Henry W. Pirkey Power Plant

Notice of Intent to Comply With the Site-Specific Alternative to Initiation of Closure

CCR Units – East Bottom Ash Pond and West Bottom Ash Pond

As required by 40 CFR 257.103(f)(2)(viii), this is a notification that on November 30, 2020 Henry W. Pirkey Power Plant (Pirkey Plant) submitted a site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler by a date certain to US EPA. The submission has been placed in Pirkey Plant's operating record and posted to the CCR Rule Compliance Data and Information website.

American Electric Power
1 Riverside Plaza
Columbus, OH 43215
aep.com

November 30, 2020

Submitted Electronically via Email

Mr. Andrew R. Wheeler, EPA Administrator
Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Mail Code 5304-P
Washington, DC 20460

RE: Southwestern Electric Power Company
Henry W. Pirkey Power Plant Alternative Closure Demonstration

Dear Administrator Wheeler,

Southwestern Electric Power Company (SWEPCO) Henry W. Pirkey Power Plant (Pirkey Plant), hereby submits this request to the U.S. Environmental Protection Agency (EPA) for approval of a site-specific alternative deadline to initiate closure pursuant to 40 C.F.R. § 257.103(f)(2) for the East Bottom Ash Pond (EBAP) and West Bottom Ash Pond (WBAP) located at the Pirkey Plant near Hallsville, Texas. Pirkey Plant is requesting an extension pursuant to 40 C.F.R. § 257.103(f)(2) to allow the EBAP and WBAP to continue to receive CCR and non-CCR wastestreams after April 11, 2021. Enclosed is a demonstration prepared by American Electric Power and Burns & McDonnell that addresses all of the criteria in 40 C.F.R. § 257.103(f)(2)(i)-(iv) and contains the documentation required by 40 C.F.R. § 257.103(f)(2)(v). As allowed by the agency, in lieu of hard copies of these documents, electronic files were submitted to Kirsten Hillyer, Frank Behan, and Richard Huggins via email. If you have any questions regarding this submittal, please contact me at 614-716-2281 or damiller@aep.com.

Sincerely,

David A. Miller

David A. Miller, P.E.
Director, Land Environment & Remediation Services
Environmental Services Division

Attachments

cc: Kirsten Hillyer – USEPA
Frank Behan – USEPA
Richard Huggins – USEPA

Southwestern Electric Power Company

Henry W. Pirkey Power Plant

Documentation of No Alternative Disposal Capacity and Risk Mitigation Plan for Permanent Cessation of Boiler(s) by a Date Certain

Prepared by:

American Electric Power Service Corporation
1 Riverside Plaza
Columbus, OH 43215

and

Burns and McDonnell
9400 Ward Parkway
Kansas City, MO 64114

Submitted

11/30/2020

Table of Contents

List of Figures

Appendices

Professional Engineer's Certification

I certify, as a Professional Engineer in the State of Texas, that the information in this document was assembled under my direct supervisory control and is accurate as of the date of my signature. This report is not intended or represented to be suitable for reuse without the specific verification or adaptation by the engineer.

DAVID ANTHONY MILLER

Printed Name of Registered Professional Engineer

David Anthony Miller

Signature

112498	TEXAS	11.30.2020
Registration No.	**Registration State**	**Date**

INTRODUCTION

American Electric Power Service Corporation (AEP) as agent for its affiliate Southwestern Electric Power Company (SWEPCO), an owner and operator of the Henry W. Pirkey Power Plant (Pirkey Power Plant) (2400 FM 3251 (Harrison County) in Hallsville, Texas) seeks Environmental Protection Agency (EPA) approval under 40 CFR 257.103(f)(2) - *"Permanent cessation of a coal-fired boiler(s) by a date certain"* for its Coal Combustion Residual (CCR) surface impoundments. As discussed herein, the coal-fired generating unit at Pirkey Plant will cease combusting coal in March 2023 and the CCR surface impoundments will be closed in order to comply with EPA's recently revised CCR regulations. Closure of the surface impoundments will be completed no later than October 17, 2023. This document will provide the required information to support the requested alternative closure deadline, including: (1) the options considered to obtain alternative disposal capacity both on and off site; (2) the risk mitigation plan developed to expedite any required corrective action; (3) required documentation and a certification of compliance with the applicable requirements of 40 CFR Part 257, Subpart D; and (4) a closure plan to demonstrate that the coal-fired units will cease combustion of coal and complete closure of the surface impoundments by the required deadlines.

On August 28, 2020, the EPA Administrator issued revisions to the CCR Rule (40 CFR Part 257, Subpart D) that require all unlined surface impoundments to initiate closure by April 11, 2021, unless an alternative deadline is requested and approved (40 C.F.R. § 257.101(a)(1) (85 Fed. Reg. 53,516)). Specifically, owners and operators of a CCR surface impoundment may continue to receive CCR and non-CCR wastestreams in an unlined CCR surface impoundment if the facility will cease operation of the coal-fired boiler(s) and complete closure of the impoundments within certain specified timeframes (40 C.F.R. § 257.103(f)(2)). To qualify for an alternative closure deadline, a facility must meet the following four criteria:

1. § 257.103(f)(2)(i) – No alternative disposal capacity is available on-site or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification.
2. § 257.103(f)(2)(ii) - Potential risks to human health and the environment from the continued operation of the CCR surface impoundment have been adequately mitigated;
3. § 257.103(f)(2)(iii) - The facility is in compliance with the CCR rule, including the requirement to conduct any necessary corrective action; and
4. § 257.103(f)(2)(iv) - The coal-fired boilers must cease operation and closure of the impoundment must be completed within the following timeframes:
    a. For a CCR surface impoundment that is 40 acres or smaller, the coal-fired boiler(s) must cease operation and the CCR surface impoundment must complete closure no later than October 17, 2023.
    b. For a CCR surface impoundment that is larger than 40 acres, the coal-fired boiler(s) must cease operation, and the CCR surface impoundment must complete closure no later than October 17, 2028.

40 CFR §257.103(f)(2)(v) details the documentation that must be provided to EPA to demonstrate that the four criteria set out above have been met. Therefore, this demonstration is organized based on the documentation requirements of 40 CFR§ 257.103(f)(2)(v)(A) – (D).

OVERVIEW OF PIRKEY POWER PLANT AND AFFECTED CCR UNITS

The Pirkey Power Plant began operations in 1985 as a coal-fired generating power plant. Throughout the life of the generating plant, CCR materials have been generated. To manage these CCR materials, Pirkey Power Plant operates four CCR units: a bottom ash pond complex of two CCR surface impoundments (East Bottom Ash Pond (EBAP) and West bottom Ash Pond (WBAP)), the Pirkey Landfill (LF), and a flue gas desulfurization (FGD) material Stack Out Area for FGD material staging prior to transport to the LF. The EBAP and WBAP were constructed in 1983 and 1984.

The Bottom Ash Complex is located at the north end of the Pirkey Power Plant property (Figure 1) and receives both CCR and non-CCR wastestreams. The EBAP and WBAP are 31.5 and 30.9 acres in size, respectively. Other ponds in the complex include the Clearwater Pond. The Clearwater Pond is not a CCR unit. The Bottom Ash Complex, including the Clearwater Pond, totals approximately 67 acres. For the CCR rule groundwater monitoring requirements, the EBAP and WBAP are monitored separately.

Pirkey Power Plant currently places CCR and non-CCR wastestreams into the pond complex alternating between the EBAP and WBAPs. Bottom ash generated at the plant is sluiced to one of the ponds (the active pond) until it is close to full. Bottom ash in the inactive pond is drained and dewatered, and then removed from the pond. Dry ash is loaded into trucks and transported to the LF. It typically takes approximately twelve months for the active pond to fill, at which time the second pond (which has been emptied of bottom ash) becomes the active pond, and the first pond is drained.

The EBAP has a surface area of 31.5 acres and a storage capacity of 188 acre-feet. The pond is almost entirely incised with a reported maximum embankment height of 4 feet. The embankments are constructed of compacted clay on a 3:1 slope. The elevation of the top of embankment around the perimeter of the EBAP is approximately 357 feet amsl and the normal operating level is approximately 354 feet amsl. The EBAP receives bottom ash and economizer ash sluiced from the unit. The EBAP meets the location restriction requirements including the minimum aquifer separation but does not meet the liner requirements of the CCR regulation and must close. A groundwater monitoring system was developed for the EBAP in 2017 and assessment monitoring was initiated in April of 2018 and continues today. Assessment monitoring identified an exceedance of the ground water protection standard for cobalt and lithium for the EBAP, but an alternate source demonstration was completed showing higher upgradient lithium concentrations and naturally occurring cobalt in the aquifer media, demonstrating that the EBAP was not the source of the cobalt and lithium detected.

The WBAP has a surface area of 30.9 acres and a storage capacity of 188 acre-feet. The maximum height of the embankment is 25 feet. The embankments are constructed of compacted clay on a slope ranging from 2.5:1 to 3:1. The elevation at the top of the embankment around the perimeter of the WBAP is approximately 357 feet amsl and the normal operating level is 354 feet amsl. The WBAP receives bottom ash and economizer ash sluiced from the unit. The WBAP meets the location restriction requirements including the minimum aquifer separation but does not meet the liner requirements of the CCR regulation and must close. A groundwater monitoring system was developed for the WBAP in 2017 and assessment monitoring was initiated in April of 2018 and continues today. Assessment monitoring identified an exceedance of the ground water protection standard for cobalt for the WBAP, but an alternate source demonstration was

completed showing naturally occurring cobalt in the aquifer media, demonstrating that the WBAP was not the source of the cobalt detected.

Water overflow from the Bottom Ash Ponds discharges into the Clearwater Pond (a non-CCR unit) located directly south of EBAP. The water level is controlled by a weir box and a manually operated gate valve on a 36-inch diameter discharge pipe at the southwest corner of the pond. Water in the Clearwater pond is recirculated back to the plant for reuse.

The EBAP and WBAP are subject to the closure requirements in order to comply with EPA's recently revised CCR regulations. Therefore, the boiler associated with generating unit will be permanently shut down and closure of the EBAP and WBAP impoundments will be completed no later than October 17, 2023.

SATIFACTION OF THE CRITERIA IN 40 CFR §257.101(f)(2) FOR THE EBAP and WBAP

NO ALTERNATIVE DISPOSAL CAPACITY

From the regulatory text

> *257.103(f)(2)(i) No alternative disposal capacity is available on or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification under this section.*
>
> *257.103(f)(2)(v)(A)To demonstrate that the criteria in paragraph (f)(2)(i) of this section have been met the owner or operator must submit a narrative that explains the options considered to obtain alternative capacity for CCR and/or non-CCR wastestreams both on and off-site.*

To demonstrate that the criteria in § 257.103(f)(2)(i) have been met, the following provides documentation that no alternative disposal capacity is currently available on-site or off-site for each CCR and non-CCR wastestream such that Pirkey Plant seeks to continue using the CCR surface impoundments after April 11, 2021. Consistent with the regulations, neither an increase in costs nor the inconvenience of existing capacity was used to support qualification under this criteria. Instead, as EPA explained in the preamble to the proposed Part A revisions, "it would be illogical to require facilities [ceasing power generation] to construct new capacity to manage CCR and non-CCR wastestreams." 84 Fed. Reg. 65,941, 65,956 (Dec. 2, 2019). EPA again reiterated in the preamble to the final revisions that "[i]n contrast to the provision under § 257.103(f)(1), the owner or operator does not need to develop alternative capacity because of the impending closure of the coal fired boiler. Since the coal-fired boiler will shortly cease power generation, it would be illogical to require these facilities to construct new capacity to manage CCR and non-CCR wastestreams." 85 Fed. Reg. at 53,547. Thus, new construction or the development of new alternative disposal capacity was not considered a viable option for any wastestream discussed below. Similarly, for the reasons documented below there is insufficient existing alternative disposal capacity available on or off-site for each CCR and non-CCR wastestream.

<u>CCR Wastestreams:</u>

The Bottom Ash Complex receives approximately 6.5 million gallons per day of sluiced water containing economizer and bottom ash. Pyrites, a non-CCR wastestream, are also managed with the CCR wastestreams.

AEP evaluated each CCR wastestream placed in the EBAP and WBAP at Pirkey Power Plant. For the reasons discussed below and in Table 1, the following CCR wastestreams must continue to be placed in the EBAP and WBAP due to lack of alternative capacity both on and off-site.

Table 1: Pirkey Power Plant CCR Wastestreams

CCR Wastestream	Average Flow (gpd)	Current Configuration	Alternative Capacity Currently Available? Yes/No	AEP Notes
Bottom Ash	6,500,000 (includes economizer ash and pyrites)	Bottom ash is currently alternately sluiced to the EBAP and WBAP. Ash from the pond not receiving sluice flows is cleaned with ash being transported to the onsite landfill.	No	There are currently no alternative CCR compliant ponds onsite and extensive modifications would be required to manage the bottom ash so that it could be disposed in the onsite landfill. These alternatives are not practicable for generating units that will retire in 2023.
Economizer Ash	Included with Bottom Ash flows	Sluiced to the existing EBAP and WBAP with bottom ash	No	There are currently no alternative CCR compliant ponds onsite and extensive modifications would be required to manage the economizer ash so that it could be disposed in the onsite landfill. These alternatives are not practicable for generating units that will retire in 2023.
Pyrites (non-CCR but handled with CCR wastestreams)	Included with Bottom Ash flows	Sluiced to the existing EBAP and WBAP using the existing bottom ash pumps and piping.	No	No alternate system is available for collection of pyrites which are comingled with bottom and economizer ash. Extensive modifications would be required to manage the pyrites so that it could be disposed in the onsite landfill. These alternatives are not practicable for generating units that will retire in 2023.

