore storage will have an effect on the data in early time, but is accounted for with the KGS Solution. Some basic assumptions of the KGS solution include:

- Aquifer has infinite areal extent;
- Aquifer is homogeneous 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 unsteady; and
- Aquifer is confined or unconfined.

The AQTESOLV report of the slug test data for MW-16(S) is presented in **Appendix B**. The estimated hydraulic conductivity of the completed slug tests was 2.482 x 10^{-9} cm/sec.

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 background 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 AVS evolved and was adapted based on the results obtained from baseline groundwater monitoring in 2016 and 2017. The final monitoring system consists of six monitoring wells that were sampled and will be included as part of the detection monitoring program going forward. The list of wells selected for sampling background and downgradient groundwater quality for each CCR unit is summarized below:

CCR unit/multi-unit	Background wells	Downgradient wells
Landfill	MW-18(S), MW-19(S)	MW-15(S), MW-16(S), MW-17(S), MW-20(S)

Monitoring well MW-14(S) is being excluded from the groundwater monitoring network due to insufficient water production to obtain a representative sample. However, it remains in place for groundwater level measurements.

Potentiometric surface maps have been constructed using the depth-to-groundwater measurements obtained during baseline groundwater monitoring. Maps of the potentiometric surface for the eight baseline events are presented as **Figures 5-1** through **Figure 5-8** respectively. The associated depth-to-groundwater measurements and calculated groundwater elevations are presented in **Table 5-1** through **Table 5-8** respectively. 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 elevation contours of the groundwater potentiometric surface. The direction of groundwater flow is generally to the east, perpendicular to the potentiometric contour lines. **Figures 5-1** though **Figure 5-8** illustrate the relatively consistent pattern between events with a low gradient groundwater flow from west to east beneath the AVS CCR unit.   The data evaluated for this report 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 CFR 257.94(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 detection 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, AVS 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 GWPS 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 AVS CCR 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 AVS CCR unit. The detection monitoring data collected at the downgradient wells will be used to determine if the CCR unit has impacted groundwater quality. The initial eight rounds of detection monitoring sampling and analysis were completed by 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 AVS, 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 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 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 AVS.

As a caveat to this approach, for constituents that occur naturally and vary substantially in concentration across AVS 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 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 AVS 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 EPA (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 EPA (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 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 background data are non-stationary and thus exhibit a clear trend, it will suggest that factors unrelated to the CCR unit are impacting background 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 background wells is not reflected in downgradient wells, further investigation may be needed to determine if the background 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. The table is based on a preliminary screening of the background well data collected to date. The proposed statistical method may be modified when all of the background data has been 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

Bouwer, H. and R. Rice. 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. Water Resources Research, 12(3), pp. 423-428.

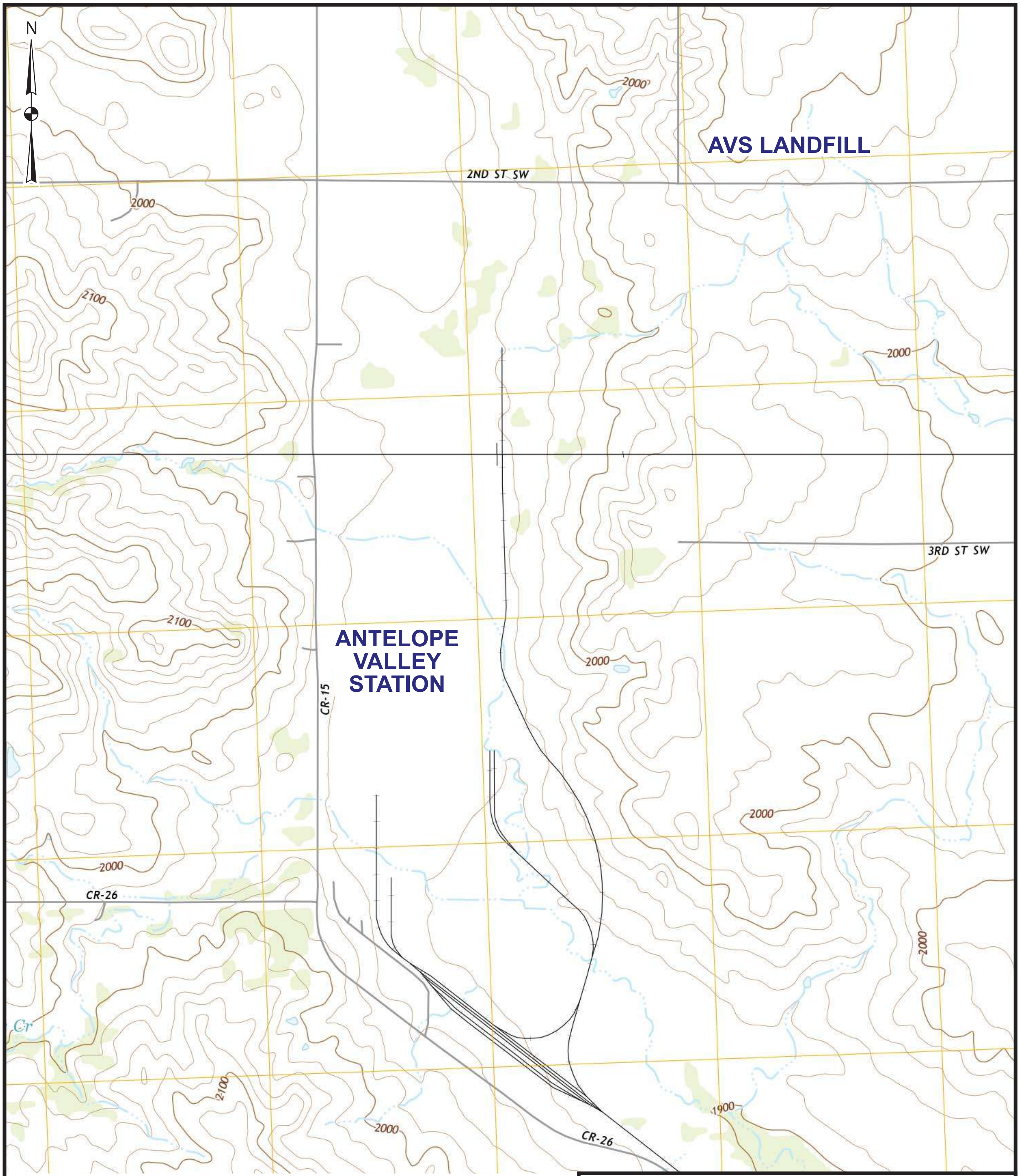
Duffield, G. M. 2007. AQTESOLV Version 4.50, s.l.: HydroSOLVE, Inc.

Theis C. 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage, 16, pp. 519-524.

U.S. Environmental Protection Agency. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities. Unified Guidance. EPA 530-R-09-007. March. 884 pp.

Figures

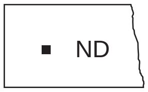
J:\Project\B\Basin Electric Coop\60495311 AVS Landfill CCR Wells\Data-Tech\TI



0 2,000 4,000

APPROXIMATE SCALE IN FEET

BASE MAP SOURCE: USGS 7½ minute topographic quadrangle maps: Beulah, North Dakota 2014; Beulah NE, North Dakota 2014.



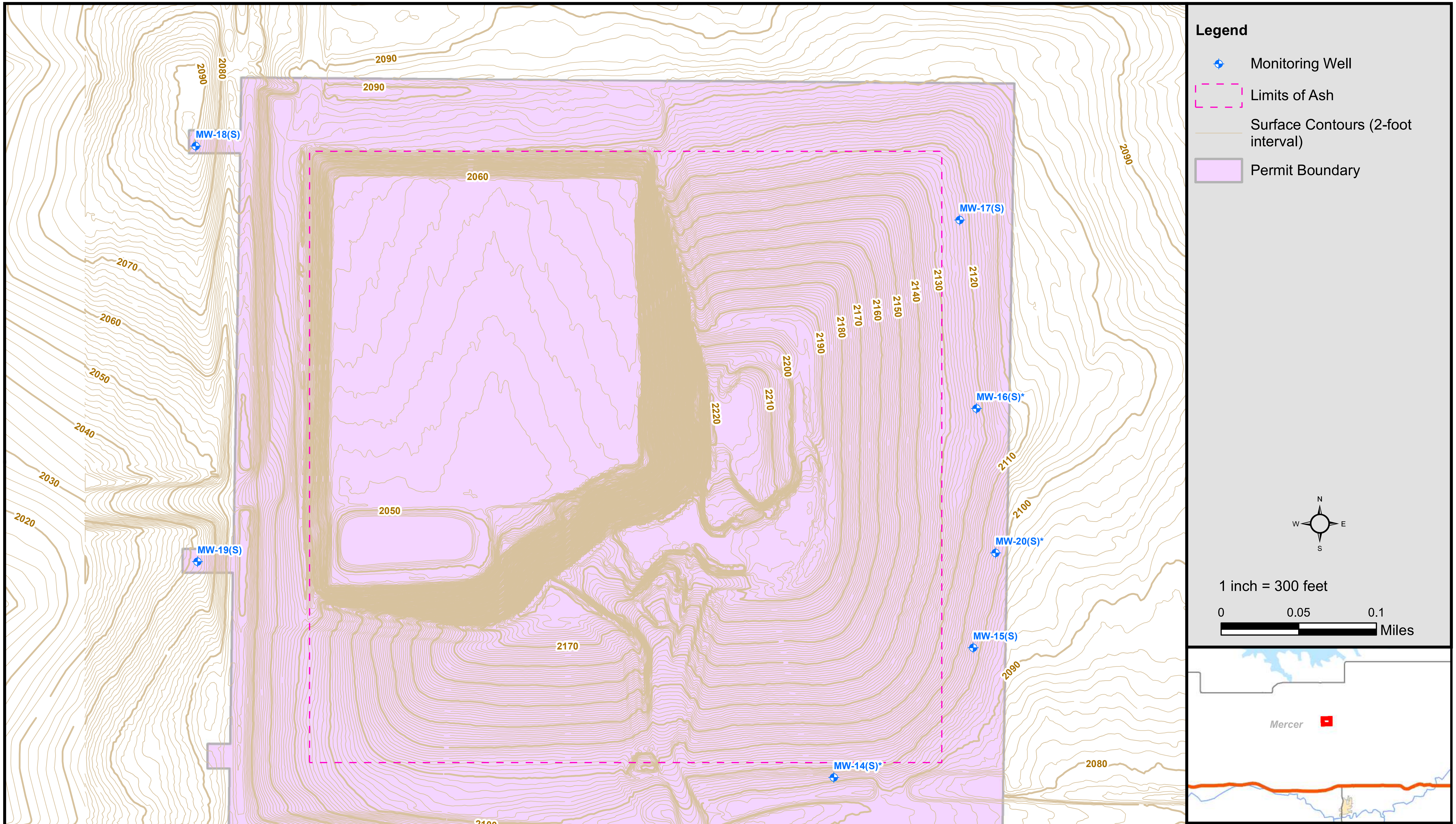
Quadrangle Location

BASIN ELECTRIC POWER COOPERATIVE

FIGURE 1-1
SITE VICINITY MAP
AVS LANDFILL

JOB NO. 60514340

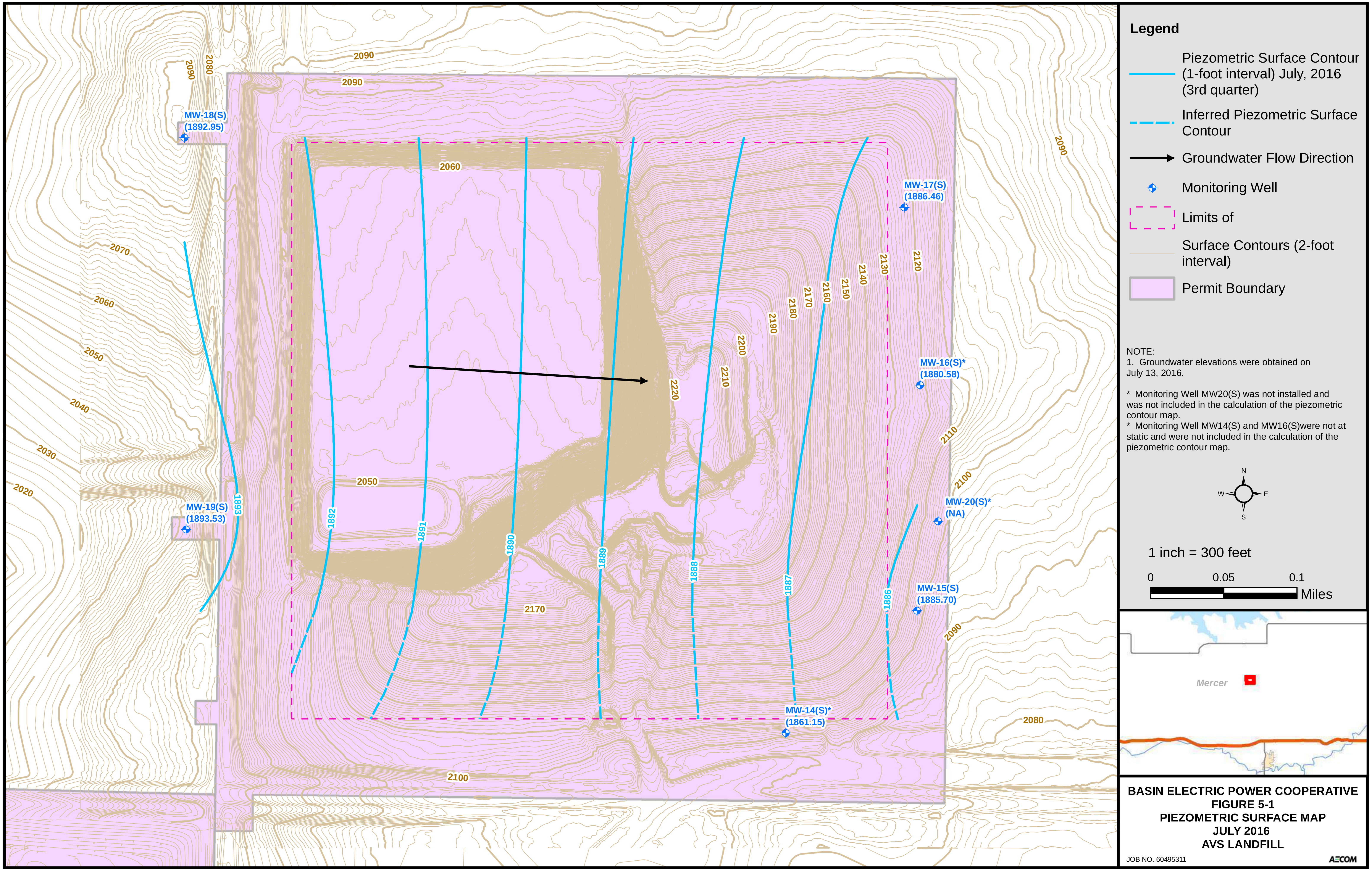
AECOM



BASIN ELECTRIC POWER COOPERATIVE
FIGURE 4-1
MONITORING WELL
LOCATION MAP
AVS LANDFILL

JOB NO. 60495311

AECOM



Legend

Piezometric Surface Contour (1-foot interval) July, 2016 (3rd quarter)

Inferred Piezometric Surface Contour

Groundwater Flow Direction

Monitoring Well

Limits of

Surface Contours (2-foot interval)

Permit Boundary

NOTE:
1. Groundwater elevations were obtained on July 13, 2016.

* Monitoring Well MW20(S) was not installed and was not included in the calculation of the piezometric contour map.
* Monitoring Well MW14(S) and MW16(S)were not at static and were not included in the calculation of the piezometric contour map.

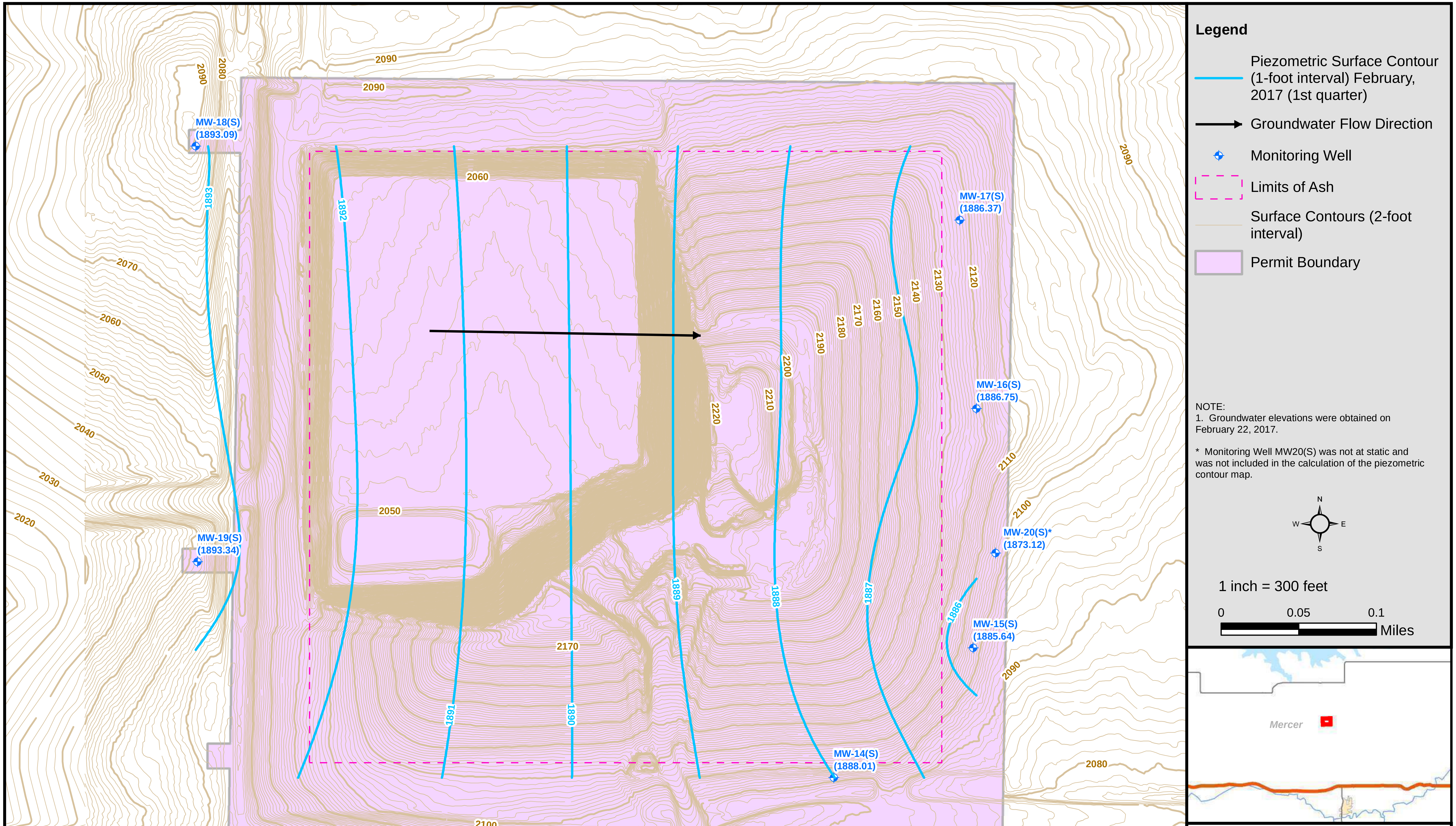
1 inch = 300 feet

0 0.05 0.1 Miles

BASIN ELECTRIC POWER COOPERATIVE
FIGURE 5-1
PIEZOMETRIC SURFACE MAP
JULY 2016
AVS LANDFILL

JOB NO. 60495311

AECOM



Legend

Piezometric Surface Contour (1-foot interval) February, 2017 (1st quarter)

Groundwater Flow Direction

Monitoring Well

Limits of Ash

Surface Contours (2-foot interval)

Permit Boundary

NOTE:
1. Groundwater elevations were obtained on February 22, 2017.

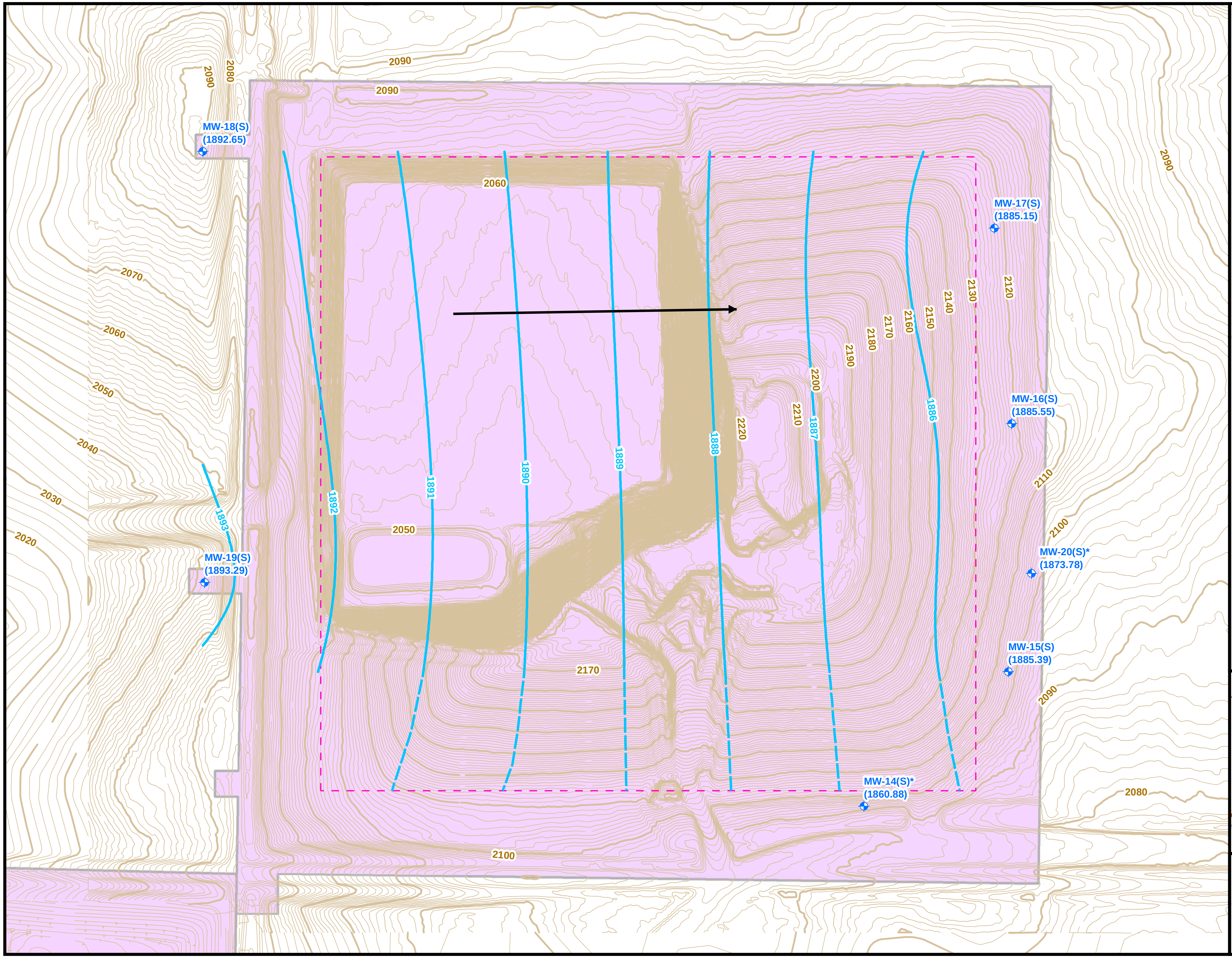
* Monitoring Well MW20(S) was not at static and was not included in the calculation of the piezometric contour map.

1 inch = 300 feet

BASIN ELECTRIC POWER COOPERATIVE
FIGURE 5-2
PIEZOMETRIC SURFACE MAP
FEBRUARY 2017
AVS LANDFILL

JOB NO. 60495311

AECOM



Legend

—	Piezometric Surface Contour (1-foot interval) March, 2017 (1st quarter)
– –	Inferred Piezometric Surface Contour
→	Groundwater Flow Direction
⊕	Monitoring Well
⬚	Limits of
—	Surface Contours (2-foot interval)
▨	Permit Boundary

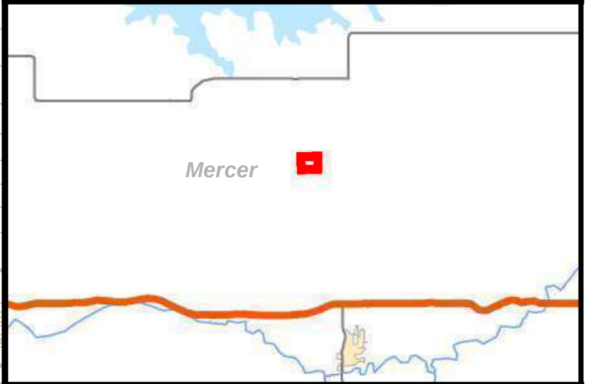
NOTE:
1. Groundwater elevations were obtained on March 21, 2017.

* Monitoring Well MW14(S) and MW20(S)were not at static and were not included in the calculation of the piezometric contour map.

N
W E
S

1 inch = 300 feet

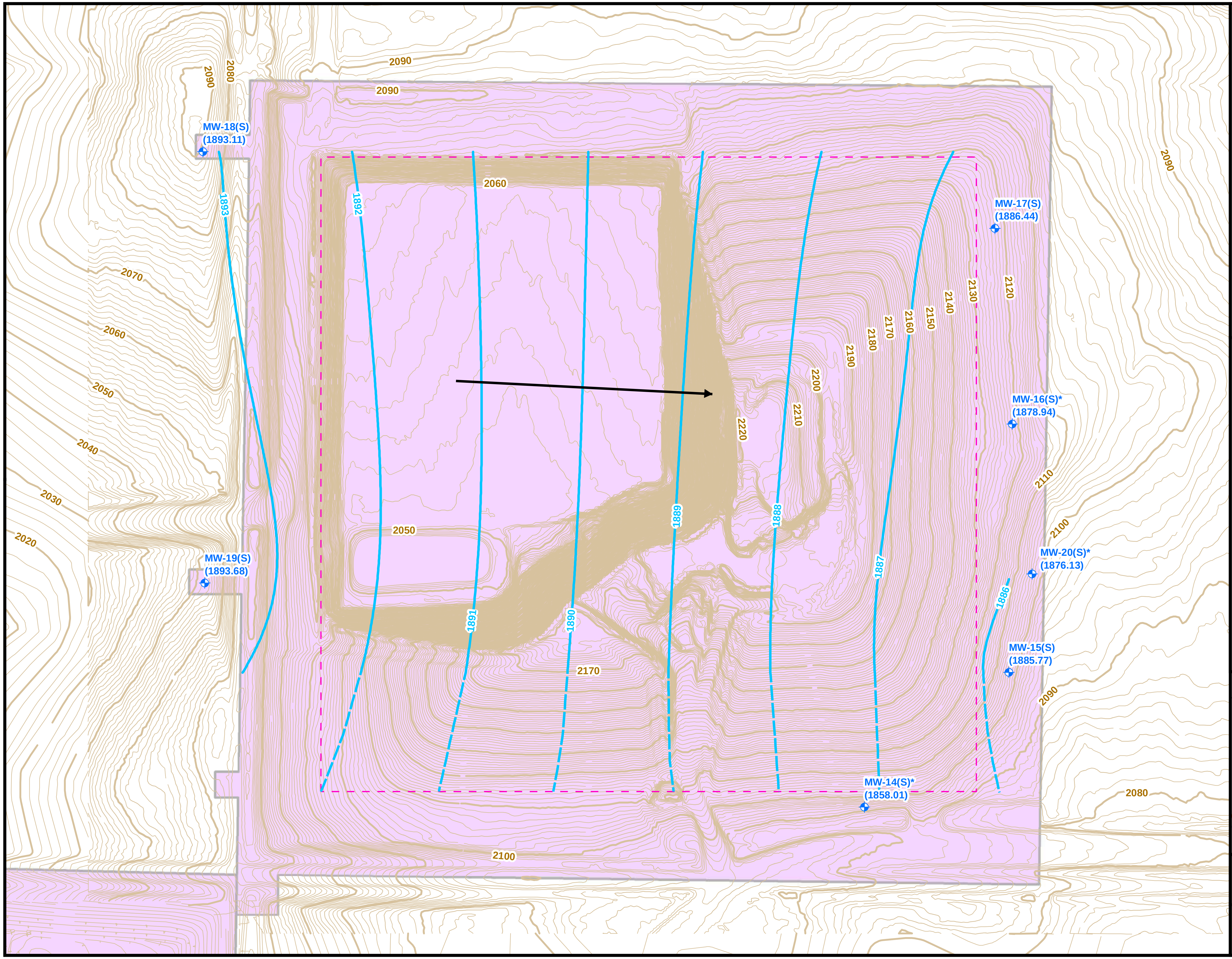
0 0.05 0.1
Miles



BASIN ELECTRIC POWER COOPERATIVE
FIGURE 5-3
PIEZOMETRIC SURFACE MAP
MARCH 2017
AVS LANDFILL

JOB NO. 60495311

AECOM



Legend

Piezometric Surface Contour (1-foot interval) April, 2017 (2nd quarter)

Inferred Piezometric Surface Contour

Groundwater Flow Direction

Monitoring Well

Limits of

Surface Contours (2-foot interval)

Permit Boundary

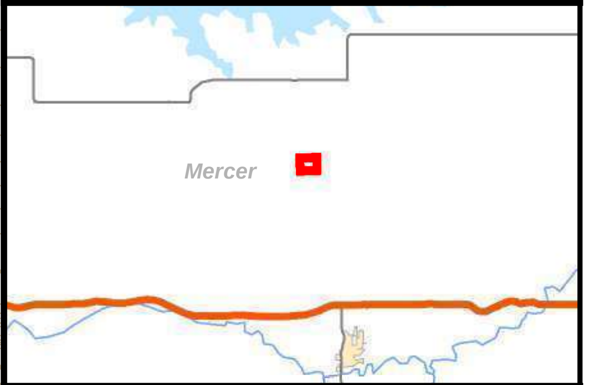
NOTE:
1. Groundwater elevations were obtained on April 19, 2017.