Pirkey Power Plant does not have an existing alternate impoundment on-site that meets the liner or aquifer separation requirements of EPA's CCR regulation, and considerable modifications to plant equipment, facilities, and processes will be necessary before Pirkey Power Plant can cease sluicing CCR and placing non-CCR wastestreams into the EBAP and WBAP. CCR sluicing flows are treated in the EBAP and WBAP to remove solids and then are recycled back to the plant for reuse. In order to meet the water quality requirements to support the plant operation and provide space for collection of solids, a new CCR compliant impoundment approximately 12 acres in size would be required. Since Pirkey Power Plant has elected to pursue the option to permanently cease combusting coal by a date certain, developing alternative disposal capacity is counterproductive to the work to retire the boilers and close the CCR surface impoundments. As EPA explained in the preamble of the 2015 rule, it is not possible for sites that sluice CCR material to an impoundment to eliminate the impoundment and dispose of the material offsite. See 80 Fed. Reg. 21,301, 21,423 (Apr. 17, 2015) ("[W]hile it is possible to transport dry ash off-site to [an] alternate disposal facility that is simply not feasible for wet-generated CCR. Nor can facilities immediately convert to dry handling systems."). A new CCR compliant impoundment would be required to treat the CCR flows as noted above.

If temporary frac tanks were used for treatment of the CCR sluice water and if 24 hours would provide sufficient residence time for the settling of the fine solids in the CCR wastestreams, approximately 650 frac tanks would be required to store and treat the bottom ash transport water. The number of tanks required was estimated by taking the total sluice flow (6.5 MGD) divided by the frac tank capacity (21,000 gallons) and doubling it to account for the 24 hours settling time requirement which resulted in 610 frac tanks. Because approximately 50 of these frac tanks would need to be rotated out of service each day for solids removal and disposal in the Pirkey landfill, an allowance, or emergency margin, of 50 frac tanks was added to this value, which resulted in a total of 660 tanks being required. These tanks would cover over 10 acres of the site. The tanks would require significant amounts of interconnecting piping which could create an unacceptable potential for significant leaks or spills.

For off-site disposal, 6.5 MGD on average would require approximately 866 trucks per day based on 7,500 gallons per truck to haul off and dispose of the water collected. This operation would need to take place 24 hours a day and 7 days a week and poses significant safety risks both on and off-site due to the truck traffic and is impossible to achieve.

The most likely facility type capable of managing industrial wastewaters are publicly-owned or private treatment works, underground injection wells, or publicly available waste management facilities capable of solidifying liquid wastes for disposal in a landfill. Given the volume and characteristics of the CCR wastestreams, increases in permitted capacity or other modifications to the permitted pretreatment programs of a public or private wastewater treatment facility would likely be required to manage this flow, if one were available. Off-site disposal is not an option for Pirkey Power Plant CCR material.

As a result, the conditions at Pirkey Power Plant satisfy the demonstration requirement in 40 CFR § 257.103(f)(2)(i) and in the interim period (prior to permanent cessation of the coal-fired boilers) Pirkey Power Plant must continue to use the EBAP and WBAP due to the absence of alternative disposal capacity both on and off-site of the facility.

Non-CCR Wastestreams:

Approximately 100,000 gallons per event of demineralizer regeneration waste.

AEP evaluated this non-CCR wastestream that is placed in the EBAP and WBAP at Pirkey Power Plant. For the reasons discussed below and in Table 2, this non-CCR wastestream must continue to be placed in the EBAP or WBAP due to lack of alternative capacity both on and off-site.

Table 2: Pirkey Power Plant non-CCR Wastestreams

Non-CCR Wastestream	Average Flow (gallons per event)	Current Configuration	AEP Notes
Demineralizer Regeneration Waste	100,000	Flows to the existing EBAP or WBAP	Regeneration of the existing anion and cation exchange resin beads occurs on a weekly basis as a batch treatment. The EBAP or WBAP provides treatment for this wastestream which allows it to be neutralized prior to returning to the plant. No alternative capacity exists for treatment.

Pirkey Power Plant does not have an existing alternate impoundment on-site that can be utilized for treatment of the non-CCR wastestream. As stated previously, since AEP has elected to pursue the option to permanently cease the use of the coal fired boilers by a certain date, developing alternative disposal capacity is “illogical,” to use EPA’s words, and also counterproductive to the work to retire the boilers and close the impoundments

There is currently no existing installed infrastructure at the plant to support reroute of these flows. Although this volume is significantly lower than the much larger volume of bottom ash transport water, rerouting this wastestream would require construction of additional treatment and storage capacity at the site, subject the facility to additional permitting obligations, and therefore is inconsistent with the work required to retire the unit and close the ponds.

Relative to the off-site disposal capacity for this non-CCR wastestream, the acidic nature of the wastestream makes it unacceptable at most off-site facilities without prior treatment. The most likely facility type capable of managing industrial wastewaters are publicly-owned or private treatment works, underground injection wells, or publicly available waste management facilities capable of solidifying liquid wastes for disposal in a landfill. Given the volume and characteristics of this non-CCR wastestream, increases in permitted capacity or other modifications to the permitted pretreatment programs of a public or private wastewater treatment facility would likely be required to manage this flow, if one were available.

There is neither on-site nor off-site capacity available to manage this non-CCR wastestream. Consequently, in order to continue to operate and generate electricity, Pirkey Power Plant must continue to use the Bottom Ash Complex to manage the non-CCR wastestream due to lack of alternative capacity both on and off-site.

Based on the evaluation of alternative disposal options, AEP selected the following options for compliance at Pirkey Power Plant:

- Cessation of the coal burning boilers
- Closure of the EBAP by CCR material removal.
- Closure of the WBAP by CCR material removal.

This strategy can be implemented in the least amount of time and accommodates the unique site features, quantity of wastestreams, and the lack of off-site disposal facilities.

Impact to Plant Operations if Alternative Capacity Not Obtained

If Pirkey Power Plant were required to immediately cease the placement of CCR and non-CCR wastestreams into the EBAP and WBAP, which is necessary for handling more than 6.5 MGD of CCR and non-CCR wastestreams, and initiate closure by April 11, 2021, AEP would have to temporarily or permanently cease power production at the Pirkey Power Plant. The EBAP and WBAP are integral in receiving and treating these flows as required to meet the plant's water balance. Therefore, the need for uninterrupted CCR and non-CCR waste stream capacity in the EBAP and WBAP will provide time to assess and mitigate any impacts of the retirement of this unit on SWEPCO's generating resources and the electric grid.

SWEPCO owns and operates three coal-fired generating facilities within northwest Arkansas and the eastern panhandle of Texas that are seeking additional time to provide alternative disposal capacity or cease combusting coal. Together, these facilities have a maximum generating capacity of over 2,000 MW. All of these facilities operate within the Southwest Power Pool Regional Transmission Organization (SPP). Because of their close geographic proximity, simultaneous immediate closure of a significant portion of this capacity would compromise SWEPCO's ability to meet electrical demand and capacity obligations of the SPP, would destabilize portions of the electricity grid and, therefore, would not be in the public interest. One facility will retire in 2023, one will be converted to satisfy both the ELG and CCR requirements, and the third will cease combusting coal in 2028. The requested extensions will allow for an orderly transition of generating resources, provide time to initiate transmission mitigation plans to avoid compromising the reliability of the grid, and maintain SWEPCO's ability to provide affordable electricity to customers.

RISK MITIGATION PLAN

257.103(f)(2)(v)(B) A risk mitigation plan describing the measures that will be taken to expedite any required corrective action, and that contains all of the following elements:

> *(1) A discussion of any physical or chemical measures a facility can take to limit any future releases to groundwater during operation.*

In order to demonstrate that the criteria in §257.103(f)(2)(ii) have been met, 40 CFR §257.103(f)(2)(v)(B) requires the applicant to describe the risk mitigation measures that will be taken to expedite any required corrective action at the plant. The following is a discussion of the physical and chemical measures the plant can take to limit any future releases to groundwater during operation to address the requirements in 40 CFR §257.103(f)(2)(v)(B)(1).

The plant could take the physical precautionary measure of minimizing the volume of CCR stored in the active surface impoundment. This will include periodic removal of the CCR throughout the

course of the year. During any time of periodic removal of CCR, the plant will implement administrative controls to limit the depth of removal to ensure the original bottom of the pond is not disturbed, thereby eliminating any integrity issues with the current in-situ material.

Additionally, to prevent future groundwater contamination flowing towards the Hatley Creek, steps could be taken to lower the operational levels as low as possible to minimize the free liquids accompanied with diminishing the amount of CCR stored in the impoundment. This action can be initiated very quickly, but there is a limit on how low the pond can be lowered due to the physical configuration of the outlet structure from the pond complex.

Another potential physical measure that could be implemented, if necessary, is the installation of a hydraulic barrier.

These mitigation measures would promptly address any contaminate migrating towards Hatley Creek.

> *(2) A discussion of the surface impoundment's groundwater monitoring data and any found exceedances; the delineation of the plume (if necessary based on the groundwater monitoring data); identification of any nearby receptors that might be exposed to current or future groundwater contamination; and how such exposures could be promptly mitigated.*

Groundwater monitoring data

Groundwater monitoring at the EBAP and WBAP is accomplished using a PE-certified groundwater monitoring network composed of three upgradient monitoring wells and three downgradient monitoring wells per CCR unit. The certified Groundwater Monitoring Well Evaluation Report is included in Appendix C.

Groundwater at the EBAP and WBAP is monitored in accordance with an assessment monitoring program, following the requirements of 40 CFR 257.95 in the CCR rule. Assessment monitoring identified an exceedance of the ground water protection standard for cobalt and lithium for the EBAP and cobalt for the WBAP, but alternate source demonstration were completed showing higher upgradient lithium concentrations, and naturally occurring cobalt in the aquifer media, demonstrating that the EBAP and WBAP were not the source of the cobalt and lithium detected. Following the requirements of 40 CFR 257.95, groundwater samples from each monitoring well are analyzed for all parameters in appendix IV of the CCR rule during the first monitoring event of the annual monitoring cycle, then during the two subsequent events in the cycle, samples from each well are analyzed for all parameters in appendix III and those parameters in appendix IV that were detected during the first sampling event in the cycle. Analysis results for each constituent at each monitoring well are compared to corresponding groundwater protection standards according to statistical procedures and performance standards specified in 40 CFR 257.93(f) and 40 CFR 257.93(g). The BAP Complex is expected to remain in assessment monitoring until closure by removal is complete, but will transition to an assessment of corrective measures and selection of a remedy following requirements in 40 CFR 257.96 and 40 CFR 257.97, and a corrective action program following requirements in 40 CFR 257.98, if necessary. The concentrations of the Appendix III and IV constituents detected within the groundwater monitoring wells are presented in Table 1 of the Groundwater Monitoring and Corrective Action Reports in **Appendix F**.

Plume

The EBAP and WBAP are currently in assessment monitoring and have not exceeded a groundwater protection standard for any appendix IV parameter, therefore, no plume delineation has been necessary.

Nearby receptors and mitigation

Private wells:

There are approximately 12 private water wells located within a 0.5-mile radius of the plant. **Figure 2** shows 0.5-mile radius of the CCR units at Pirkey Power Plant. The groundwater production zones in most of these private wells are completed between 240 to 330 feet below ground surface. This production zone is at a different depth than the groundwater zone sampled by the monitor wells, which are completed at depths ranging from 18 to 57 feet below ground surface. The private water wells are used for non-potable water sources.

Hatley Creek:

To prevent future groundwater contamination from entering Hatley Creek, steps could be taken to lower the operational levels in the EBAP and WBAP as low as possible to minimize the free liquids accompanied with diminishing the amount of CCR stored in the impoundment and/or a hydraulic barrier could be constructed by the impoundments. These mitigation measures would promptly address any contaminate migrating toward the reservoir.

> (3) *A plan to expedite and maintain the containment of any contaminant plume that is either present or identified during continued operation of the unit*

AEP will establish contracts with consultants and drilling companies who are immediately available to prepare and execute a nature and extent report. Based on the results of the report, AEP will be able to readily implement a temporary containment plan until the proper Assessment of Corrective Action Report evaluates the appropriate potential methods for remediation.

As noted above in (1), a hydraulic barrier (cutoff wall) could be implemented in a relatively short timeframe after the identification of a release from the pond complex. Hydraulic barriers are commonly used to contain and/or isolate the migration of a plume and are incorporated into other Corrective Measures for groundwater remediation. This could be accomplished while the Assessment of Correct Action is being evaluated.

Cutoff walls act as barriers to migration of impacted groundwater and can isolate soils that have been impacted by CCR to prevent contact with unimpacted groundwater. Cutoff walls are often used in conjunction with an interior pumping system to establish a reverse gradient within the cutoff wall. The reverse gradient maintains an inward flow through the wall, keeping it from acting as a groundwater dam and controlling potential end-around or breakout flow of contaminated groundwater.

A commonly used cutoff wall construction technology is the slurry trench method, which consists of excavating a trench and backfilling it with a soil-bentonite mixture, often created with the soils excavated from the trench. The trench is temporarily supported with bentonite slurry that is

pumped into the trench as it is excavated. Excavation for cutoff walls is conducted with conventional hydraulic excavators, hydraulic excavators equipped with specialized booms to extend their reach (i.e., long-stick excavators), or chisels and clamshells, depending upon the depth of the trench and the material to be excavated. For a cutoff wall to be technically feasible, there must be a low-permeability lower confining layer into which the barrier can be keyed, and it must be at a technically feasible depth.