* Monitoring Well MW14(S), MW16(S), and MW20(S) were not at static and were not included in the calculation of the piezometric contour map.

N
W E
S

1 inch = 300 feet

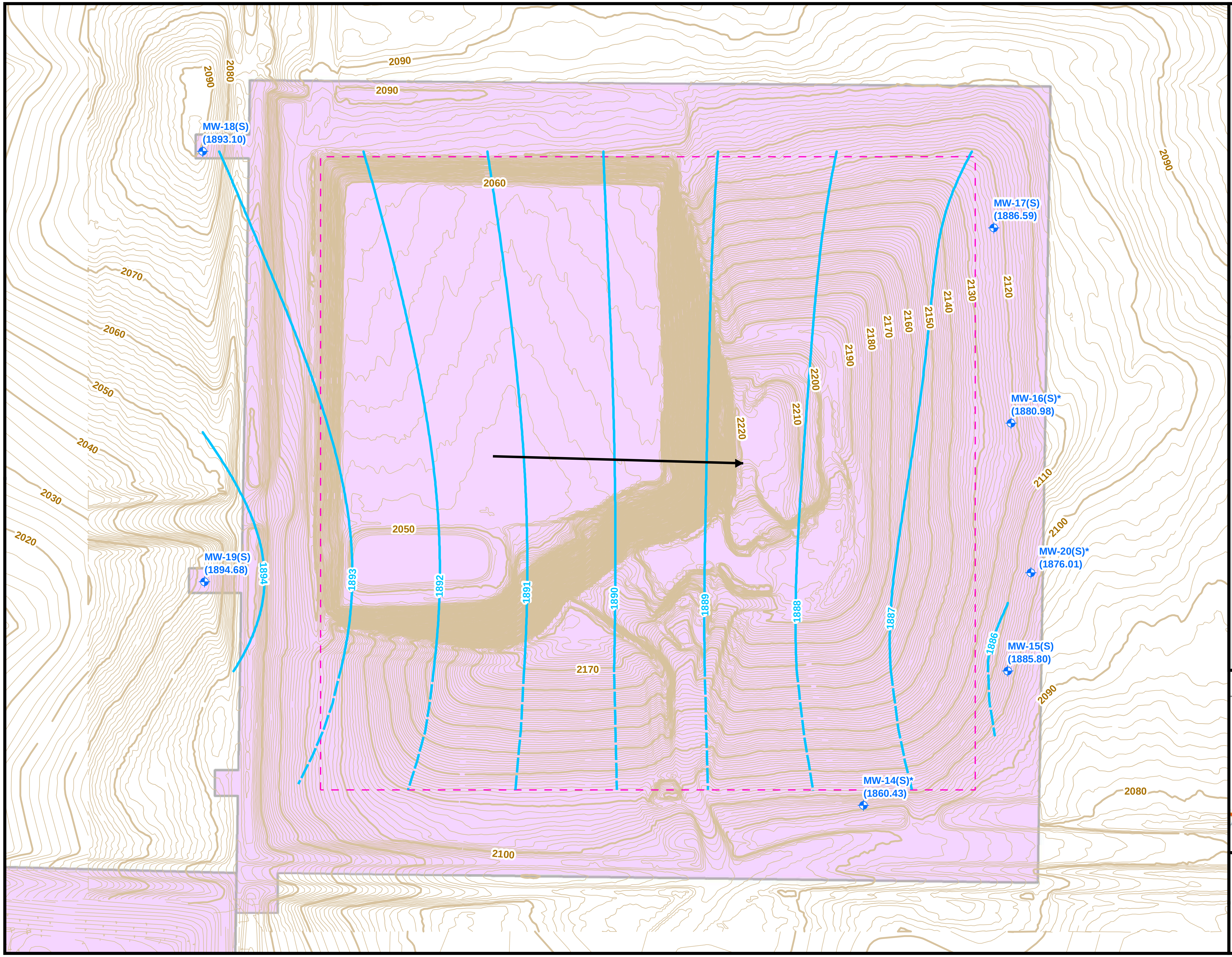
0 0.05 0.1
Miles



BASIN ELECTRIC POWER COOPERATIVE
FIGURE 5-4
PIEZOMETRIC SURFACE MAP
APRIL 2017
AVS LANDFILL

JOB NO. 60495311

AECOM



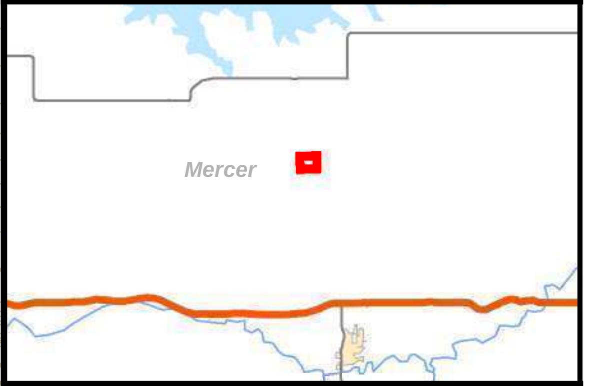
Legend

—	Piezometric Surface Contour (1-foot interval) May, 2017 (2nd quarter)
- -	Inferred Piezometric Surface Contour
→	Groundwater Flow Direction
⊕	Monitoring Well
⬚	Limits of Ash
—	Surface Contours (2-foot interval)
▨	Permit Boundary

NOTE:
1. Groundwater elevations were obtained on May 23, 2017.

* Monitoring Well MW14(S), MW16(S), and MW20(S) were not at static and were not included in the calculation of the piezometric contour map.

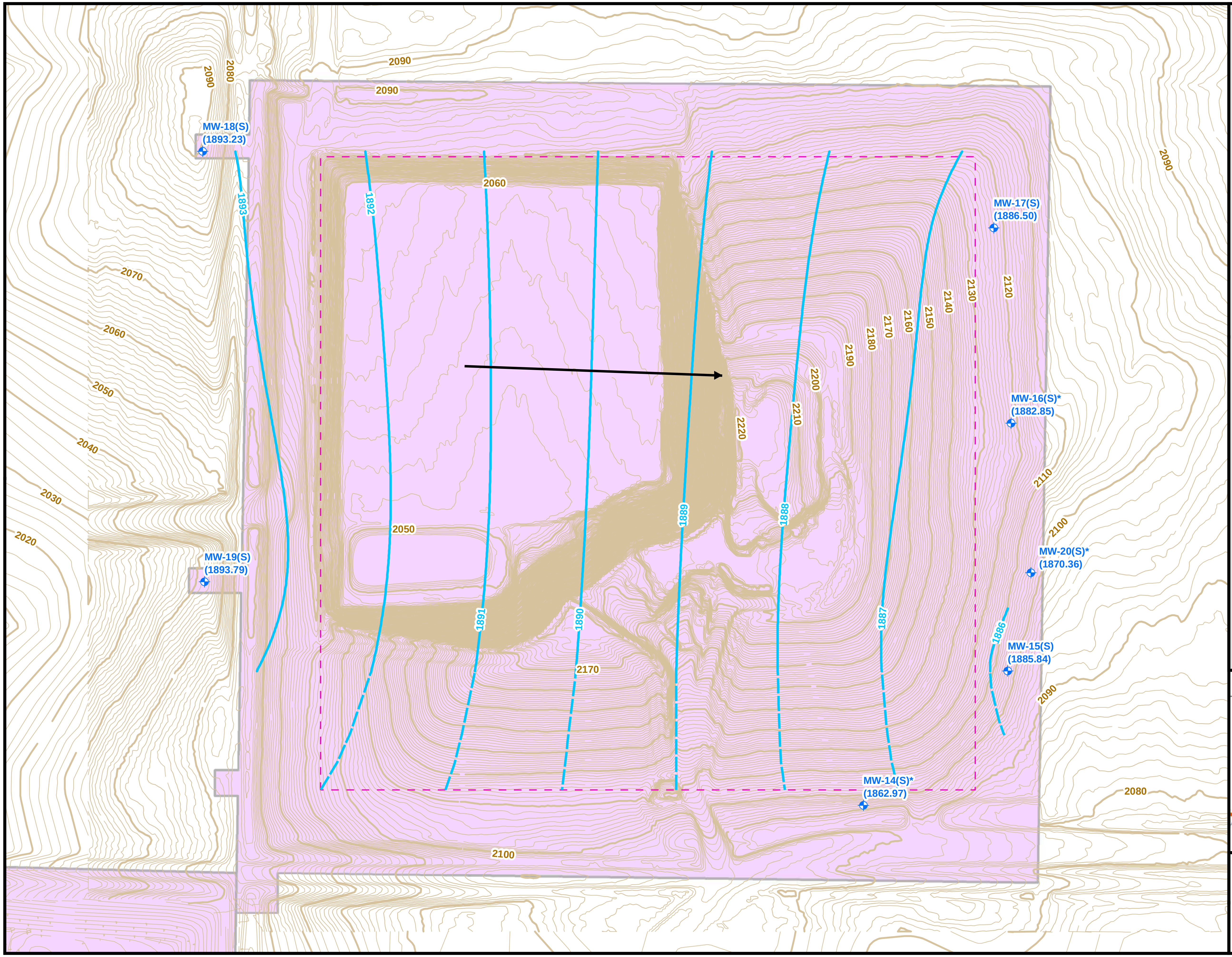
1 inch = 300 feet



BASIN ELECTRIC POWER COOPERATIVE
FIGURE 5-5
PIEZOMETRIC SURFACE MAP
MAY 2017
AVS LANDFILL

JOB NO. 60495311

AECOM



Legend

Piezometric Surface Contour (1-foot interval) June, 2017 (2nd quarter)

Inferred Piezometric Surface Contour

Groundwater Flow Direction

Monitoring Well

Limits of

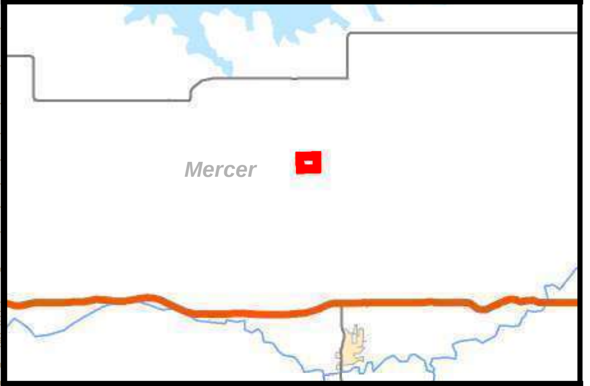
Surface Contours (2-foot interval)

Permit Boundary

NOTE:
1. Groundwater elevations were obtained on June 28, 2017.

* Monitoring Well MW14(S), MW16(S), and MW20(S) were not at static and were not included in the calculation of the piezometric contour map.

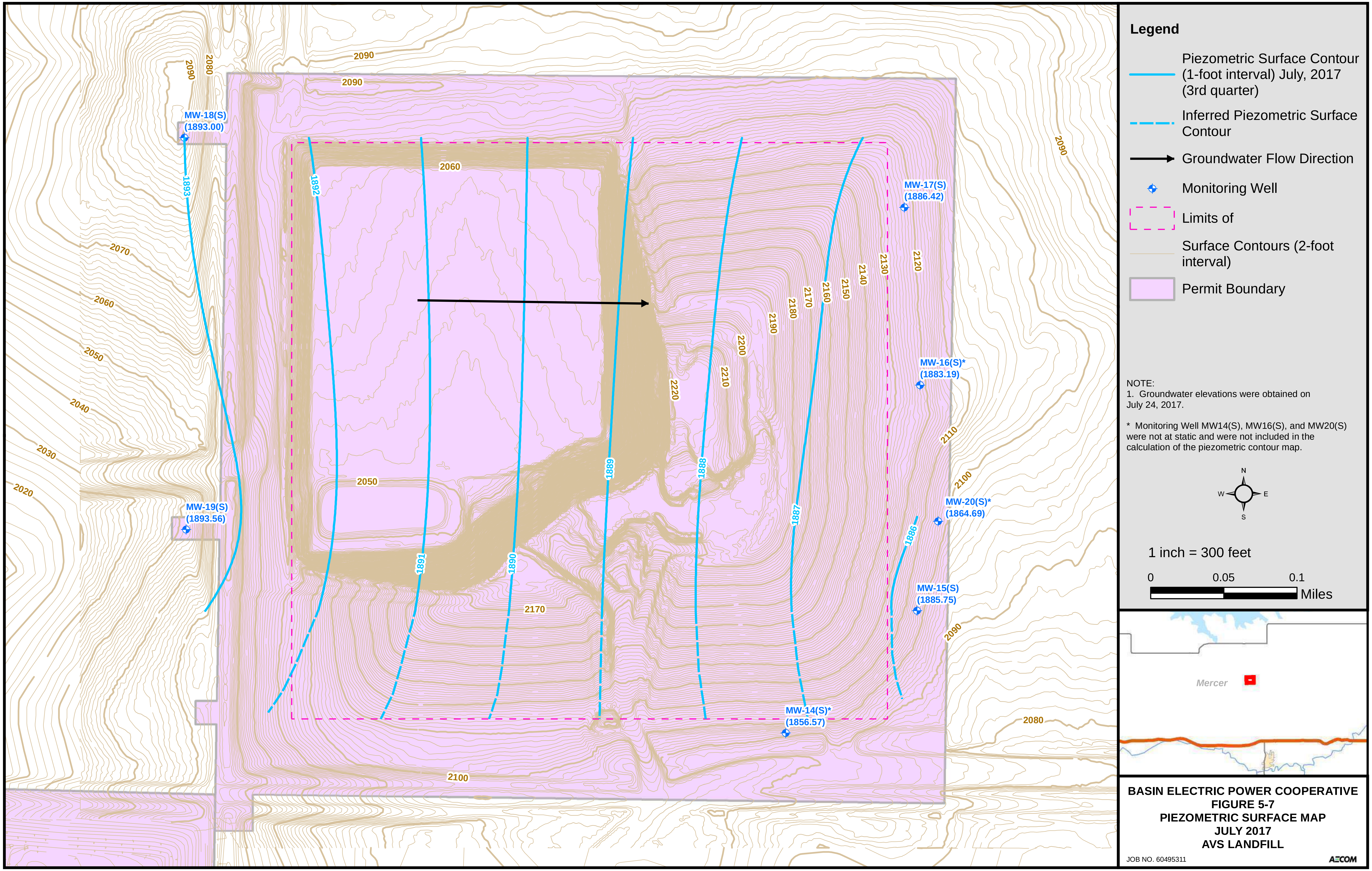
1 inch = 300 feet



BASIN ELECTRIC POWER COOPERATIVE
FIGURE 5-6
PIEZOMETRIC SURFACE MAP
JUNE 2017
AVS LANDFILL

JOB NO. 60495311

AECOM



NOTE:

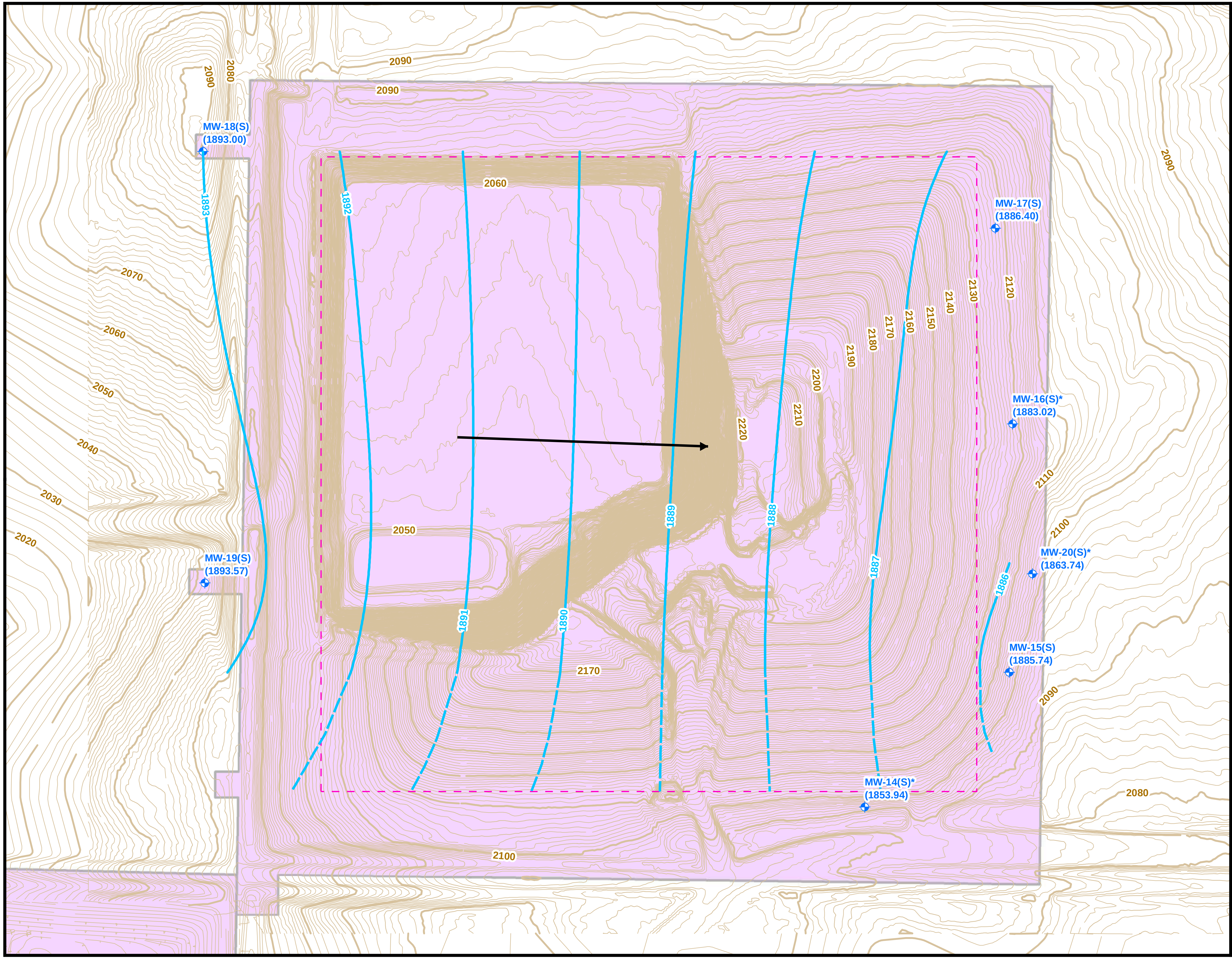
1. Groundwater elevations were obtained on July 24, 2017.

* Monitoring Well MW14(S), MW16(S), and MW20(S) were not at static and were not included in the calculation of the piezometric contour map.

BASIN ELECTRIC POWER COOPERATIVE
FIGURE 5-7
PIEZOMETRIC SURFACE MAP
JULY 2017
AVS LANDFILL

JOB NO. 60495311

AECOM



Legend

Piezometric Surface Contour (1-foot interval) August, 2017 (3rd quarter)

Inferred Piezometric Surface Contour

→ Groundwater Flow Direction

⊕ Monitoring Well

Limits of

Surface Contours (2-foot interval)

▨ Permit Boundary

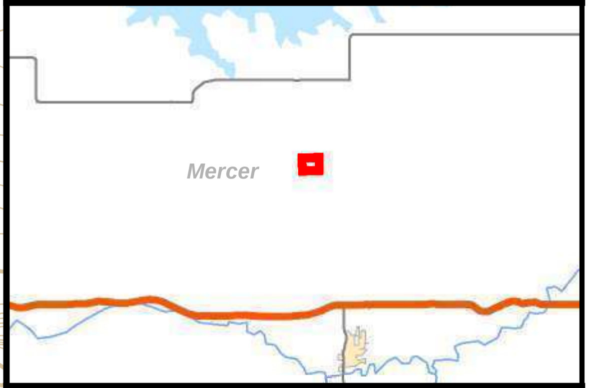
NOTE:
1. Groundwater elevations were obtained on August 16, 2017.

* Monitoring Well MW14(S), MW16(S), and MW20(S) were not at static and were not included in the calculation of the piezometric contour map.

N
W E
S

1 inch = 300 feet

0 0.05 0.1
Miles



BASIN ELECTRIC POWER COOPERATIVE
FIGURE 5-8
PIEZOMETRIC SURFACE MAP
AUGUST 2017
AVS LANDFILL

JOB NO. 60495311

AECOM

Tables

TABLE 4-1

CCR GROUNDWATER MONITORING SYSTEM

BASIN ELECTRIC - ANTELOPE VALLEY STATION
CCR LANDFILL
MERCER COUNTY, NORTH DAKOTA

Well Identification	Site Position	Location*		Reference Elevation**		Casing Length (feet, TOIC)	Size / Type (ID / Material)	Sand Pack Interval (feet below GS)		Screened Interval (Elevation, feet, NAVD)			Bottom of Boring (feet, GS)
		Northing	Easting	TOIC (feet, NAVD)	GS (feet, NAVD)			Top	Bottom	Top	Pump Intake	Bottom	
MW-14(s)	Cross-Gradient	629969.02	1674533.2	2093.54	2091.54	249	2 inch / PVC	235	248	1854.54	NA	1844.54	256
MW-15(s)	Down-gradient	630410.64	1675007.2	2104.89	2102.89	252	2 inch / PVC	236	251	1862.89	1853.89	1852.89	264
MW-16(s)	Down-gradient	631224.67	1675017.9	2123.7	2121.7	270	2 inch / PVC	255	268	1863.70	1855.20	1853.70	276
MW-17(s)	Down-gradient	631865.98	1674961.2	2125.06	2123.26	268	2 inch / PVC	250	268	1867.26	1860.06	1857.26	278
MW-18(s)	Up-gradient	632117.57	1672362.9	2091.7	2090	246	2 inch / PVC	231	262	1856.00	1848.70	1846.00	262
MW-19(s)	Up-gradient	630703.79	1672368.4	2042.68	2039.68	189	2 inch / PVC	174	186	1863.68	1854.68	1853.68	208
MW-20(s)	Down-gradient	630733.34	1675082.7	2107.573	2106.143	252	4 inch / PVC	236	252	1865.14	1857.57	1855.14	255

Reference elevation of monitoring wells surveyed by Basin Electric Registered Land Surveyors.
Horizontal Datum* - NAD 83 (1983), Vertical Datum** - NAVD 88 GPS
NAVD = North American Vertical Datum of 1988 (NAVD 88)
PVC = Polyvinyl chloride
ID = Internal Diameter
TOIC = Top of internal casing
GS = Ground Surface Estimated from Top of Casing reported on boring log
NA = Pump not installed due to insufficient recharge.

TABLE 5-1

MONITORING WELL GROUNDWATER ELEVATIONS - JULY 2016 THROUGH AUGUST 2017

BASIN ELECTRIC
ANTELOPE VALLEY STATION - MERCER COUNTY, NORTH DAKOTA

LANDFILL

Well ID	Reference Elevation Top of Casing* (feet, NAVD 88)	July 13, 2016		February 1, 2017		February 22, 2017		March 21, 2017		April 19, 2017		May 23, 2017		June 28, 2017		July 24, 2017		August 16, 2017	
		DTW (feet)	Groundwater Elevation (ft, NAVD 88)	DTW (feet)	Groundwater Elevation (ft, NAVD 88)	DTW (feet)	Groundwater Elevation (ft, NAVD 88)	DTW (feet)	Groundwater Elevation (ft, NAVD 88)	DTW (feet)	Groundwater Elevation (ft, NAVD 88)	DTW (feet)	Groundwater Elevation (ft, NAVD 88)	DTW (feet)	Groundwater Elevation (ft, NAVD 88)	DTW (feet)	Groundwater Elevation (ft, NAVD 88)	DTW (feet)	Groundwater Elevation (ft, NAVD 88)
MW-14(S)	2093.54	232.39	1861.15	NS	NA	205.53	1888.01	232.66	1860.88	235.53	1858.01	233.11	1860.43	230.57	1862.97	236.97	1856.57	239.60	1853.94
MW-15(S)	2104.89	219.19	1885.70	NA	NA	219.25	1885.64	219.50	1885.39	219.12	1885.77	219.09	1885.80	219.05	1885.84	219.14	1885.75	219.15	1885.74
MW-16(S)	2123.70	243.12	1880.58	NA	NA	236.95	1886.75	238.15	1885.55	244.76	1878.94	242.72	1880.98	240.85	1882.85	240.51	1883.19	240.68	1883.02
MW-17(S)	2125.06	238.60	1886.46	NA	NA	238.69	1886.37	239.91	1885.15	238.62	1886.44	238.47	1886.59	238.56	1886.50	238.64	1886.42	238.66	1886.40
MW-18(S)	2091.70	198.75	1892.95	NA	NA	198.61	1893.09	199.05	1892.65	198.59	1893.11	198.60	1893.10	198.47	1893.23	198.70	1893.00	198.70	1893.00
MW-19(S)	2042.68	149.15	1893.53	149.66	1893.02	149.34	1893.34	149.39	1893.29	149.00	1893.68	148.00	1894.68	148.89	1893.79	149.12	1893.56	149.11	1893.57
MW-20(S)	2107.57	NA	NA	242.21	1865.36	234.45	1873.12	233.79	1873.78	231.44	1876.13	231.56	1876.01	237.21	1870.36	242.88	1864.69	243.83	1863.74

(Horizontal Datum* - NAD 83 (1983), Vertical Datum** - NAVD 88 GPS)
NAVD = North American Vertical Datum of 1988 (NAVD 88)
TOIC = Top of internal casing
U = Upgradient / Background
D = Downgradient
C = Crossgradient
NM = Not Measured (Well did not exist or no longer sampled)
DTW = Depth To Water
GW = Groundwater

TABLE 6-1

PROPOSED STATISTICAL METHODS FOR APPENDIX III CONSTITUENTS IN BACKGROUND WELLS

BASIN ELECTRIC – ANTELOPE VALLEY STATION
CCR LANDFILL
MERCER COUNTY, NORTH DAKOTA

CCR Unit	Background Wells	Statistical Method	Constituent
AVS Landfill	MW-18(s), MW-19(S)	Parametric Prediction Interval	Calcium, Chloride, Fluoride, pH, TDS
AVS Landfill	MW-18(s), MW-19(S)	Nonparametric Prediction Interval	Boron, Sulfate

Appendix A

Boring Logs and Well Construction Diagrams

AECOM

WELL NUMBER MW-14 (S)

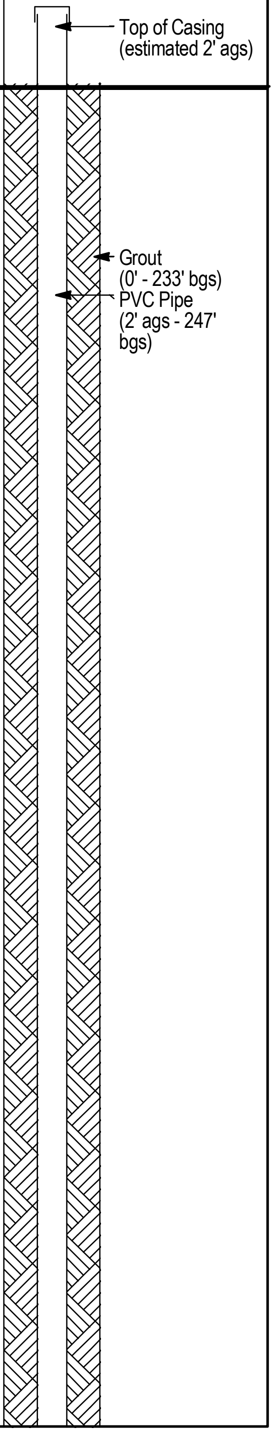
PAGE 1 OF 4

CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND
DATE STARTED 5/21/2016 **COMPLETED** 5/22/2016
GROUND ELEVATION 2091.54 ft **HAMMER TYPE** Not Applicable
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
DRILLING METHOD Rotary Sonic
AT TIME OF DRILLING ---
LOGGED BY Ryan Klutes **CHECKED BY** A. Lanning
AT END OF DRILLING ---
COORDINATES 629969.02 N 1674533.21 E
▽ **AFTER DRILLING** 243.50 ft / Elev 1848.04 ft from BTOC