A slurry wall, which is constructed with low permeable material such as bentonite, would be applicable to the Pirkey site since the uppermost aquifer is not deep below the surface. Slurry walls can be constructed up to depths of 60-80 feet. Sheet pile walls are limited to depths less than 60 feet. If the subsurface materials are very consolidated, the depths may even be less.

Another measure to contain the migration of the plume is extraction of the groundwater. This measure includes installation of a series of groundwater pumping wells or trenches to control and extract impacted groundwater. Groundwater extraction captures and contains impacted groundwater and can limit plume expansion.

Installation of a groundwater extraction system, whether wells or trenches, can be expedited with the assumption that there is a good conceptual site model (CSM) of the hydrogeological system around the CCR unit, groundwater flow and transport model, and aquifer test if a well system is the best option for intercepting the groundwater contaminant plume. Upon notification of an SSL exceedance of a GWPS for one or more Appendix IV parameters, an aquifer test will be conducted, and groundwater model developed for designing a groundwater extraction system for optimization of contaminant plume capture.

Based on site specific hydrogeology and future potential plume width and depth, a groundwater extraction system will typically consist of one to three extraction wells manifolded together with HDPE conveyance pipe to a common tank or lined collection vault prior to treatment at the on-site wastewater treatment plant and discharge via the NPDES permitted outfall.

NATTATIVE STRATEGY FOR COMPLIANCE WITH ALL REQUIREMENTS OF 40 CFR 257 SUBPART D

From the regulatory text

40 C.F.R. § 257.103(f)(2)(v)(C)(1) To demonstrate that the criteria in paragraph (f)(2)(iii) of this section have been met, the owner or operator must submit all of the following:

> *(1) A certification signed by the owner or operator that the facility is in compliance with all of the requirements of this subpart;*
>
> I hereby certify that, based on my inquiry of those persons who are immediately responsible for compliance with environmental regulations for the Pirkey Power Plant, the facility is in compliance with all of the requirements contained in 40 CFR §257 Subpart D – *Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments*.
>
> X David A. Miller
> David A. Miller P.E.

Director – Land Environmental and Remediation Services

The Pirkey Power Plant is maintaining compliance with all requirements of Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. Reports documenting compliance with the rule's provisions, such as location restriction, design criteria, operating criteria, and groundwater monitoring are posted to the AEP public CCR Rule Compliance Data and Information Internet site at the following link: http://www.aep.com/about/codeofconduct/ccrrule/.

From the regulatory text

40 CFR §257.103(f)(2)(v)(C)(2) Visual representation of hydrogeologic information at and around the CCR unit(s) that supports the design, construction and installation of the groundwater monitoring system. This includes all of the following:

> *(i) Map(s) of groundwater monitoring well locations in relation to the CCR unit;*
> *(ii) Well construction diagrams and drilling logs for all groundwater monitoring wells; and*
> *(iii) Maps that characterize the direction of groundwater flow accounting for seasonal variations;*

Groundwater monitoring at the Pirkey Power Plant CCR units is accomplished using PE-certified groundwater monitoring networks. The EBAP and WBAP are composed of three upgradient monitoring wells and three downgradient monitoring wells each. The LF GWMN is composed of four upgradient and 3 downgradient monitoring wells. The FGD Stack Out Area GWMN is composed of two upgradient and three downgradient monitoring wells. The complete GWMN Reports are provided in **Appendix C** and include the following:

- A map showing the location of the monitoring wells relative to the CCR units is included in the GWMN report as **Figure 10**
- Boring logs and well construction diagrams are included in the GWMN Report in **Appendix C**.
- A typical groundwater flow direction map is included in the GWMN Report as **Figure 9**

40 CFR §257.103(f)(2)(v)(C)(3) Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event;

The most recent Groundwater Monitoring and Corrective Action Reports summarize Appendix III and IV constituent concentrations at each groundwater monitoring well monitored during each sampling event as Table 1 (see **Appendix F**).

40 CFR §257.103(f)(2)(v)(C)(4) Description of site hydrogeology including stratigraphic cross-sections;

The central and northern part of Pirkey Plant is located within an outcrop of the Eocene age Recklaw Formation. The Recklaw formation consists predominantly of clay and fine grained sand with a maximum thickness of 100 feet. The Recklaw Formation is underlain by the Eocene age Carrizo Sand. The topographically low southern portion of the plant is located in outcrop of the Carrizo Sand. The Carrizo Sand consists of fine to medium grain sand interbedded with silt and clay with a thickness of approximately 100 feet. The Carrizo Sand is underlain by Upper Wilcox.

The monitor wells installed on-site have a depth to groundwater ranges from to 20 to 58 feet below ground surface. The complete GWMN Reports for each CCR unit at Pirkey Power Plant are provided in **Appendix C** and include a description of the site hydrogeology. Stratigraphic cross-sections are included in each of the GWMN Reports as **Figures 4 – 8**.

The Bottom Ash Pond Complex is located approximately 2,000 feet north-northwest of Brandy Branch Reservoir, which was dammed during plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. Shallow groundwater flow direction at the site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the site. Groundwater flow direction maps of the latest monitoring events completed in the spring and fall to show seasonal changes are provided in Figures 3 and 4.

40 CFR §257.103(f)(2)(v)(C)(5) Any corrective measures assessment required at § 257.96;

The Pirkey Power Plant CCR units have not entered Assessment of Corrective Measures, therefore, no corrective measures assessment reports have been required or prepared.

40 CFR §257.103(f)(2)(v)(C)(6) Any progress reports on remedy selection and design and the report of final remedy selection required at § 257.97(a);

The Pirkey Power Plant CCR units have not entered Assessment of Corrective Measures, therefore no progress reports on remedy selection and design and a report of final remedy selection have been required or prepared.

40 CFR §257.103(f)(2)(v)(C)(7) The most recent structural stability assessment required at § 257.73(d); and

The most recent structural stability assessments required at 40 CFR§ 257.73(d) for the EBAP and WBAP can be found in **Appendix D**. These reports will be updated every 5 years as required by the CCR rule.

40 CFR §257.103(f)(2)(v)(C)(8) The most recent safety factor assessment required at § 257.73(e).

The most recent safety factor assessments required at 40 CFR § 257.73(e) for the EBAP and WBAP can be found in Appendix E. These reports will be updated every 5 years as required by the CCR rule.

COAL-FIRED BOILERS CEASE OPERATION AND IMPOUNDMENT CLOSURE

From the regulatory text

(D) To demonstrate that the criteria in paragraph (f)(2)(iv) of this section have been met, the owner or operator must submit the closure plan required by § 257.102(b) and a narrative that specifies and justifies the date by which they intend to cease receipt of waste into the unit in order to meet the closure deadlines.

AEP will oversee detailed planning and design of the closure activities which includes: engineering and design; prepare and file all required permit applications; receive approval from

the respective regulatory agencies; bid and award construction contract; development of a revised water balance diagram after the generating units cease operations; and sequencing construction activities.

The following are the planned activities that will be necessary to meet the closure date of October 17, 2023.

Engineering, Design and Permitting
The conceptual design of the pond closure has been completed. Detailed design of the final closure and repurposing activities will begin December 2020 and is planned to be completed by May 2021.

Contractor Selection
Construction bid packages for the EBAP and WBAP closure are planned to be issued to bidders in May 2021 with an award date of November 2021. Six months have been allowed for bidding, selection and award of construction contracts to the selected contractors in accordance with AEP's typical process.

Construction
The majority of the CCR material is currently being removed from the EBAP as part of the operational activities of the plant. Once the CCR material is removed, the EBAP will only be used to receive CCR or non-CCR flows during extreme rainfall events, such as hurricanes, as a means for emergency capacity for the WBAP. At the end of the hurricane season in 2022, the EBAP will no longer be needed as emergency capacity for the WBAP which will allow for the final closure of the EBAP to start. The removal of ash will be verified by comparing the excavated contours to the original design contours when the ponds were constructed. When the excavation has reached the original construction contours, an additional one foot of material will be removed to confirm removal of CCR. All CCR material excavated plus the one foot of over excavation will be hauled to the on-site landfill. An engineer will certify that the removal activities satisfy the specification and completion of closure by removal for the EBAP. The completion of the removal of the CCR from the EBAP is planned for January 2023.

Once CCR sluicing from the operating unit has ceased to the WBAP in March 2023, closure by removal will start. WBAP closure will begin with dewatering of the pond. Once dewatered, the ash will be removed (approx. 300,000 CY) and hauled to the onsite landfill. The planned duration of the dewatering and CCR removal work is 5 months based on previous cleaning efforts at the plant. The removal of ash will be verified by comparing the excavated contours to the original design contours when the ponds were constructed. When the excavation has reached the original construction contours, an additional one foot of material will be removed (approx. 49,000 CY) to confirm removal of CCR; this is estimated to require 2 months. All CCR material excavated plus the one foot of over excavation will be hauled to the on-site landfill. An engineer will certify that the removal activities satisfy the specification and completion of closure by removal for the WBAP. The completion of the removal of the CCR from the WBAP is planned for October 2023.

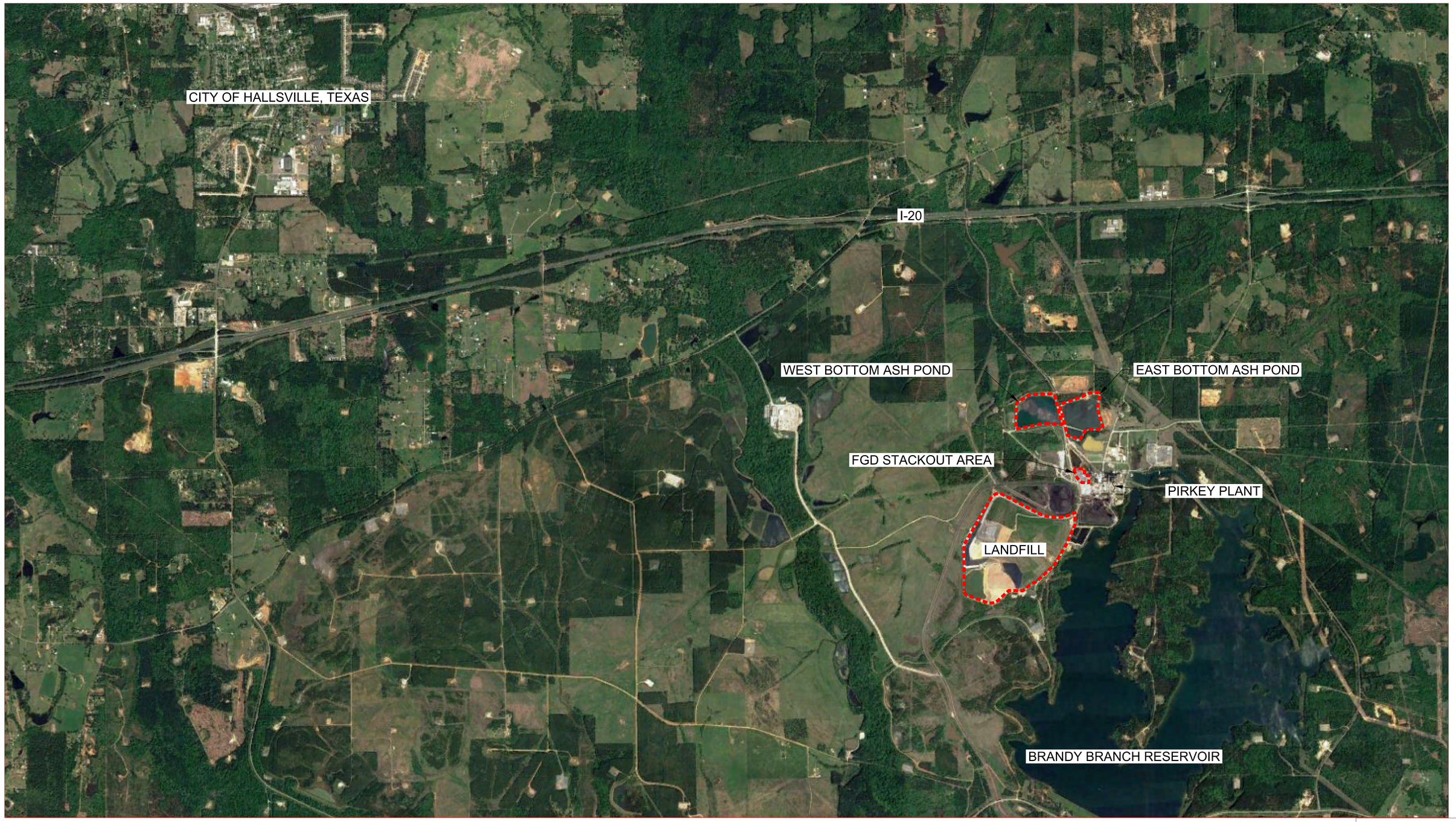
Table below summarizes the major tasks, durations and milestone dates associated with closing the EBAP and WBAP.

Closure Planning and Engineering	6 months
Spec, bid, and Award construction contracts	6 months
EBAP Dewatering	2 months
EBAP CCR Material Removal	3 months
EBAP Impacted Soil Removal	2 months
EBAP Closure Complete	January 2023
Cease Coal Combustion & Sluicing Wastestreams	March 2023
Commence WBAP Dewatering and CCR Removal	March 2023
WBAP Dewatering	2 months
WBAP CCR material removal	3 months
WBAP Impacted soil removal	2 months
WBAP Closure Complete	October 17, 2023

CONCLUSION

Based upon the information submitted in this demonstration, it has been shown that the Henry W. Pirkey Power Plant is unable to obtain alternative disposal capacity for the CCR and non-CCR wastestreams before April 11, 2021 and qualifies for the site specific alternate time frame for the initiation of closure as allowed by 40 CFR 257.103 – Alternate Closure Requirements and specifically 40 CFR 257.103(f)(2) – *Permanent cessation of a coal-fired boiler(s) by a date certain.*Therefore, it is requested that EPA approve this demonstration.