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0	SONIC	100				CLAY, with gravel, yellow clay intrusions; moist, brown (Mine Spoils)	
10	SONIC	100					
20					20.0	S.A.A, with silt and black intrusions, very crumbly; gray	2071.5
	SONIC	100					
30	SONIC	100		CL			
					37.0	S.A.A., very moist	2054.5
40					41.0	S.A.A.; gravel with pebble intrusions	2050.5
	SONIC	100					
50	SONIC	100				@ 57' bgs: <1 inch lense of lignite	
					59.0	S.A.A., sandy clay	2032.5
60	SONIC	100					
70							

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

WELL DIAGRAM

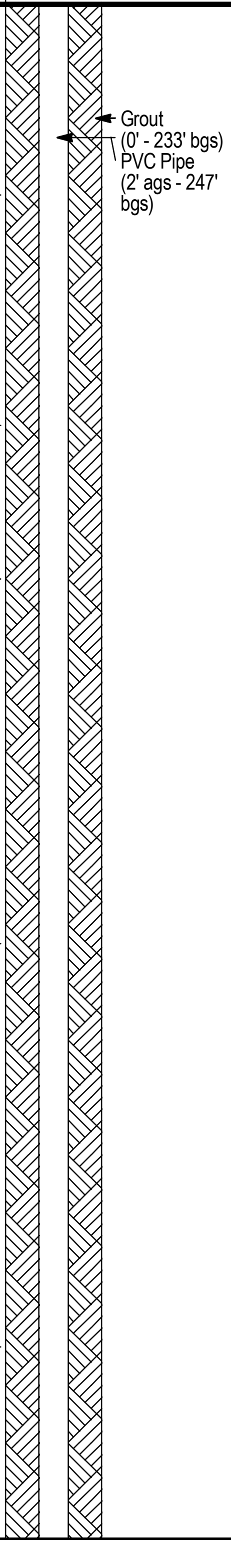


(Continued Next Page)

CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
70	SONIC	100			▨	S.A.A., sandy clay
80	SONIC	100			▨	80.0 2011.5 S.A.A., clay, with small lignite lenses; gray to brown
90	SONIC	100			▨	92.0 1999.5 S.A.A., trace sand, no lignite fragments; gray
100	SONIC	100			▨	100.0 1991.5 S.A.A., trace lignite fragments
110	SONIC	100		CL	▨	
120	SONIC	100			▨	119.0 1972.5 S.A.A.; sandy clay, no lignite fragments, crumbly
130	SONIC	100			▨	
140	SONIC	100			▨	140.0 1951.5 S.A.A.; with gravel, no sand; very moist
150						

WELL DIAGRAM



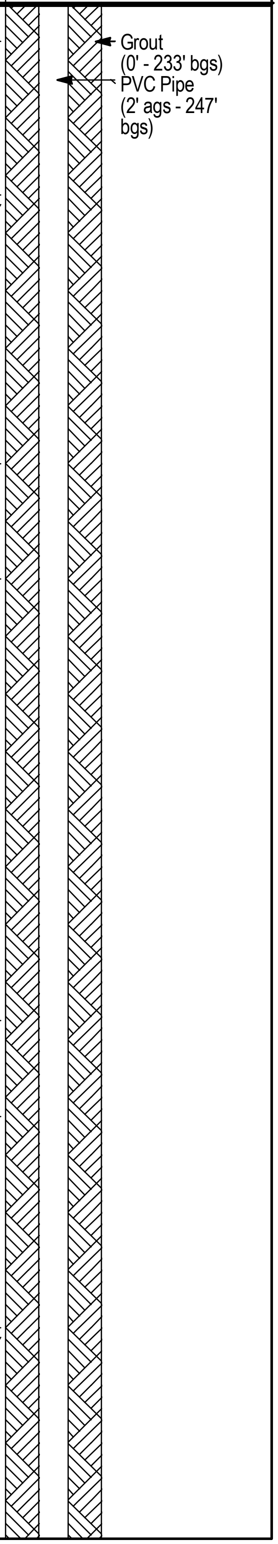
(Continued Next Page)

WELL NUMBER MW-14 (S)

CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
150	SONIC	100		CL		152.0 S.A.A., with lignite fragments, hard; gray to brown 1939.5
160	SONIC	100		SHALE		160.0 SHALE (6" lense) 1931.5 160.5 CLAY, with gravel, very hard; very moist, brown 1931.0
170	SONIC	100				174.0 S.A.A., crumbly; gray 1917.5
180	SONIC	100		CL		180.0 S.A.A., very hard 1911.5
190	SONIC	100				
200	SONIC	100				203.0 S.A.A., with lignite fragments; brown and black 1888.5 208.0 S.A.A., no lignite fragments, very hard; gray 1883.5
210	SONIC	100				
220	SONIC	100		CL CL		219.0 LIGNITE, crumbly, (6" lense); black and brown 1872.5 219.5 CLAY, very hard; gray 1872.0
230						

WELL DIAGRAM



(Continued Next Page)

WELL NUMBER MW-14 (S)

CLIENT Basin Electric

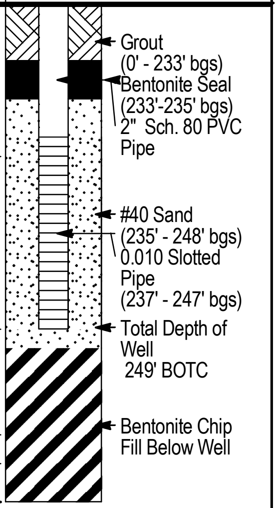
PROJECT NAME Antelope Valley

PROJECT NUMBER 60495311

PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
230	SONIC	100		CL	▨	CLAY, very hard; gray 238.0 1853.5
				CL	▨	LIGNITE, crumbly; very dry, black and brown ▽ 247.0 1844.5
240	SONIC	100				
				CL	▨	CLAY, very hard; gray 252.5 1839.0
250	SONIC	100		CHERT		CHERT; light brown 254.0 1837.5
				CL	▨	CLAY, very hard; gray 256.0 1835.5

WELL DIAGRAM



Bottom of borehole at 256.0 feet.

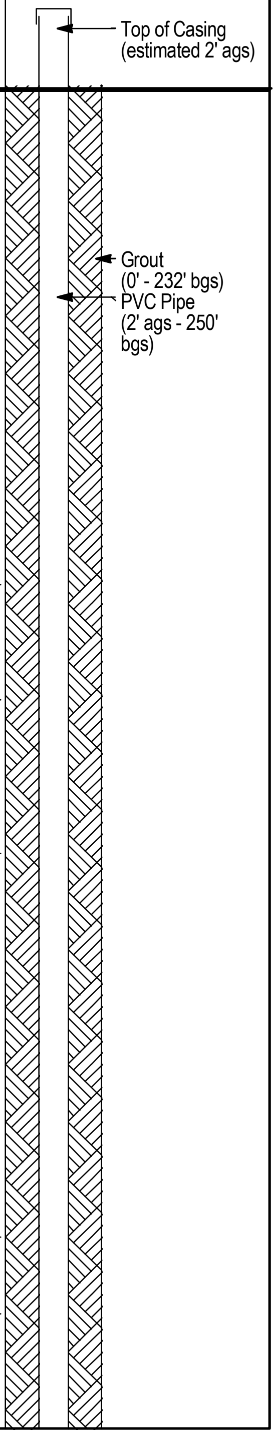
WELL NUMBER MW-15 (S)

CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND
DATE STARTED 5/23/2016 **COMPLETED** 5/24/2016
GROUND ELEVATION 2102.89 ft **HAMMER TYPE** Not Applicable
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
DRILLING METHOD Rotary Sonic
AT TIME OF DRILLING ---
LOGGED BY Ryan Klutes **CHECKED BY** A. Lanning
AT END OF DRILLING ---
COORDINATES 630410.64 N 1675007.24 E
▽ **AFTER DRILLING** 221.70 ft / Elev 1881.19 ft from BTOC

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0	SONIC	100				CLAY, with gravel; brown (Mine Spoils)	
10	SONIC	100					
20	SONIC	100					
26.0						S.A.A., gray	2076.9
30	SONIC	100					
32.0				CL		S.A.A., brown clay mixed with gray clay	2070.9
40.0	SONIC	100				S.A.A., no gray coloring	2062.9
50	SONIC	100					
60.0	SONIC	100				S.A.A., brown and gray clay	2042.9
64.0						S.A.A., trace lignite, no gravel	2038.9
70							

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

WELL DIAGRAM



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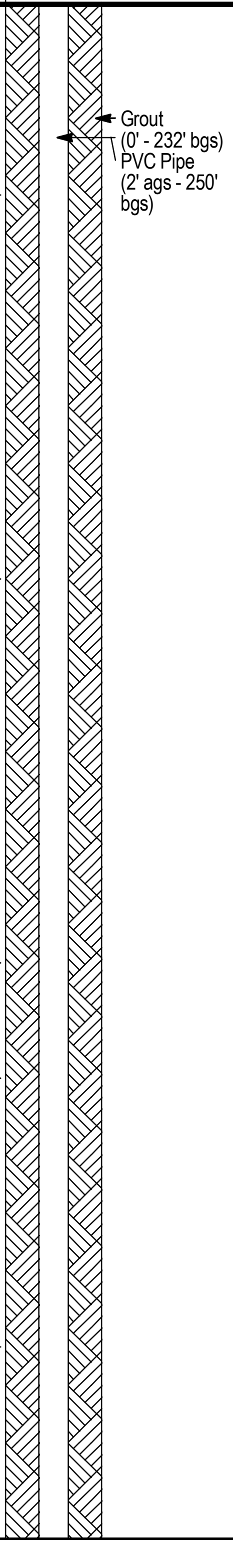
WELL NUMBER MW-15 (S)

CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
70	SONIC	100			▨	S.A.A., trace lignite, no gravel
80	SONIC	100			▨	80.0 2022.9 S.A.A., with gravel, no lignite
90	SONIC	100			▨	
100	SONIC	100			▨	100.0 2002.9 S.A.A., no gravel
110	SONIC	100		CL	▨	
120	SONIC	100			▨	120.0 1982.9 S.A.A., very hard 126.0 1976.9 S.A.A., silty clay; gray
130	SONIC	100			▨	
140	SONIC	100			▨	140.0 1962.9 S.A.A., no silt
150						150.0 1952.9

WELL DIAGRAM



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CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENETROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
150						S.A.A., with gravel; brown and gray	Grout (0' - 232' bgs) PVC Pipe (2' ags - 250' bgs)
	SONIC	100					
160				CL			
	SONIC	100					
				COAL		168.0 — 1934.9 168.5 LIGNITE (6" lense) 1934.4	
170						CLAY, trace silt; gray	
	SONIC	100					
180						180.0 — 1922.9 S.A.A., trace sand	
	SONIC	100					
190				CL		191.0 — 1911.9 S.A.A., sandy clay	
	SONIC	100				196.0 — 1906.9 S.A.A., with shale, no sand, very hard	
200							
	SONIC	100					
210				COAL		211.0 — 1891.9 212.0 LIGNITE (1' lense); brown 1890.9	
	SONIC	100				CLAY, very hard; gray	
220				CL		▼	
	SONIC	100		SHALE		225.0 — 1877.9 226.0 SHALE (1' lense); gray 1876.9	
230				CL		CLAY, very hard; gray	

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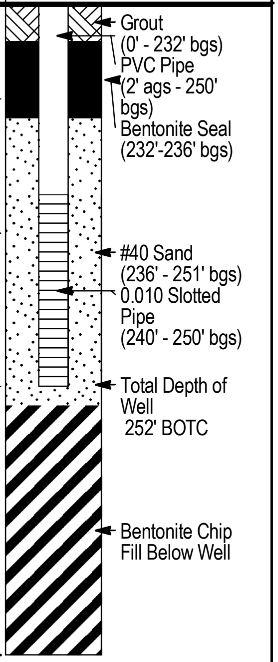
WELL NUMBER MW-15 (S)

CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
230	SONIC	100		CL		CLAY, very hard; gray
						235.0 1867.9
						S.A.A., crumbly
240	SONIC	100				242.0 1860.9
				COAL		LIGNITE; brown
250	SONIC	100				250.0 1852.9
				CL		CLAY, very hard; gray
260	SONIC	100				264.0 1838.9

Bottom of borehole at 264.0 feet.