Figures



NORTH

0 1225' 2450'
SCALE IN FEET

Figure 1

PRELIMINARY - NOT FOR CONSTRUCTION

no.	date	by	ckd	description
A	06/22/20	KTM	MDB	ISSUED FOR EXTENSION REQUEST

LIMITS OF CCR UNIT

BURNS McDONNELL
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Company, Inc.
Firm Reg. No. F-845

designed R. OWENS | detailed J. RIDDER

AMERICAN ELECTRIC POWER
BOUNDLESS ENERGY™

CCR / ELG COMPLIANCE PROJECT
PIRKEY POWER PLANT
HARRISON COUNTY, TEXAS

CCR UNIT LOCATION MAP

project 120792 | contract

drawing SK - C501 | rev. A

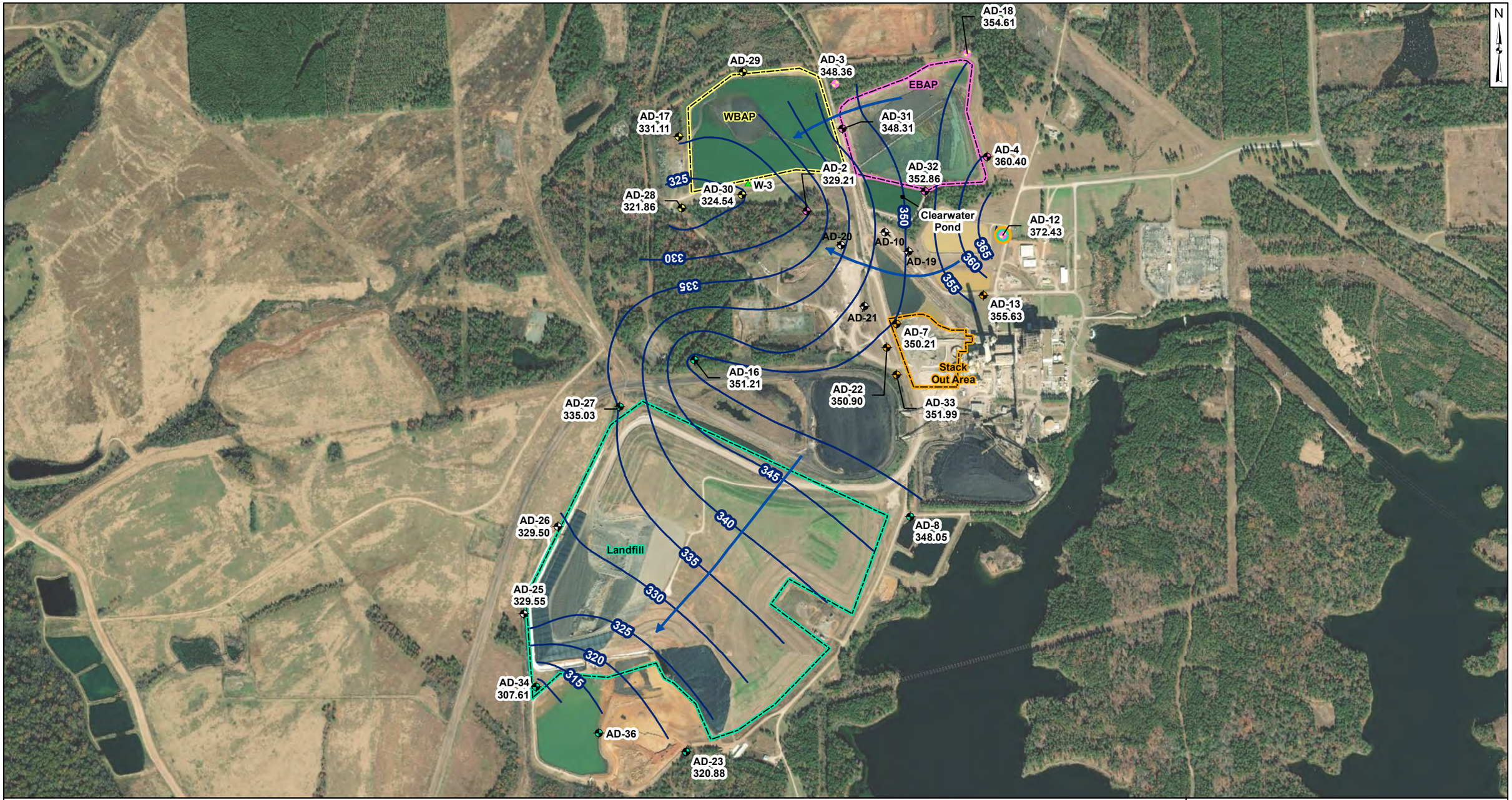
sheet | of | sheets

file 120792SK-C501.DGN

Z:\Clients\ENR\AEPSvc\AEPCCRELG\120792_PirkeyCCRELG\Design\Civil\Dwgs\Sketches\120792SK-C501.dgn

6/22/2020

Scale For Microfilming
Millimeters
Inches



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on February 23-28, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in February 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer February 2019

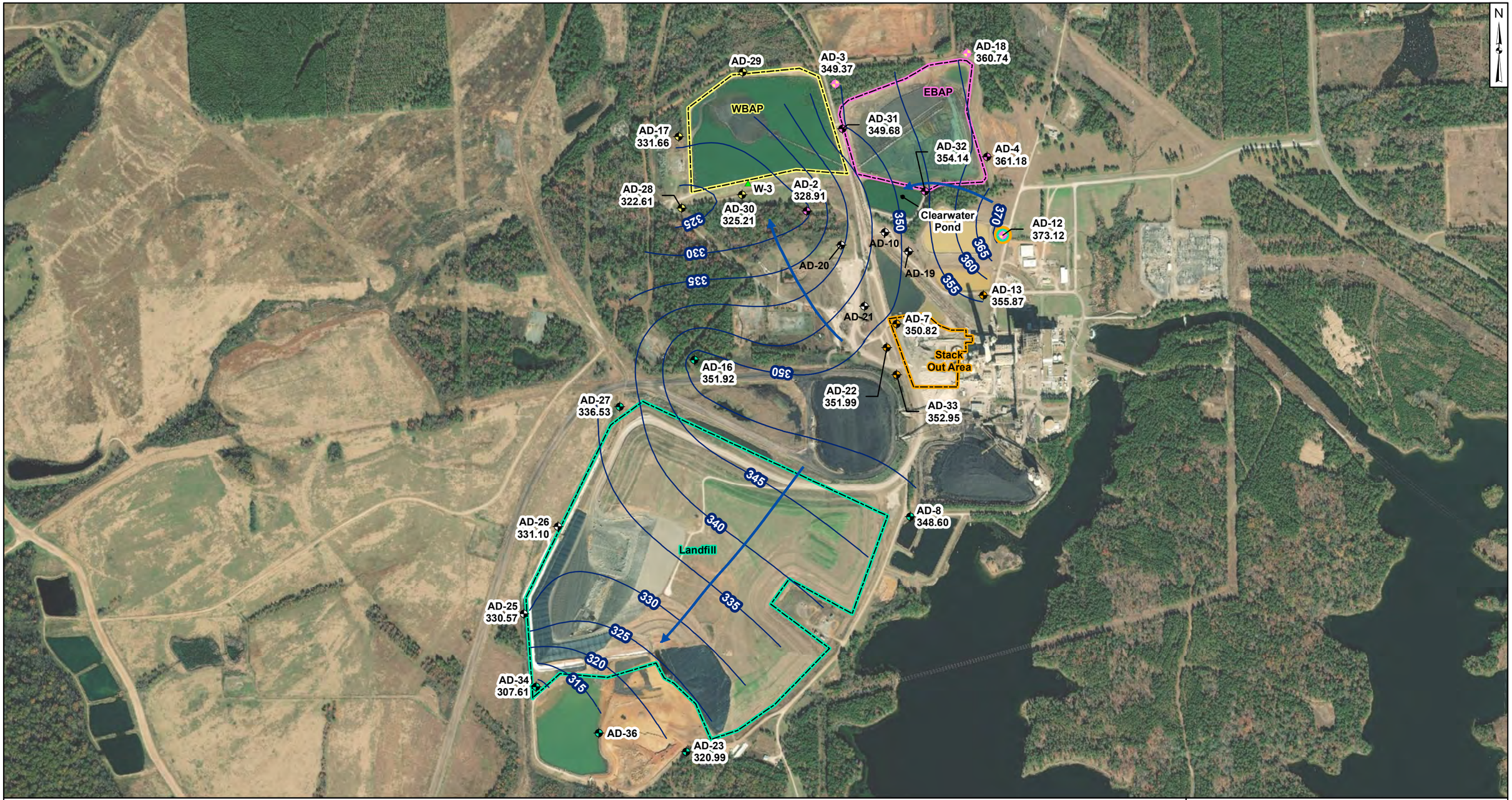
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure 2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201902-February.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 21-23, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in May 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer May 2019

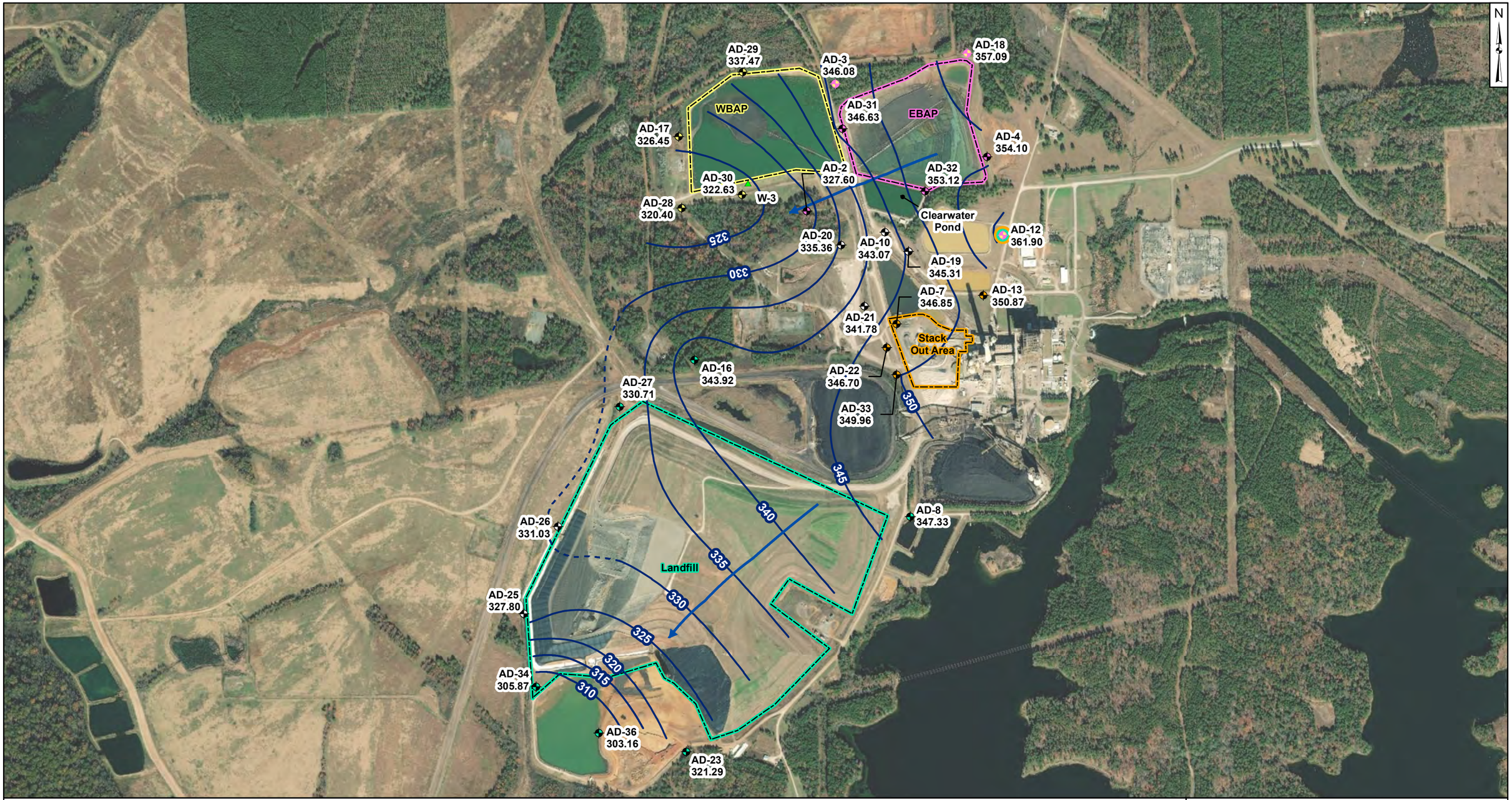
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure **3**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201905-May.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on August 12-16, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in August 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer August 2019

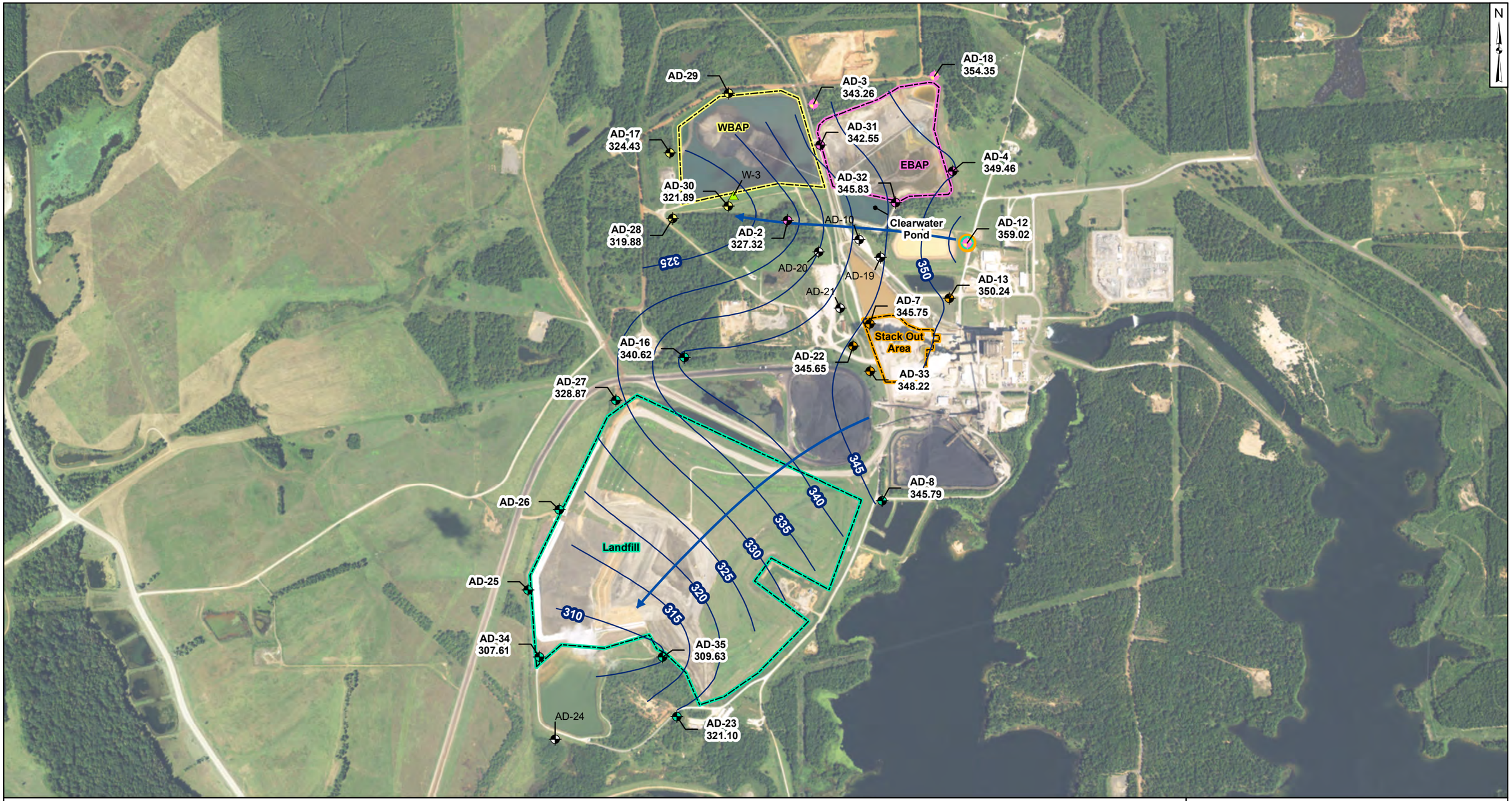
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure 4

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201908-August.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stack Out Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected November 14 - 15, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer November 2016

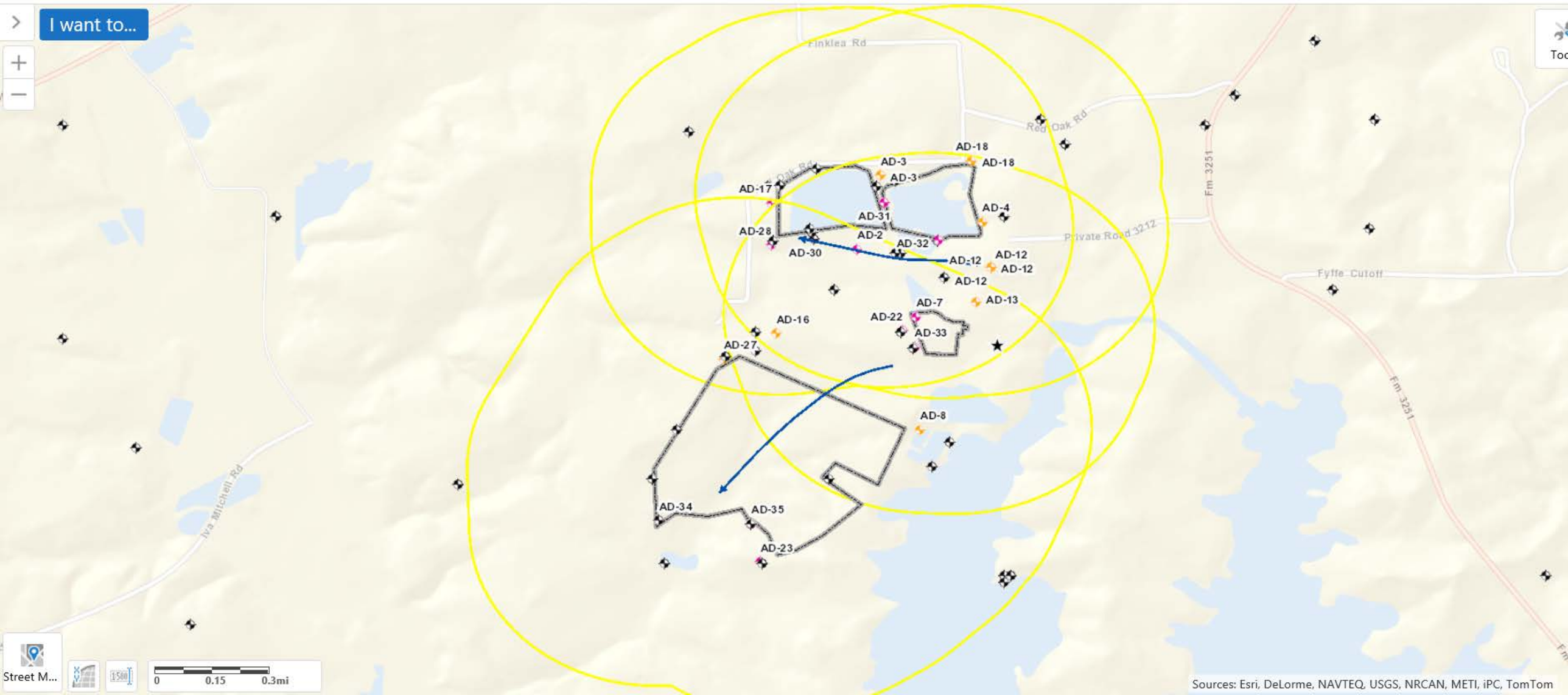
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

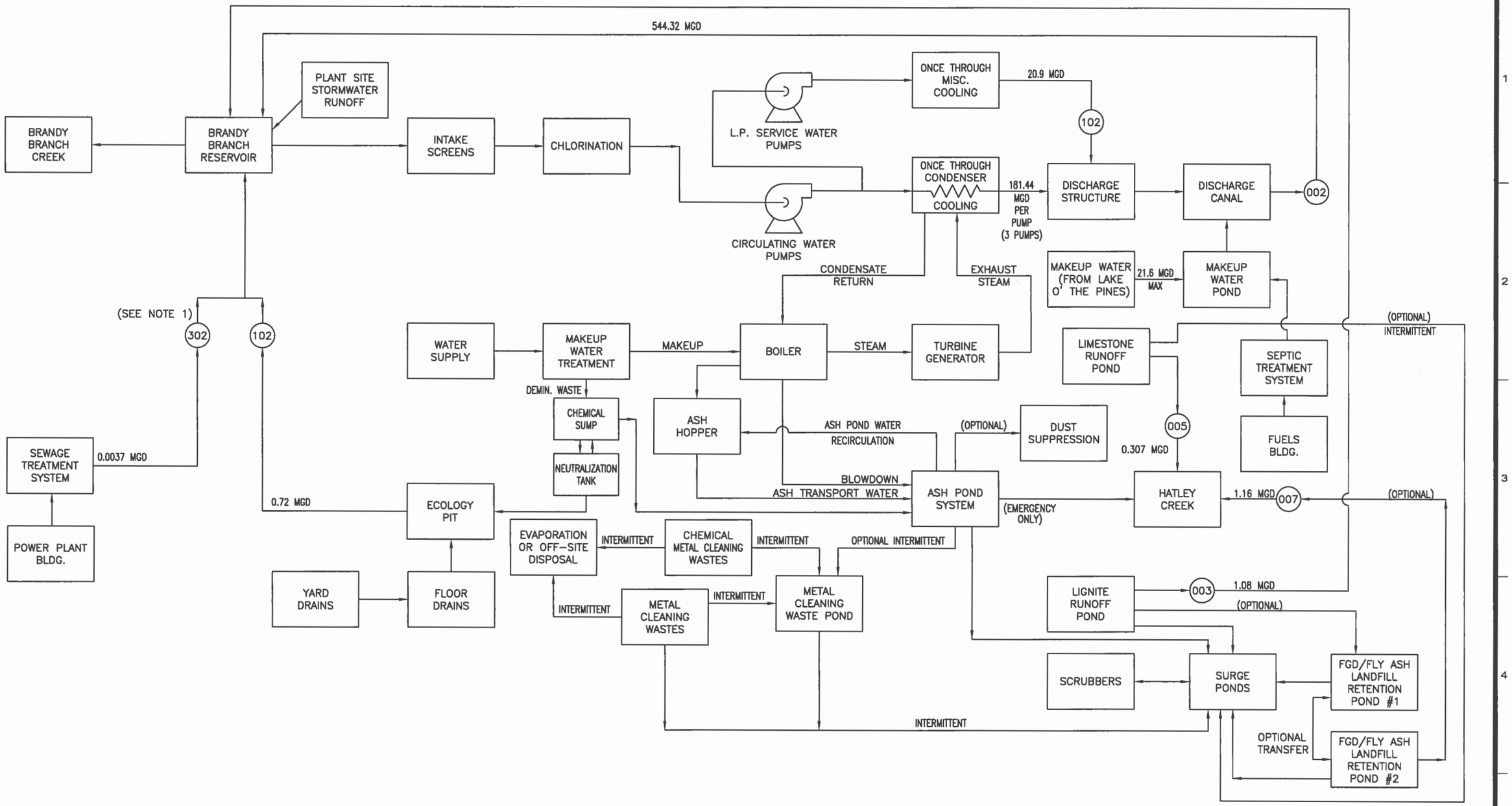
Columbus, Ohio | 2017/12/13

Figure 5

C:\Users\mmuenich\Documents\local_projects\AEP_GIS\Pirkey\MXDs\AEP-Pirkey_GW_2016-11November.mxd. MMuenich. 12/13/2017. Project/Phase/Task.


I want to...
Finklea Rd
Red Oak Rd
Fm 3251
Private Road 3212
Fyffe Cutoff
Iva Mitchell Rd
AD-18
AD-3
AD-17
AD-4
AD-31
AD-28
AD-2
AD-32
AD-30
AD-12
AD-7
AD-13
AD-16
AD-22
AD-33
AD-27
AD-8
AD-34
AD-35
AD-23
Street M...
0
0.15
0.3mi
Sources: Esri, DeLorme, NAVTEQ, USGS, NRCAN, METI, iPC, TomTom

Appendix A
Existing Water Balance



DATE	NO.	DESCRIPTION	APPD.
	4	ISSUED FOR REVISION	

REVISIONS

PRELIMINARY - REFERENCE ONLY

THIS DRAWING IS CLASSIFIED AS:

AEP CONFIDENTIAL

REFERENCE AEP's CORPORATE INFORMATION SECURITY POLICY

SOUTHWESTERN ELECTRIC POWER COMPANY

HENRY W.PIRKEY PLANT

SOUTH HALLSVILLE TEXAS

ENVIRONMENTAL

SCHEMATIC OF WATER FLOW

UNIT:	DRAWING NUMBER:	REV:
1	SWP07	4

SCALE:
DR:
CH:
SUP:
ENG:
DATE: SEE REV 0

APPROVED BY

CIVIL ENGINEERING

AEP AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

PLOT DATE: DD-MMM-YYYY
PLOT TIME: HOUR:MINUTE
PLOT SCALE: XX

Appendix B

Closure Plan required by §257.73(b)

CLOSURE PLAN

CFR 257.102(b)

East and West Bottom Ash Ponds

Pirkey Power Plant
Hallsville, Texas

October 2016
Revised November 2020

Prepared for : Southwest Electric Power Company - Pirkey Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

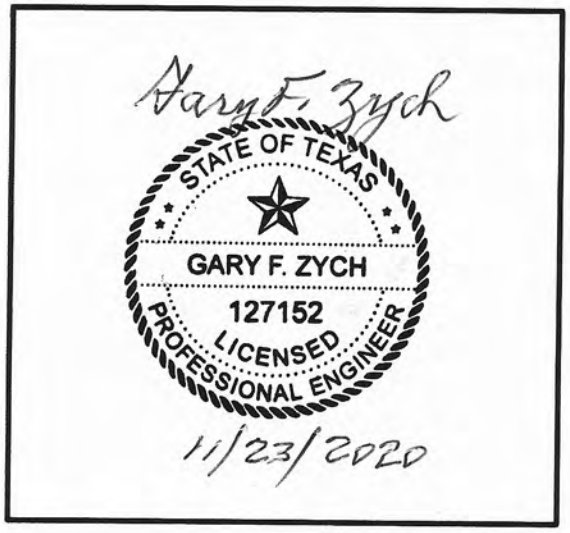
GERS – 20 –012

CLOSURE PLAN
CFR 257.102(b)
PIRKEY POWER PLANT
EAST AND WEST BOTTOM ASH PONDS

PREPARED BY Gary F. Zych DATE 11/20/2020
Gary F. Zych, P.E.