WELL DIAGRAM



AECOM

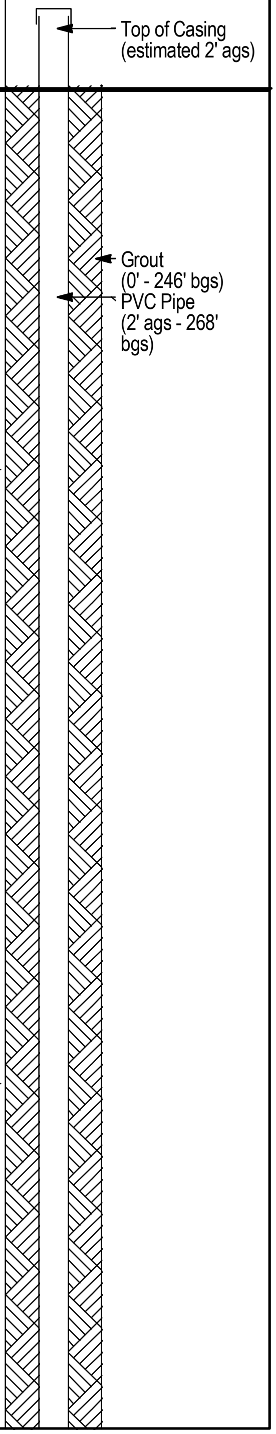
WELL NUMBER MW-16 (S)

CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND
DATE STARTED 5/25/2016 **COMPLETED** 6/1/2016
GROUND ELEVATION 2121.7 ft **HAMMER TYPE** Not Applicable
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
DRILLING METHOD Rotary Sonic
AT TIME OF DRILLING ---
LOGGED BY Ryan Klutes **CHECKED BY** A. Lanning
AT END OF DRILLING ---
COORDINATES 631224.67 N 1675017.86 E
▽ **AFTER DRILLING** 249.60 ft / Elev 1872.10 ft from BTOC

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENETROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0						CLAY, with gravel; brown (Mine Spoils)	
	SONIC	100					
10	SONIC	100					
20	SONIC	100			20.0	S.A.A., brown to gray	2101.7
30	SONIC	100		CL			
40	SONIC	100					
50	SONIC	100			52.0	S.A.A., gray	2069.7
60	SONIC	100					
70							

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

WELL DIAGRAM



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CLIENT Basin Electric

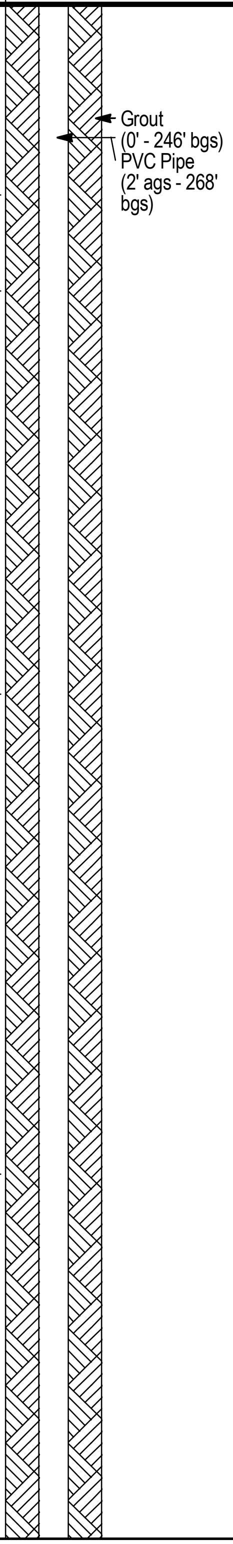
PROJECT NAME Antelope Valley

PROJECT NUMBER 60495311

PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
70	SONIC	100				S.A.A., gray	
80	SONIC	100				80.0 S.A.A., brown to gray	2041.7
						85.0 S.A.A., very hard; gray	2036.7
90	SONIC	100					
100	SONIC	100					
				CL		106.0 S.A.A., brown to gray	2015.7
110	SONIC	100					
120	SONIC	100					
130	SONIC	100					
						131.0 S.A.A., gray	1990.7
140	SONIC	100					
150							

WELL DIAGRAM



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AECOM

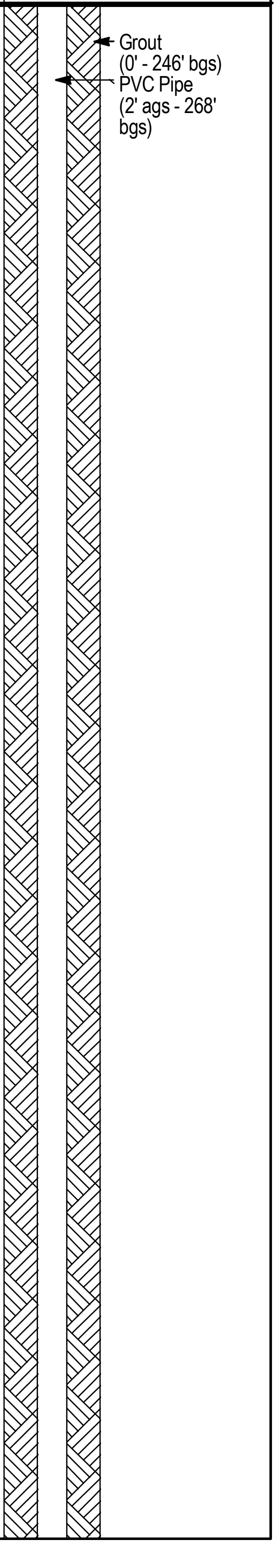
WELL NUMBER MW-16 (S)

CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF
150	SONIC	100	
160	SONIC	100	
170	SONIC	100	
180	SONIC	100	
190	SONIC	100	
200	SONIC	100	
210	SONIC	100	
220	SONIC	100	
230			

U.S.C.S.	MATERIAL DESCRIPTION		
	S.A.A., gray	156.0	1965.7
CL	S.A.A., brown to gray	194.0	1927.7
COAL	LIGNITE; brown	198.0	1923.7
CL	CLAY, hard; gray	203.0	1918.7
COAL	LIGNITE; brown	206.0	1915.7
	CLAY, crumbly; brown	210.0	1911.7
CL	S.A.A., trace silt; gray	215.0	1906.7
	S.A.A., no silt, very hard	222.0	1899.7
COAL	LIGNITE; brown	224.0	1897.7
	CLAY, very hard; brown	227.0	1894.7
CL	S.A.A., trace sand, very hard; light brown		

WELL DIAGRAM



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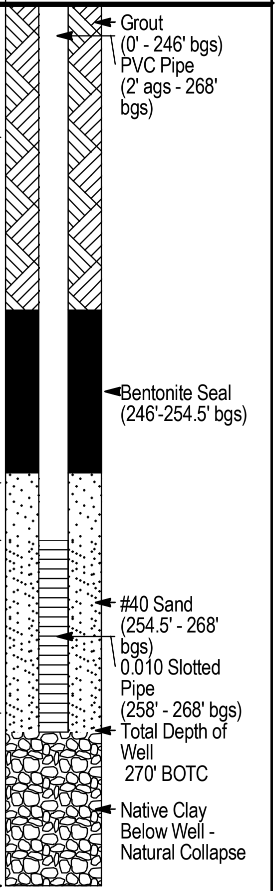
CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
230	SONIC	100			▨	S.A.A., trace sand, very hard; light brown	237.0 / 1884.7
240	SONIC	100		CL	▨	S.A.A., very hard, crumbly; gray	
250	SONIC	100			▨	▼	255.0 / 1866.7
					▨	S.A.A., light brown to gray	258.0 / 1863.7
260	SONIC	100		COAL	■	LIGNITE; brown	267.0 / 1854.7
270	SONIC	100		CL	▨	CLAY, very hard; gray	276.0 / 1845.7

Bottom of borehole at 276.0 feet.

WELL DIAGRAM



AECOM

WELL NUMBER MW-17 (S)

CLIENT Basin Electric

PROJECT NAME Antelope Valley

PROJECT NUMBER 60495311

PROJECT LOCATION Beulah, ND

DATE STARTED 6/2/2016 **COMPLETED** 6/3/2016

GROUND ELEVATION 2123.06 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Cascade Drilling

GROUND WATER LEVELS:

DRILLING METHOD Rotary Sonic

AT TIME OF DRILLING ---

LOGGED BY Ryan Klutes **CHECKED BY** A. Lanning

AT END OF DRILLING ---

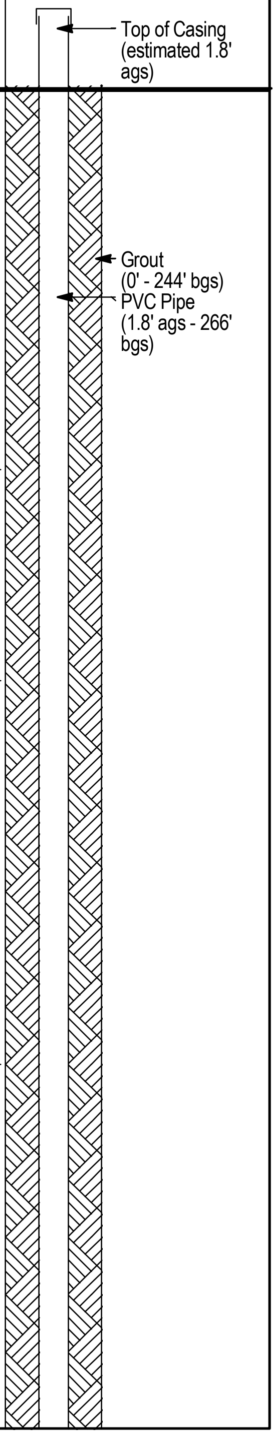
COORDINATES 631865.98 N 1674961.19 E

▽ **AFTER DRILLING** 238.40 ft / Elev 1884.66 ft from BTOC

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						CLAY, trace sand; brown to orange (Mine Spoils)
	SONIC	100				
10						
	SONIC	100				
20						20.0 2103.1
						S.A.A., brown to light brown
	SONIC	100				
30						
						31.0 2092.1
						S.A.A., with gravel, no sand; brown
	SONIC	100		CL		
40						
	SONIC	100				
50						
						51.0 2072.1
						S.A.A., very sticky
	SONIC	100				
60						
	SONIC	100				
70						

Casing Top Elev: 1.8 (ft)
Casing Type: 2" PVC Pipe

WELL DIAGRAM



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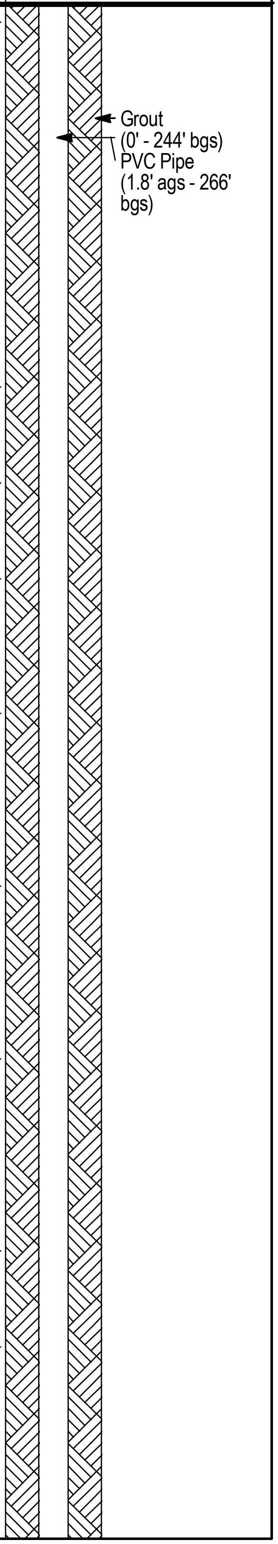
CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF
70–80	SONIC	100	
80–90	SONIC	100	
90–100	SONIC	100	
100–110	SONIC	100	
110–120	SONIC	100	
120–130	SONIC	100	
130–140	SONIC	100	
140–150	SONIC	100	

Depth	U.S.C.S.	MATERIAL DESCRIPTION	Elevation
71.0		S.A.A., hard; brown to gray	2052.1
90.0		S.A.A., trace gravel, very hard	2033.1
95.0		S.A.A., gray	2028.1
100.0		S.A.A., increasing gravel	2023.1
107.0	CL	S.A.A., with poorly cemented brown sandstone	2016.1
116.0		S.A.A., no sandstone	2007.1
125.0		S.A.A., gravel lenses of lignite and scoria; brown to gray	1998.1
135.0		S.A.A., with gravel and gray clay; brown	1988.1
140.0		S.A.A., trace gravel	1983.1

WELL DIAGRAM



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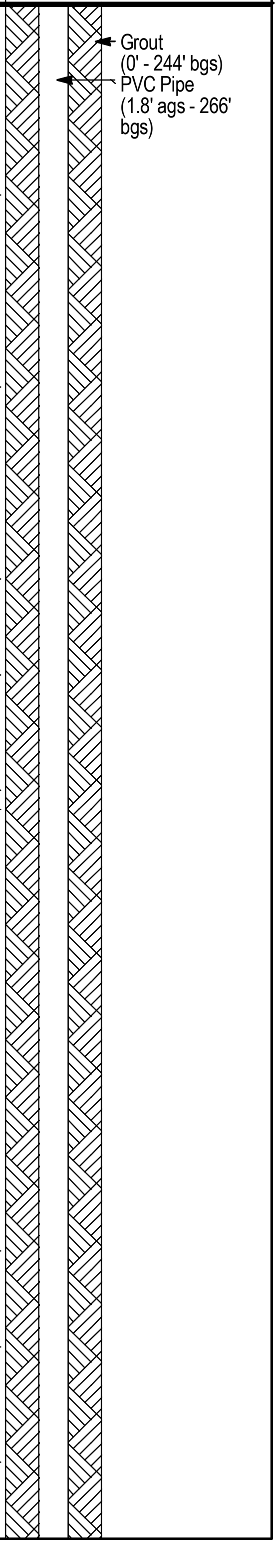
CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
150	SONIC	100				S.A.A., trace gravel
160	SONIC	100				160.0 1963.1 S.A.A., increasing gravel
170	SONIC	100		CL		170.0 1953.1 S.A.A., no gravel; gray
180	SONIC	100				180.0 1943.1 S.A.A., with gravel, trace brown clay 185.0 1938.1 S.A.A., trace sand, no gravel
190	SONIC	100		COAL		191.0 1932.1 192.0 LIGNITE (less than 1' in thickness); brown 1931.1 CLAY, trace sand; gray
200	SONIC	100		CL		
210	SONIC	100				215.0 1908.1 S.A.A., dark gray
220	SONIC	100		SC CL		220.0 1903.1 SANDY CLAY, crumbly; gray 226.0 1897.1 CLAY, crumbly; gray with yellow sand lenses
230						

WELL DIAGRAM



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CLIENT Basin Electric

PROJECT NAME Antelope Valley

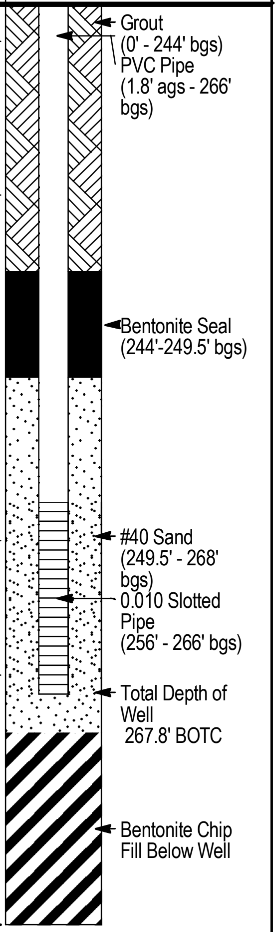
PROJECT NUMBER 60495311

PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
230	SONIC	100			▨		
232.0					▨	S.A.A., no yellow sand lenses ▼	1891.1
240.0	SONIC	100		CL	▨	S.A.A., trace sand	1883.1
250	SONIC	100			▨		
258.0				COAL	■	LIGNITE, very crumbly; dry, brown to black	1865.1
260	SONIC	100			■		
265.0				CL	▨	CLAY, very hard; gray	1858.1
270	SONIC	100			▨		
278.0							1845.1

Bottom of borehole at 278.0 feet.

WELL DIAGRAM



AECOM

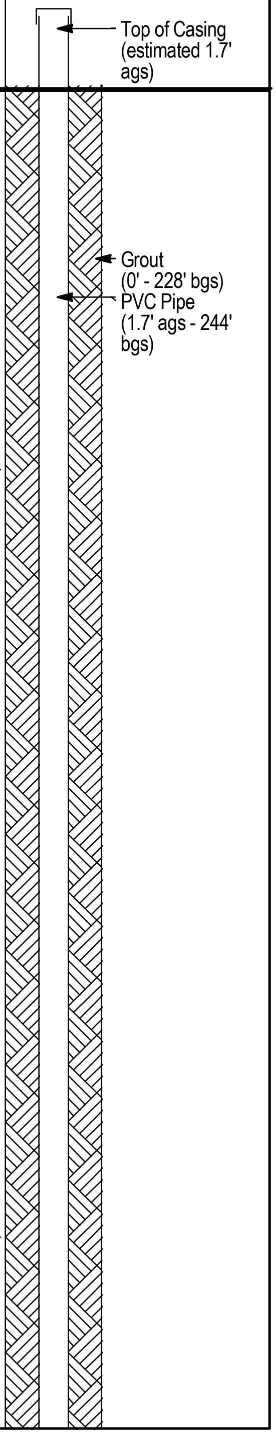
WELL NUMBER MW-18 (S)

CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND
DATE STARTED 5/17/2016 **COMPLETED** 5/18/2016
GROUND ELEVATION 2089.7 ft **HAMMER TYPE** Not Applicable
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
DRILLING METHOD Rotary Sonic
AT TIME OF DRILLING ---
LOGGED BY Ryan Klutes **CHECKED BY** A. Lanning
AT END OF DRILLING ---
COORDINATES 632117.57 N 1672362.93 E
▽ **AFTER DRILLING** 198.75 ft / Elev 1890.95 ft from BTOC

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0	SONIC	100		CL	▨	CLAY; brown (Mine Spoils)
10	SONIC	100			▨	
20	SONIC	100			▨	20.0 2069.7 S.A.A., with sand
30	SONIC	100			▨	
40	SONIC	100			▨	
50	SONIC	100			▨	
60	SONIC	100		ML	▥	60.0 2029.7 SILT, with clay and gravel, stiff; brown to gray
70						

Casing Top Elev: 1.7 (ft)
Casing Type: 2" PVC Pipe

WELL DIAGRAM



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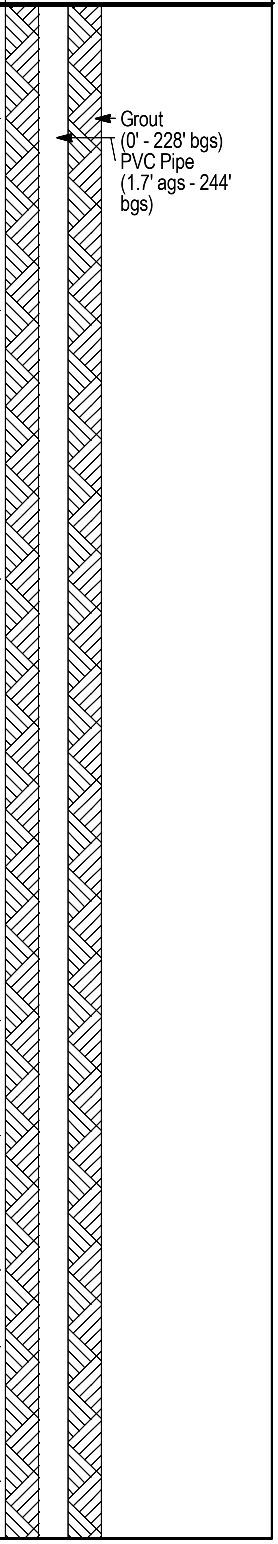
WELL NUMBER MW-18 (S)

CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
70	SONIC	100				SILT, with clay and gravel, stiff; brown to gray	
76.0				ML		S.A.A., trace sand, no gravel, crumbly; gray (2013.7)	
80	SONIC	100					
86.0				CL		CLAY with silt and gravel, very hard; brown (2003.7)	
90	SONIC	100					
100.0	SONIC	100		ML		SILT, with brown clay, trace gravel, trace coarse sand, crumbly; gray (1989.7)	
110	SONIC	100					
120	SONIC	100					
123.0				CL		CLAY, trace silt, very stiff; brown (1966.7)	
129.0				ML		SILT, trace sand, crumbly; gray (1960.7)	
130	SONIC	100					
136.0						CLAY, trace sand and gravel, firm; brown (1953.7)	
140.0	SONIC	100		CL		S.A.A., very stiff (1949.7)	
147.0				SP		SAND, medium-grained, trace brown clay; orange (1942.7)	
150							



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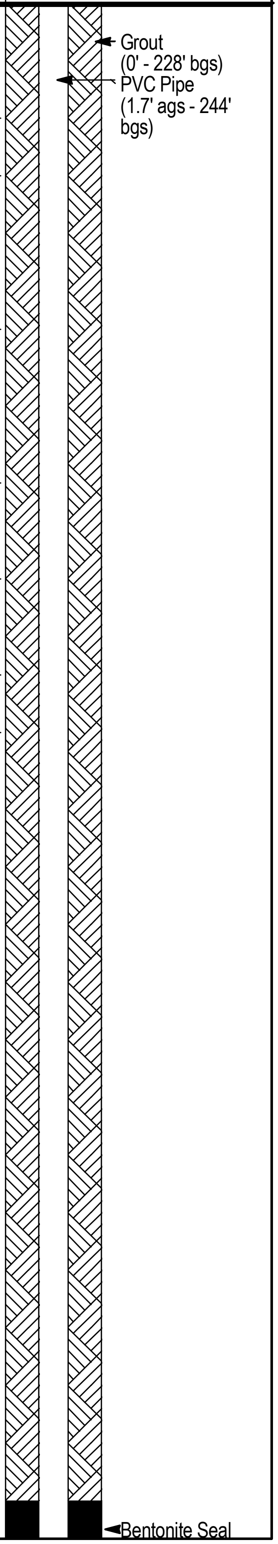
CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENETROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
150	SONIC	100		SP		SAND, medium-grained, trace brown clay; orange 156.0 1933.7
				ML		SILT, trace brown clay, very stiff, crumbly; gray 159.0 1930.7
160	SONIC	100				CLAY, trace gravel, very stiff; brown 167.0 1922.7
170	SONIC	100				S.A.A., with small lenses of medium-grained sand and gravel 175.0 1914.7
						S.A.A., no sand or gravel lenses 180.0 1909.7
180	SONIC	100				S.A.A., very hard 185.0 1904.7
						S.A.A., with some gravel (possible slough) 188.0 1901.7
190	SONIC	100		CL		S.A.A., no gravel ▽
200	SONIC	100				
210	SONIC	100				
220	SONIC	100				
230						

WELL DIAGRAM



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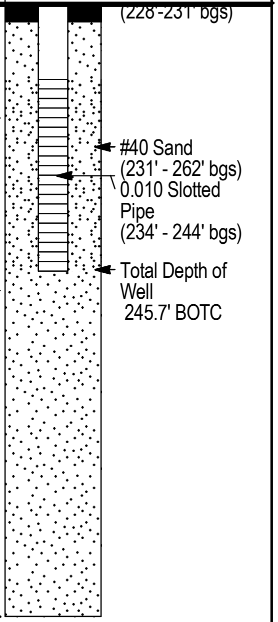
WELL NUMBER MW-18 (S)

CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENETROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
230	SONIC	100		CL	▨	S.A.A., no gravel 236.0 1853.7
240	SONIC	100		COAL	■	LIGNITE, with peat; very dry, brown 245.0 1844.7
250	SONIC	100		CL	▨	CLAY, very hard; gray 262.0 1827.7
260	SONIC	100				

WELL DIAGRAM



Bottom of borehole at 262.0 feet.

AECOM

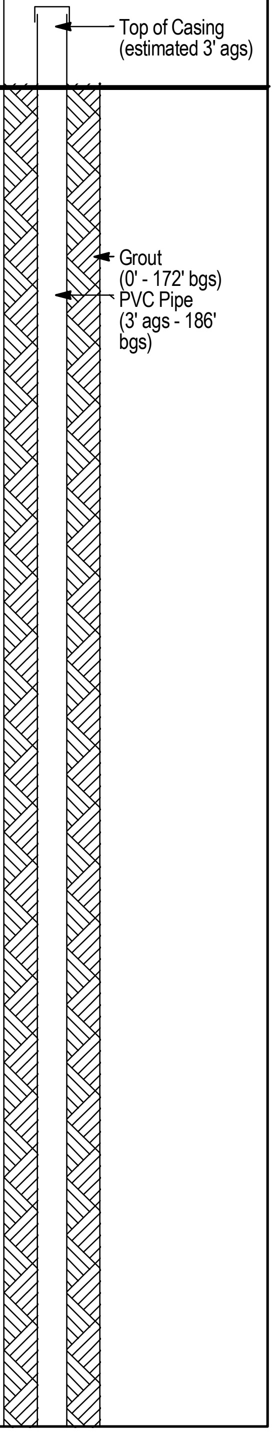
WELL NUMBER MW-19 (S)

CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND
DATE STARTED 5/19/2016 **COMPLETED** 5/20/2016
GROUND ELEVATION 2040.68 ft **HAMMER TYPE** Not Applicable
DRILLING CONTRACTOR Cascade Drilling
GROUND WATER LEVELS:
DRILLING METHOD Rotary Sonic
AT TIME OF DRILLING ---
LOGGED BY Ryan Klutes **CHECKED BY** A. Lanning
AT END OF DRILLING ---
COORDINATES 630703.79 N 1672368.4 E
▽ **AFTER DRILLING** 149.50 ft / Elev 1891.18 ft from BTOC

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0				CL		CLAY, with medium-grained gravel; dark brown (Mine Spoils)
	SONIC	100				
10						
	SONIC	100				
20						20.0 2020.7 S.A.A., grades moist; dark brown to light brown
	SONIC	100				
30						
	SONIC	100				
40						40.0 2000.7 S.A.A., trace, gravel; brown with light brown horizons
	SONIC	100				
50						
	SONIC	100				
						58.0 1982.7 S.A.A., trace poorly cemented sandstone fragments; brown
60						
	SONIC	100				
70						

Casing Top Elev: 3 (ft)
Casing Type: 2" PVC Pipe

WELL DIAGRAM



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CLIENT Basin Electric

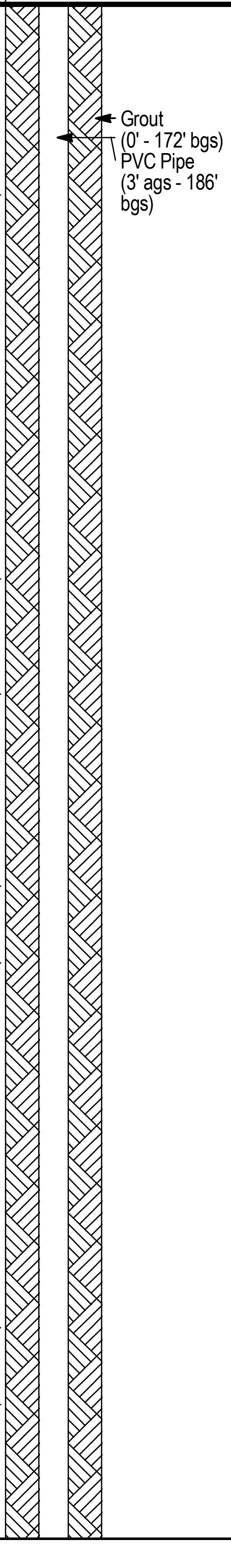
PROJECT NAME Antelope Valley

PROJECT NUMBER 60495311

PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENETROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
70	SONIC	100			▨	S.A.A., trace poorly cemented sandstone fragments; brown	
80	SONIC	100		CL	▨	80.0 S.A.A., sandy clay, dry, crumbly	1960.7
90	SONIC	100			▨		
100	SONIC	100			▨	100.0 S.A.A., grades moist	1940.7
					▨	106.0 S.A.A., moist; gray with small brown inclusions	1934.7
110	SONIC	100			▨		
					▥	116.0 SILT, trace clay, very hard, very compacted; gray	1924.7
120	SONIC	100		ML	▥	120.0 S.A.A., CLAYEY SILT	1920.7
130	SONIC	100			▥		
					▨	139.0 CLAY, with chert, some shale, very hard, crumbly; gray	1901.7
140	SONIC	100		CL	▨	143.0 S.A.A., grades without chert and shale	1897.7
150						▼	

WELL DIAGRAM



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WELL NUMBER MW-19 (S)

CLIENT Basin Electric

PROJECT NAME Antelope Valley

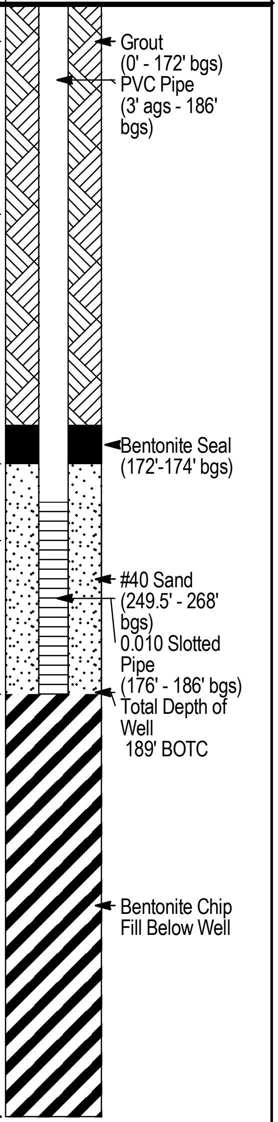
PROJECT NUMBER 60495311

PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
150							
	SONIC	100				152.0 S.A.A., mottled black and brown	1888.7
160	SONIC	100		CL		161.0 S.A.A., grades gray	1879.7
170	SONIC	100				174.0 S.A.A., grades with silt	1866.7
				COAL		178.0 LIGNITE, very crumbly; black to brown	1862.7
180	SONIC	100					
				CL		186.0 CLAY, very hard; gray	1854.7
190	SONIC	100					
200	SONIC	100					
						208.0	1832.7

Bottom of borehole at 208.0 feet.