REVIEWED BY Arthur W. Rentzsch DATE 11/23/2020
Arthur W. Rentzsch

APPROVED BY Gary F. Zych DATE 11/23/2020
Gary F. Zych, P.E.
Department Manager – AEP Geotechnical Engineering



I certify to the best of my knowledge, information, and belief that the information contained in this closure plan meets the requirements of 40 CFR § 257.102(b)

Table of CONTENTS

1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of CCR 257.102(b) for Closure Plans of Existing CCR Surface Impoundments.

2.0 DESCRIPTION OF THE CCR UNIT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas. It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for managing CCR materials called the East Bottom Ash Pond (East BAP) and the West Bottom Ash Pond (West BAP). These two ponds and a Clearwater Pond are collectively referenced at the Bottom Ash Complex. The Clearwater Pond is not a CCR surface impoundment.

The East BAP is located directly adjacent to and east of the West BAP. The East BAP receives sluiced bottom ash and has a surface area of 31.5 acres and a storage capacity of 188 acre-feet. The pond is almost entirely incised, with a reported maximum embankment height of 4 feet.

The West BAP, which also receives sluiced bottom ash, is located northwest of the main plant buildings and shares its eastern border with the western border of the East BAP. The West BAP receives sluiced bottom ash and has a surface area of 30.9 acres and a storage capacity of 188 acre-feet. The maximum embankment height is 25 feet. The main upstream embankment slopes are 3 feet horizontal to 1 foot vertical (3:1 H:V); while the main downstream slopes area 2.5:1 H:V.

The sluicing of CCR materials is alternated between the two CCR surface impoundments. CCR material is sluiced to one pond while the CCR material is dewatered and excavated from the other pond. The transport water from the sluicing operation is discharged into the Clearwater Pond. The plant recycles the water from the Clearwater Pond for plant operations.

3.0 DESCRIPTION OF CLOSURE PLAN 257.102(b)(1)(i)

[A narrative description of how the CCR unit will be closed in accordance with this section]

Closure of the Pirkey Power Plant East and West Bottom Ash Ponds will be completed by removal of all CCR material and sediments from each pond.

4.0 CLOSURE BY REMOVAL 257.102 (b)(1)(ii)

[If closure of the CCR unit will be accomplished through removal of CCR from the CCR unit, a description of the procedures to remove the CCR and decontaminate the CCR unit in accordance with paragraph (c) of this section.]

Closure by removal of the East and West bottom ash ponds will include removal of all CCR from the surface impoundments. The removal of all CCR and any sediments will be accomplished by dredging and/or mechanical means. The CCR material will be either placed in the onsite CCR landfill or hauled offsite for beneficial reuse. A visual evaluation of the pond bottom by a third party consultant will be the basis for declaring the CCR material has been removed. After all CCR material has been removed, an additional 12 inches of soil from the pond bottom will be removed. Following the removal of CCR and

soil, the dikes forming the pond will be used as subgrade material to regrade the area. The disturbed area will be seeded at the completion.

4.1 CLOSURE PERFORMANCE STANDARDS 257.102 (c)

[An owner or operator may elect to close a CCR unit by removing and decontaminating all areas affected by releases from the CCR unit. CCR removal and decontamination of the CCR unit are complete when constituent concentrations throughout the CCR unit and any areas affected by releases from the CCR unit have been removed and groundwater monitoring concentrations do not exceed the groundwater protection standard established pursuant to §257.95(h) for constituents listed in appendix IV to this part.]

Closure of the CCR unit will be completed when all CCR materials in the unit, and any areas that may have been affected by releases from the CCR unit, have been removed and groundwater monitoring demonstrates that all concentrations of the assessment monitoring constituents listed in appendix IV to part 257 do not exceed either statistically equivalent background levels or MCLs for two consecutive sampling events using the statistical procedures in § 257.93(g).

5.0 ESTIMATE OF MAXIMUM CCR VOLUME 257.102 (b)(1)(iv)

[An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit.]

The estimated maximum CCR volume on-site is 188 Acre-Ft. or 303,307 cubic yards for the East Bottom Ash Pond and 188 Acre-Ft. or 303,307 cubic yards for the West Bottom Ash Pond.

6.0 ESTIMATE OF LARGEST AREA OF CCR REQUIRING COVER 257.102 (b)(1)(v)

[An estimate of the largest area of CCR unit ever requiring a final cover

This pond will be closed by removal of CCR materials as such this section is not applicable.

7.0 CLOSURE SCHEDULE 257.102(b)(1)(vi)

[A schedule for completing all activities necessary to satisfy the closure criteria in the section, including an estimate of the year in which all closure activities for the CCR unit will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR unit, including identification of major milestones such as coordinating with and obtaining necessary approvals and permits from other agencies, the dewatering and stabilization phases of the CCR surface impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of the CCR unit closure.

The generating units will cease operation in March 2023. During 2020, ash was removed from the East bottom ash pond as part of normal plant operations. The East pond will remain available to receive CCR or non-CCR material as a means for emergency capacity. The following schedule is related to the work necessary to complete final closure activities of both ponds.

Initiate engineering and design for closure	December 2020
Complete design and submit permit applications as necessary	May 2021
Remove CCR from East BAP	June 2020 –September 2020
Bid and award construction contract	May 2021 – November 2021
Receive Approval of State/Local Permits	Spring 2023
Complete closure of East BAP	November 2022 – January 2023
Dewater and remove CCR from West BAP	March 2023 – August 2023
Remove soil and Regrade area to drain	August 2023- October 2023
Complete closure of West BAP	October,17 2023

Appendix C

Groundwater Monitoring Well Network Evaluation Report

ARCADIS
Infrastructure · Water · Environment · Buildings

Imagine the result

American Electric Power Service Corporation

East Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

May 25, 2016

ARCADIS

Kenneth Brandner, P.E., P.G.
Senior Project Engineer

Matthew J. Lamb
Project Manager

John Holm, P.E.
Professional Engineer

East Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Prepared for:
AEP

Prepared by:
ARCADIS U.S., Inc.
100 E Campus View Blvd
Suite 200
Columbus
Ohio 43235-1447
Tel 614 985 9100
Fax 614 985 9170

Our Ref.:
OH015976.0010

Date:
May 25, 2016

Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
PTI	Permit to Install
TDS	total dissolved solids

ARCADIS

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the adequacy of the groundwater monitoring well network included in the Coal Combustion Residual (CCR) requirements, as specified in Code of Federal Regulations (CFR) 40 CFR 257.91, for the East Bottom Ash Pond (BAP) CCR Unit at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above and isolated from the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zone, or in an unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report summarizes the evaluation of the groundwater monitoring well network in the uppermost aquifer at the East BAP (Site). The evaluation of the location restriction criteria is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the East BAP CCR unit, as well as publically-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on all documents reviewed and will further describe the uppermost aquifer, include an evaluation of the adequacy of the existing monitoring well network, and provide recommendations for monitoring well augmentation, as necessary.

ARCADIS

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant East BAP.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The East BAP CCR unit is located at the north end of the Plant and approximately 2,000 feet north-northwest of Brandy Branch Reservoir (**Figures 1** and **2**).

2.2 Description of East BAP CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the East BAP.

2.2.1 Embankment Configuration

The East BAP is partially incised into native soils with an embankment height of approximately 4 feet (AMEC, 2011). The East BAP embankments are constructed of compacted clay on a 3:1 slope (3 feet horizontal, 1 foot vertical) (Sargent & Lundy, 1983). The elevation of the top of the embankment around the perimeter of the East BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, May 2011). The interior bottom elevation of the East BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Johnson & Pace, June 2011).

2.2.2 Area/Volume

The East BAP is approximately 31.5 acres in size. The design maximum ash storage capacity of the East BAP is 188 acre feet (Sargent & Lundy, 1983). Johnson & Pace calculated the East BAP ash storage capacity in 2011 at 161 acre feet at an elevation of 355 feet amsl (maximum operating level) (Johnson & Pace, June 2011).

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, flue gas desulfurization sludge) have been generated. The East BAP,

which was placed into operation in 1985, receives bottom ash and economizer ash sluiced from the power plant boiler (**Figure 3**). Clear water overflow from the East BAP discharges into the Clearwater Pond located directly south of the East BAP. Bottom ash and economizer ash are periodically excavated from the East BAP and hauled by truck to either the on-site landfill for disposal, or sold for offsite beneficial re-use.

The base of the East BAP was constructed in 1983 with a compacted clay liner (Sargent & Lundy, 1983). Following installation of the compacted clay liner, soil borings S-4 through S-7 were advanced below the base of the East BAP to total depths of six feet in September 1983 (Southwestern Laboratories, 1984). The lithologic data from soil borings S-4 through S-7 confirm at least six feet of clay is present below the base of the East BAP (Sargent & Lundy, 1984).

2.2.4 Surface Water Control

Surface water elevation in the East BAP is controlled by a weir box and a manually operated gate valve on a 36-inch-diameter discharge pipe at the southwest corner of the pond. Clear water overflow from the East BAP discharges through the 36-inch-diameter pipe into the 2.7- acre Clearwater Pond located directly south of the East BAP (**Figure 3**). Water in the Clearwater Pond is pumped (re-circulated) back into the boiler ash hopper.

2.3 Previous Investigations

The initial soils investigation and design of the East BAP was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, and design of the East BAP. As discussed above in Section 2.2.3, the design included installation of a clay liner below the East BAP.

In September-October 1983, Southwestern Laboratories conducted a soil investigation at the Plant, including advancement of four soil borings (S-4 through S-7) below the East BAP (Southwestern Laboratories, 1984).

In 1984, Sargent & Lundy conducted an evaluation of the East BAP. This report included evaluation of soil sample geotechnical data, and concluded a low-permeability clay liner was present below the East BAP (Sargent & Lundy, 1984).

In 2009, ETTL Engineers & Consultants (ETTL) conducted a geotechnical investigation of the East BAP earthen embankment. The investigation included installation of two soil borings through the embankment (E1, E2), completion of the soil borings as

piezometers PE-1 and PE-2, respectively, and collection of soil samples for geotechnical analyses. The report concluded the embankment was stable and the existing embankment slopes were acceptable if conditions are maintained (ETTL, 2010). The conditions to be maintained included embankment protection from erosion (vegetative cover), removal of brush and trees two feet or more in height, and control of animal burrowing.

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, 2011).

In 2011, Johnson & Pace performed a hydraulic analysis of the East BAP for a 10-year, 24-hour rainfall event in accordance with the TCEQ TPDES permit design criteria. The report concluded the storage capacity of the East BAP is hydraulically adequate (Johnson & Pace, May 2011).

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of six monitoring wells (AD-30 through AD-35) (Auckland Consulting, 2016).

2.4 Hydrogeologic Setting

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of approximately 100 feet (Broom, 1966).

These features are further illustrated on five lines of cross section that were prepared through the East BAP area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A') through **Figure 8** (E-E').

ARCADIS

2.4.1 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1° Fahrenheit (F) in January to 83.8°F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.2 Regional and Local Geologic Setting

The central and northern portions of the Plant, including the East BAP, are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

Figure 9 is a potentiometric surface map based on January 2016 water level data for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figure 9**, shallow groundwater flow direction in the area of the East BAP is west-southwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The East BAP is located approximately 2,000 feet north-northwest of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figure 9**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow

groundwater in the area of the East BAP does not discharge into Brandy Branch Reservoir.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled approximately 500 feet south (side gradient) of the East BAP in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 350 to 430 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled approximately ¼-mile southwest (downgradient) of the East BAP for NFR Energy in 2008 for use as a rig supply well. The water well was screened from 250 to 310 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (up gradient) of the Pirkey Power Plant.

ARCADIS

3. Groundwater Monitoring Well Network Evaluation

The existing monitoring well network present at the Site was evaluated to determine if any of the wells were viable for continued use as part of the groundwater monitoring well network or also retained as part of a larger groundwater hydraulic monitoring well network. The hydrogeologic conditions were also evaluated to determine if the uppermost aquifer unit has an effective well network. The evaluation was completed in accordance with 40 CFR 257.91 to have an established monitoring well network that effectively monitors the uppermost aquifer up gradient and down gradient of the Site. The up gradient wells represent background groundwater quality and the down gradient wells are to be placed down gradient of the CCR unit boundary to monitor water quality.

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost aquifer in the area of the East BAP is a very fine to fine grained clayey and silty sand stratum with an average thickness of approximately 15 feet that is located between an elevation of approximately 325 and 340 feet amsl (**Appendix A**). The base of the East BAP is at an elevation of 347 feet amsl. Therefore the separation distance between the uppermost aquifer and the base of the East BAP is approximately seven feet. This separation distance is further illustrated on cross section A-A' (**Figure 4)** and cross section E-E' (**Figure 8)**.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness (approximately 15 feet), the yield of the uppermost aqufier is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Available groundwater elevations are summarized on **Table 1** for 2011 through 2016. The most recent comprehensive groundwater data set from January 20, 2016 is depicted on **Figure 9**. The groundwater flow is west-southwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

ARCADIS

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

Per 40 CFR 257.60(a), new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five ft) above the upper limit of the uppermost aquifer, or must demonstrate there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high conditions).