WELL DIAGRAM



AECOM

WELL NUMBER MW-20 (S)

CLIENT Basin Electric

PROJECT NAME Antelope Valley

PROJECT NUMBER 60495311

PROJECT LOCATION Beulah, ND

DATE STARTED 11/7/2016 **COMPLETED** 11/16/2016

GROUND ELEVATION 2105.695 ft **HAMMER TYPE** Not Applicable

DRILLING CONTRACTOR Cascade Drilling

GROUND WATER LEVELS:

DRILLING METHOD Rotary Sonic

AT TIME OF DRILLING ---

LOGGED BY Ryan Klutes **CHECKED BY** A. Lanning

AT END OF DRILLING ---

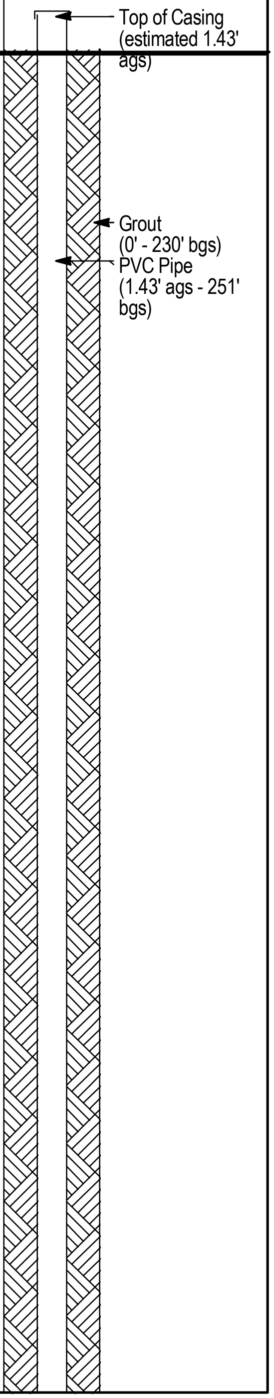
COORDINATES 630733.344 N 1675082.654 E

AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0						CLAY, reworked; brown
10	SONIC	100				
20	SONIC	100				
30	SONIC	100				
40	SONIC	100		CL		
50	SONIC	100				
60	SONIC	100				
70	SONIC	100				

Casing Top Elev: 1.43 (ft)
Casing Type: 4" PVC Pipe

WELL DIAGRAM



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CLIENT Basin Electric

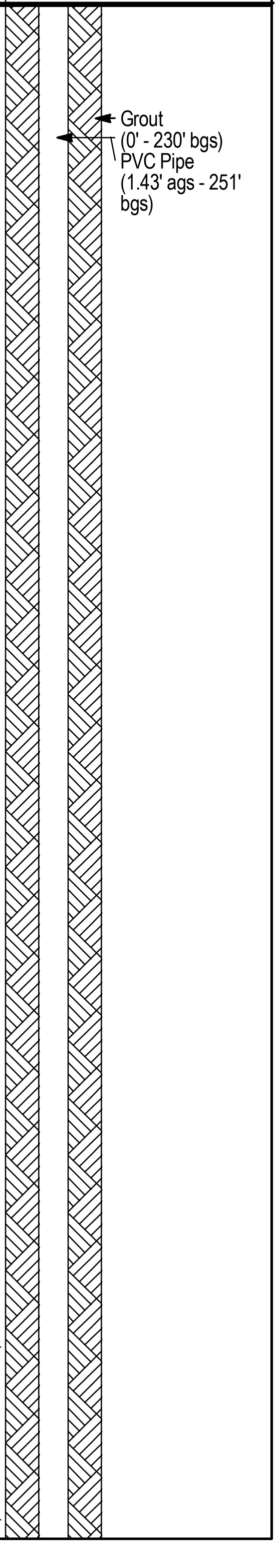
PROJECT NAME Antelope Valley

PROJECT NUMBER 60495311

PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENETROMETER, TSF	U.S.C.S.	MATERIAL DESCRIPTION
70	SONIC	100		CL	CLAY, reworked; brown
80	SONIC	100			
90	SONIC	100			
100	SONIC	100			
110	SONIC	100			
120	SONIC	100			
130	SONIC	100			
140	SONIC	100		CL	140.0 — 1965.7 SILTY CLAY, very hard, reworked material; gray
150				CL	149.0 — 1956.7

WELL DIAGRAM



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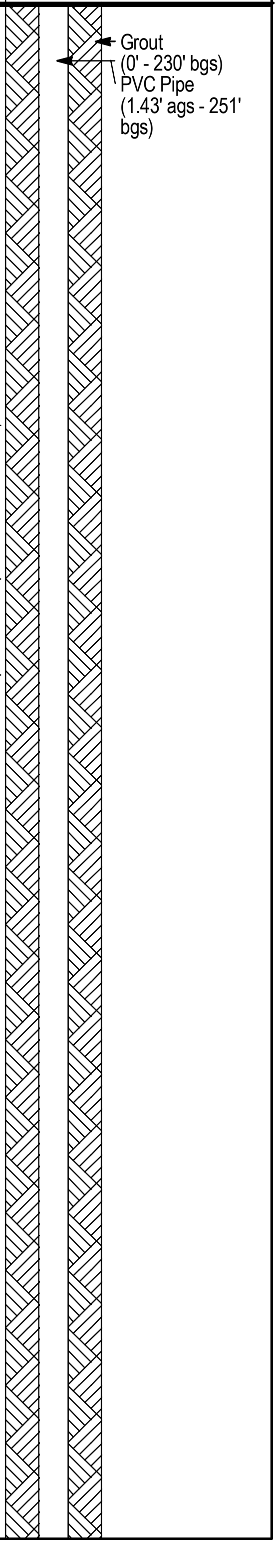
CLIENT Basin Electric
PROJECT NAME Antelope Valley
PROJECT NUMBER 60495311
PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENE-TROMETER, TSF	U.S.C.S.	MATERIAL DESCRIPTION	
150	SONIC	100		CL	CLAY, reworked; brown	
160	SONIC	100				
170	SONIC	100		CL	172.0 CLAY/SILT, lignite fragments, native material; gray	1933.7
180	SONIC	70		COAL	180.0 LIGNITE, clay; gray	1925.7
				CL	185.0 LIGNITE (<1") CLAY; gray very hard drilling	1920.7
190	SONIC	100				
	SONIC	100				
200	SONIC	100				
	SONIC	100				
210	SONIC	100				
220	SONIC	100				
	SONIC	100				
230						

WELL DIAGRAM



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WELL NUMBER MW-20 (S)

CLIENT Basin Electric

PROJECT NAME Antelope Valley

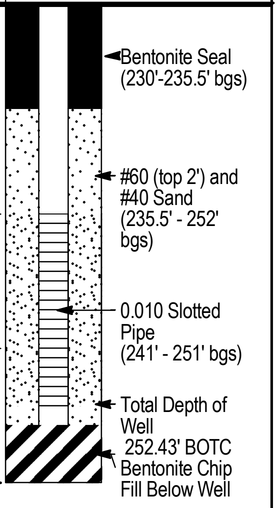
PROJECT NUMBER 60495311

PROJECT LOCATION Beulah, ND

DEPTH (ft)	SAMPLE TYPE NUMBER	% RECOVERY	POCKET PENETROMETER, TSF	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
230				CL	▨	CLAY; gray very hard drilling
	SONIC	100				
240	SONIC	100				
241.0				COAL	■	LIGNITE (1864.7)
	SONIC	100				
248.0				CL	▨	CLAY; gray (1857.7)
250	SONIC	100				
255.0	SONIC	100				(1850.7)

Bottom of borehole at 255.0 feet.

WELL DIAGRAM



Appendix B

Aquifer Test Procedures, Data and Analysis

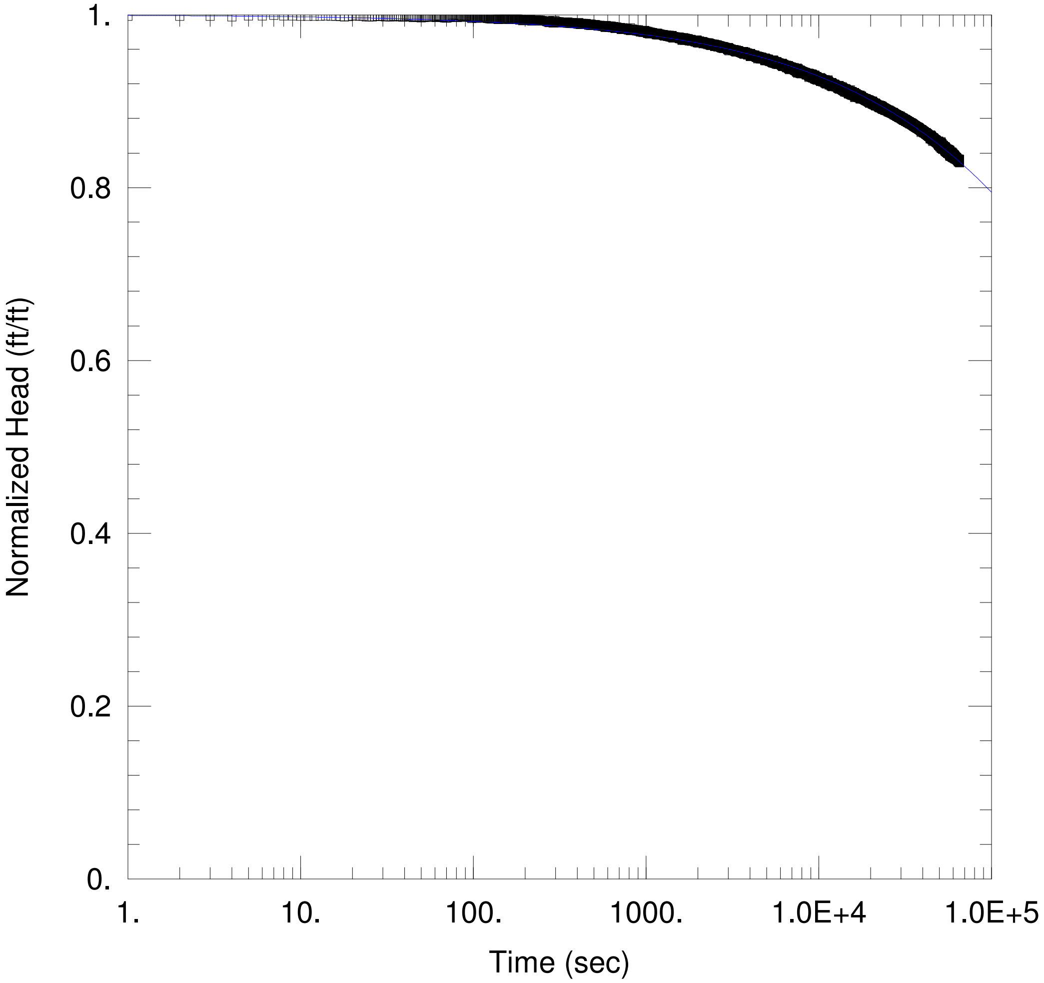
MW-16(S)

Prepared By:
AECOM

Prepared For:
Basin Electric Coop

Project:
60495311

Location:
Antelope Valley Station



SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

Kr = 2.482E-9 cm/sec
Ss = 0.01111 ft^{-1}
Kz/Kr = 1.

AQUIFER DATA

Saturated Thickness: 9. ft

WELL DATA (MW-16(S))

Initial Displacement: 4.374 ft
Static Water Column Height: 32. ft
Total Well Penetration Depth: 10. ft
Screen Length: 10. ft
Casing Radius: 0.08079 ft
Well Radius: 0.25 ft

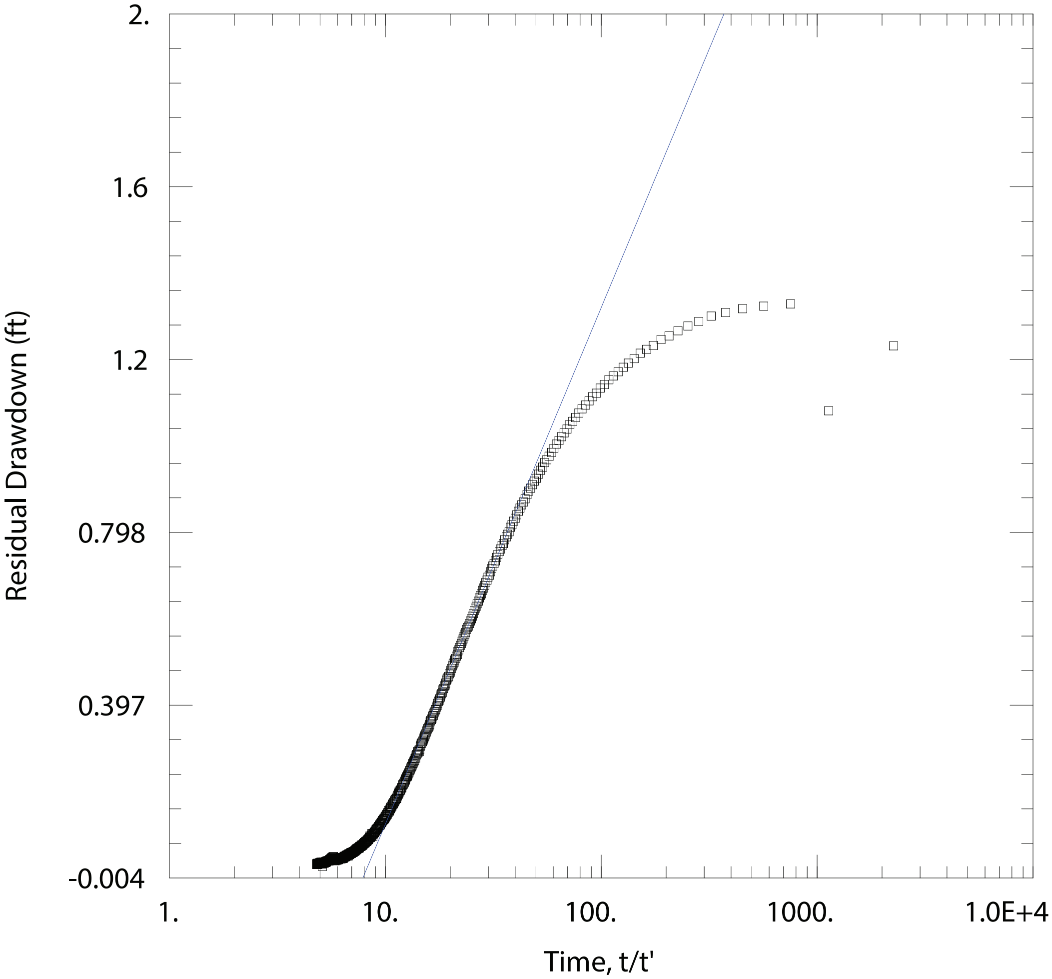
MW-19(S)

Prepared By:
AECOM

Prepared For:
Basin Electric Coop

Project:
60495311

Location:
Atelope Valley Station



SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)

T = 0.04029 cm^2/sec S/S' = 7.943

K = T/b

K = 1.652E-4 cm/sec

AQUIFER DATA

Saturated Thickness(b): 8. ft Anisotropy Ratio (Kz/Kr): 1.

AECOM
1000 E Calgary Avenue, Suite 1
Bismarck, ND 58503
aecom.com