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as 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 groundwater surface to which the aquifer rises during the wet season.

3.2.1.1 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the area of the East BAP is the clayey and silty sand stratum that is located between an elevation of approximately 325 and 340 feet amsl.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 19, 2015 to review existing well network conditions and locations. A well construction table that summarizes the location, ground surface elevation, borehole depth, installation date, and associated well construction details of the monitoring well network is included as

ARCADIS

Table 2. Photo documentation of the located wells during the August 19, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-2, AD-3, AD-4, AD-12, and AD-18 were previously installed at the Site to monitor the uppermost aquifer (clayey and silty sand stratum) associated with the East BAP. As discussed above in Section 3.1.1, the uppermost aquifer below the East BAP is approximately 15 feet thick and is located between an elevation of approximately 325 and 340 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on Geologic Cross Section A-A' (**Figure 4**), existing monitoring well AD-4 is screened in the uppermost aquifer upgradient (east) of the East BAP, and existing monitoring well AD-3 is screened in the uppermost aquifer sidegradient (northwest) of the East BAP. Existing monitoring wells AD-4, AD-12 and AD-18 (also located east of the East BAP) will be utilized as upgradient monitoring wells for the East BAP. Existing monitoring well AD-2, located west-southwest of the East BAP, will be utilized as a downgradient monitoring well for the East BAP.

As shown on **Figure 9**, shallow groundwater flow direction in the area of the East BAP is west-southwesterly. One existing monitoring well (AD-2) was located hydraulically downgradient of the East BAP during the August 19, 2015 site visit, and three downgradient monitoring wells are required to monitor groundwater quality downgradient of a CCR unit. This data gap was addressed by installation of new downgradient monitoring wells AD-31 and AD-32 during December 2015 as shown on **Figure 9** and **10**. With the addition of monitoring wells AD-31 on the west side of the East BAP and AD-32 on the south central side of the East BAP, there are no gaps remaining in the groundwater monitoring network for the East BAP.

ARCADIS

4. Recommended Monitoring Network and PE Certification

The recommended existing groundwater monitoring well network is intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the East BAP (up gradient or down gradient), well depth, and well construction. The recommended network would provide an improved understanding of groundwater quality, hydraulics, and groundwater flow at the East BAP.

4.1 Recommended Monitoring Well Network Distribution

Three up gradient well locations (existing monitoring wells AD-4, AD-12, and AD-18) and three down gradient well locations (existing monitoring wells AD-2, AD-31, and AD-32) are recommended to establish a groundwater quality monitoring well network for the East BAP. In addition, existing sidegradient monitoring well AD-3 may be utilized as a piezometer to obtain additional groundwater flow direction and gradient data for the East BAP.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the East BAP is summarized on **Table 3** and illustrated on **Figure 10.**

4.1.2 Depth

The screen depths for the monitoring wells recommended for inclusion in the monitoring network are within the shallow saturated sand stratum (uppermost aquifer) that occurs between an elevation of approximately 325 and 340 feet amsl as shown on Geologic Cross Sections A-A' (**Figure 4**) and E-E' (**Figure 8**). The screen elevations are presented in **Table 3**.

4.1.3 Well Construction

As discussed above in Section 3.3.2, the gap in the monitoring well network for the uppermost aquifer at the East BAP was addressed by installation of monitoring wells AD-31 and AD-32 during December 2015. Monitoring wells AD-31 and AD-32 were installed by a Texas Department of Licensing and Regulation (TDLR)-licensed water well driller. Well construction data for the monitoring well network are summarized on **Tables 2** and **3**, and the monitoring well completion diagrams are provided in **Appendix A**.

ARCADIS

4.2 Professional Engineer's Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, the proposed groundwater monitoring system will be adequate to meet the requirements of 40 CFR Part 257.91.

Kenneth J. Brandner

Printed Name of Registered Professional Engineer

Kent J Brandner

Signature

69586	Texas	5-25-16
Registration No.	Registration State	Date

ARCADIS

5. References

AMEC, "Report of Dam Safety Assessment of Coal Combustion Surface Impoundments, American Electric Power (AEP) and Southwest Electric Power Company (SWEPCO) H.W. Pirkey Power Plant, Hallsville, TX", August 2011.

Apex Geoscience Inc., "USWAG Monitoring Wells and Groundwater Evaluation, AEP Pirkey Power Station, Hallsville, Texas", March 2011.

Auckland Consulting LLC, "Monitoring Well Installation – 2015, Pirkey Generating Station, Hallsville, Texas", January 26, 2016.

Banks Information Solutions, "Water Well Report, Pirkey Power Plant, 2400 FM 3251, Hallsville, Texas, Harrison County", October 8, 2015.

Broom, M.E., and B. N. Myers, "Ground-Water Resources of Harrison County, Texas", Texas Water Development Board Report 27, August 1966.

ETTL Engineers & Consultants Inc., "Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas", October 2010.

Fetter, C.W., "Applied Hydrogeology", University of Wisconsin – Oshkosh, 1980.

Flawn, Peter T., "Geologic Atlas of Texas, Tyler Sheet", The University of Texas at Austin Bureau of Economic Geology, March 1965.

George, Peter G., et. al., "Aquifers of Texas", Texas Water Development Board Report 380, July 2011.

Johnson & Pace Incorporated, "Hydrology & Hydraulic Report, North Surge Pond, East & West Ash Ponds, Secondary Ash Pond, Landfill Pond, H.W. Pirkey Power Plant, Hallsville, Texas", May 2011.

Johnson & Pace Incorporated, "East Bottom Ash Pond June 2011 As-Built Plan & Profile, H.W. Pirkey Power Plant, Hallsville, Texas", June 2011.

Sargent & Lundy, "Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities", January 31, 1983.

Sargent & Lundy, "Henry W. Pirkey Power Plant Unit 1, Wastewater Ponds – Liner Verification & Monitoring Wells", September 14, 1984.

Southwestern Laboratories, "Subsurface Exploration, Waste Water Ponds, Pirkey Power Plant, Hallsville, Texas", September 7, 1984.

Texas Commission on Environmental Quality, "Groundwater Classification, RG-366/TRRP-8", March 2010.

USGS, Aquifers and Groundwater. 2015. Available online at www.usgs.gov.

USGS, "Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin", Open-File Report 88-450K, 1988.

USGS, "Texas Seismic Hazard Map", 2014.

ARCADIS

Tables

ARCADIS

Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[a]	Top of Casing Elevation[a]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen[b]		Bottom of Screen[b]		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																					
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48
AD-30[d]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70
AD-31[d]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60
AD-32[d]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32
AD-33[d]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13
AD-34[d]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61
AD-35[d]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85
Piezometers[c]																					
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	NM	NM	NM	NM	NM	NM	NM	NM	NM

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
NM - Not Measured

ARCADIS

Table 2
Well Construction Details
AEP Pirkey Power Plant - CCR Units
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[a]	Top of Casing Elevation[a]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen[b]		Bottom of Screen[b]	
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
Monitoring Wells																
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	18	323	40	301	20	321.25	40	301.25
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	35	338	57	316	37	335.76	57	315.76
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	24	340	46	318	26	337.69	46	317.69
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	18	342	40	320	20	339.61	40	319.61
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	18	339	35	322	20	336.92	35	321.92
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	18	341	40	319	20	339.48	40	319.48
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	29	350	51	328	31	347.84	51	327.84
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	17.5	344.5	40.5	321.5	30.5	331.48	40.5	321.48
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	13	344	35	322	15.0	341.81	35.0	321.81
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	8	335	30	313	10.0	332.65	30.0	312.65
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	13	347	25	335	15.0	345.48	25.0	335.48
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	8	352	30	330	10.0	349.50	30.0	329.50
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	13	339	35	317	15.0	337.30	35.0	317.30
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	8	339	30	317	10.0	337.23	30.0	317.23
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	8	348	30	326	10.0	345.57	30.0	325.57
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	13	334	35	312	15.0	331.72	35.0	311.72
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	3	285	20	268	5.0	282.68	20.0	267.68
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	8	326	30	304	10.0	324.15	30.0	304.15
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	8	334	40	302	10.0	332.41	40.0	302.41
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	15.5	334.3	37.5	312.3	17.5	332.33	37.5	312.33
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	13	323	35	301	15.0	320.92	35.0	300.92
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	8	342	30	320	10.0	340.21	30.0	320.21
AD-30[d]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	8	331	25	314	10.0	329.04	25.0	314.04
AD-31[d]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	18	340	35	323	20.0	337.75	35.0	322.75
AD-32[d]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	11	346	33	324	13.0	344.23	33.0	324.23
AD-33[d]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	12	347	30	329	15.0	344.30	30.0	329.30
AD-34[d]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	8	297	25	280	10.0	294.64	25.0	279.64
AD-35[d]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	2.5	313.5	20	296	3.0	313.01	18.0	298.01
Piezometers[c]																
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	26	330	38	318	28.0	328.30	38.0	318.30

General Note:
Elevations in feet above mean sea level.

Footnotes:
(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011). Top of sand pack estimated 2 feet above top of screened interval.
(c) Souce: EETL (October 2010).
(d) Source: Aukland Consulting LLC (January 26, 2016).
Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

Table 3
Proposed Well Network
AEP Pirkey Power Plant - East Bottom Ash Pond
Hallsville, Harrison County, Texas

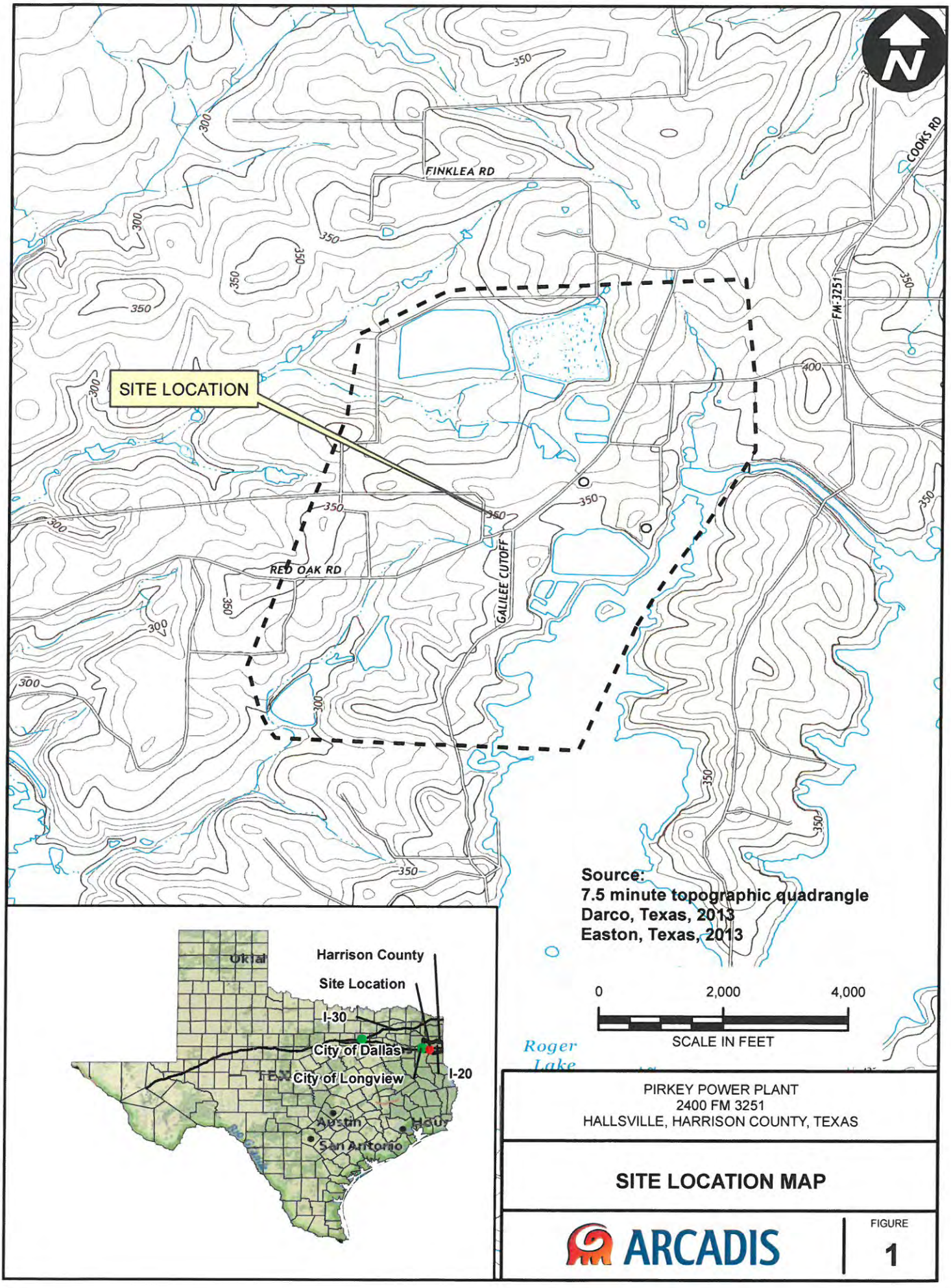
Well ID	Exisiting/ Proposed	Hydrostratigraphic Unit Target	Location Description		Screen Top Target Elevation[(a)] (ft amsl)	Screen Bottom Target Elevation[(a)] (ft amsl)	Screen Length (ft)	Comments
Upgradient								
AD-4	Exisiting	Uppermost Water-Bearing Unit	East of East Bottom Ash Pond	Upgradient	337.7	317.7	20	Existing well installed in 1983; well will be utilitzed to establish backgroud water quality
AD-12	Exisiting	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilitzed to establish backgroud water quality
AD-18	Exisiting	Uppermost Water-Bearing Unit	East of East Bottom Ash Pond	Upgradient	345.5	335.5	10	Existing well installed in 2011; well will be utilitzed to establish backgroud water quality
Downgradient								
AD-2	Existing	Uppermost Water-Bearing Unit	West-Southwest of East Bottom Ash Pond	Down gradient	321.3	301.3	20	Existing well installed in 1983; uppermost shallow aquifer adjacent to the East Bottom Ash Pond - downgradient
AD-31	Existing	Uppermost Water-Bearing Unit	West of East Bottom Ash Pond	Down gradient	337.8	322.8	15	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to the East Bottom Ash Pond - downgradient
AD-32	Existing	Uppermost Water-Bearing Unit	South of East Bottom Ash Pond	Down gradient	344.2	324.2	20	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to the East Bottom Ash Pond - downgradient
Piezometers								
AD-3	Exisiting	Uppermost Water-Bearing Unit	Northwest of East Bottom Ash Pond	Side gradient	335.8	315.8	20	Existing well installed in 2011; and utilitzed to obtain water level data for uppermost water-bearing unit

Footnotes:
a. Target elevations are an estimated range.

Acronyms and Abbreviations:
U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

ARCADIS

Figures



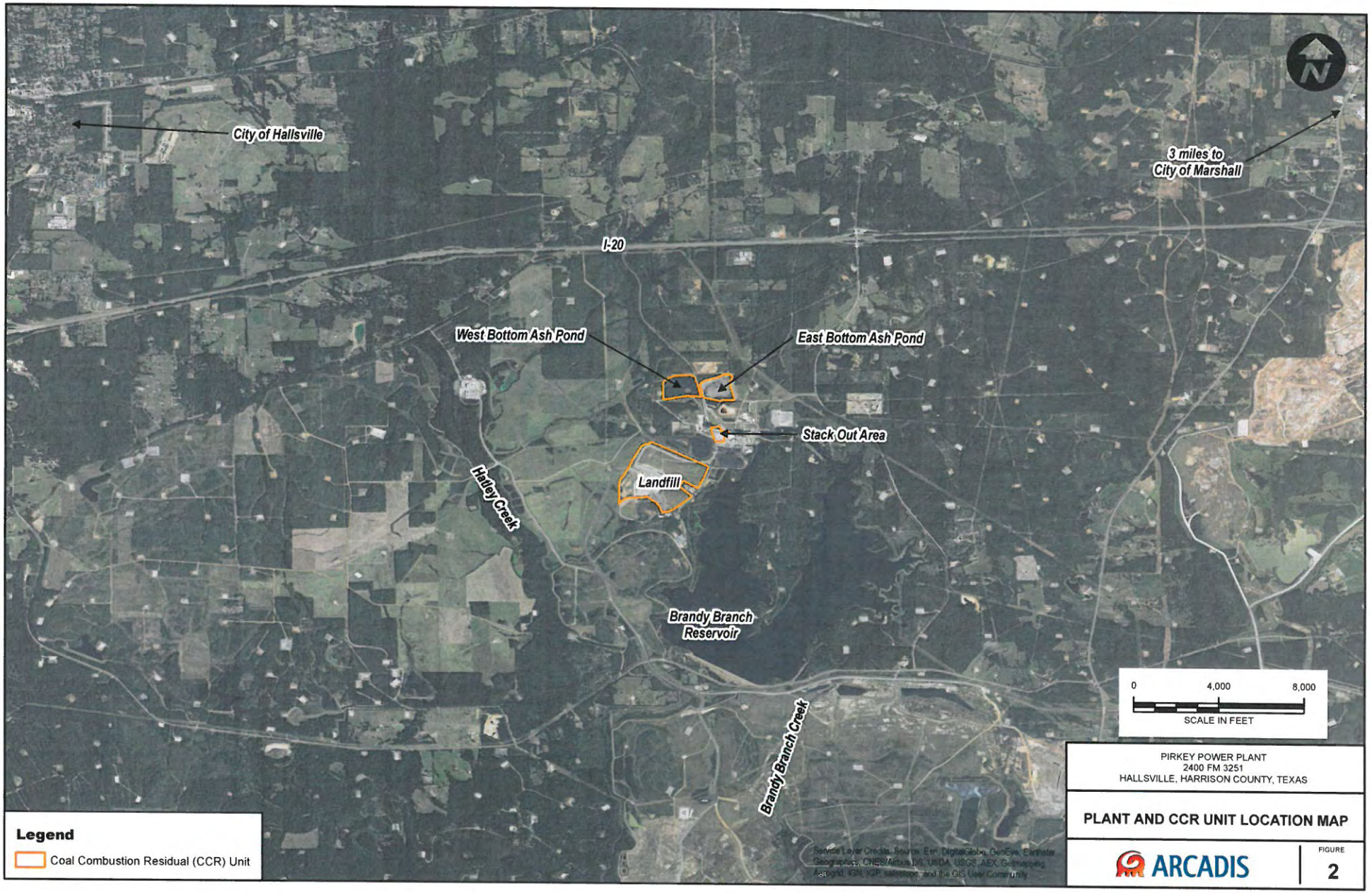
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

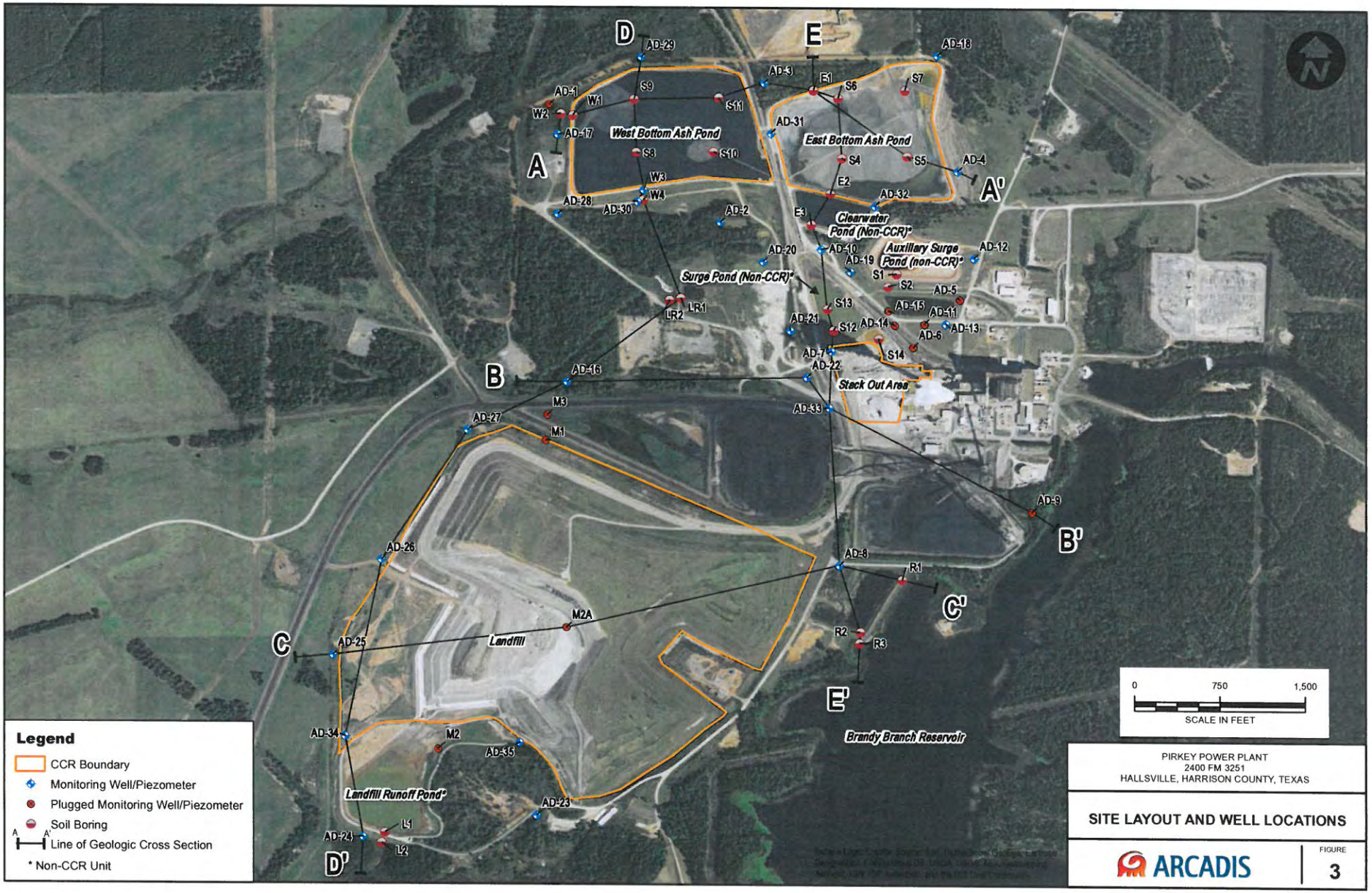
SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENVAEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd


City of Hallsville
3 miles to City of Marshall
I-20
West Bottom Ash Pond
East Bottom Ash Pond
Stack Out Area
Landfill
Hatley Creek
Brandy Branch Reservoir
Brandy Branch Creek
0
4,000
8,000
SCALE IN FEET
Legend
Coal Combustion Residual (CCR) Unit
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS
PLANT AND CCR UNIT LOCATION MAP
ARCADIS
FIGURE
2
Document Path: Z:\GIS\PROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



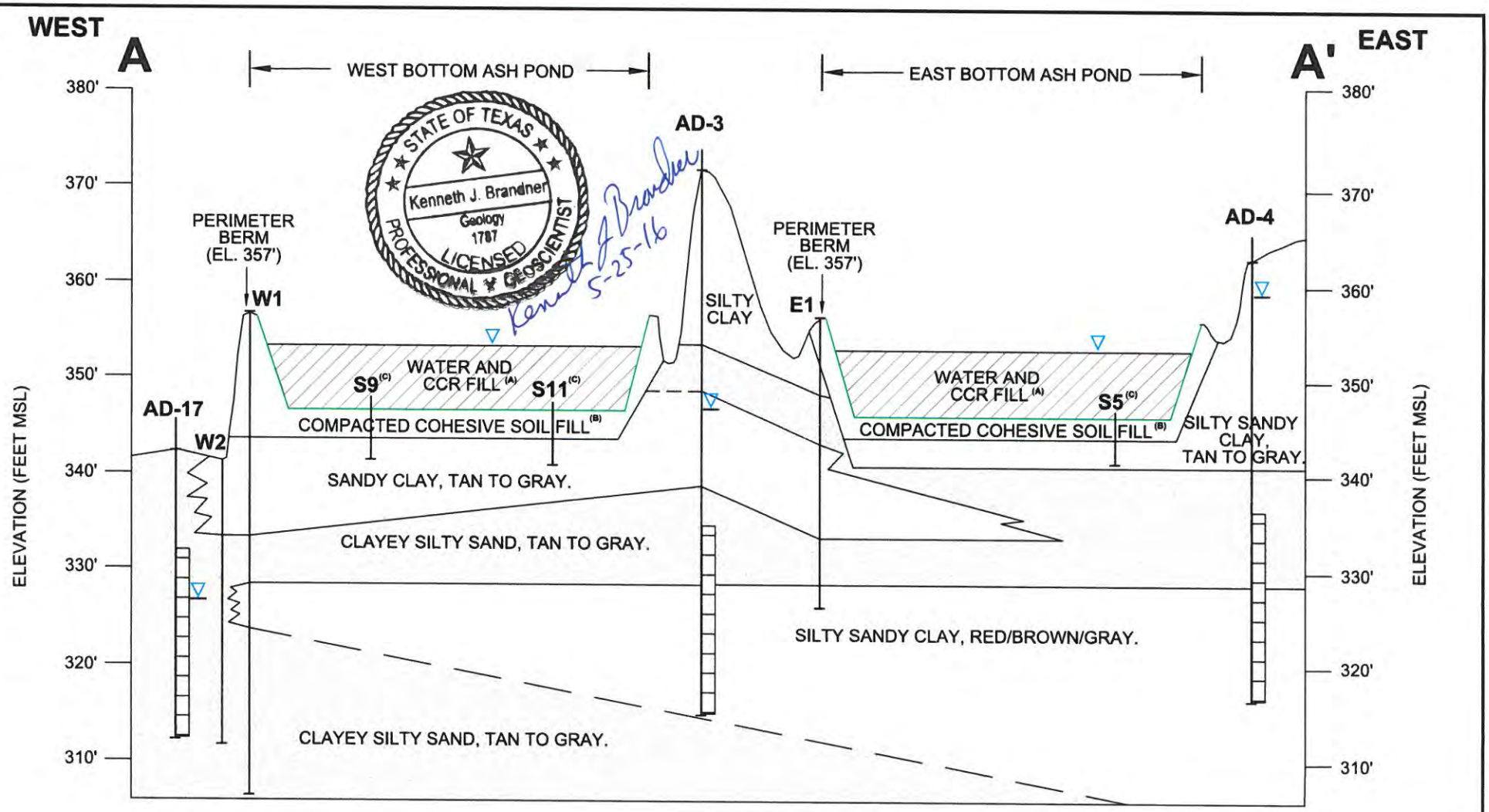
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE 3

Document Path: Z:\GIS\PROJECTS_ENVVAEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd



LEGEND

- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

NOTES:

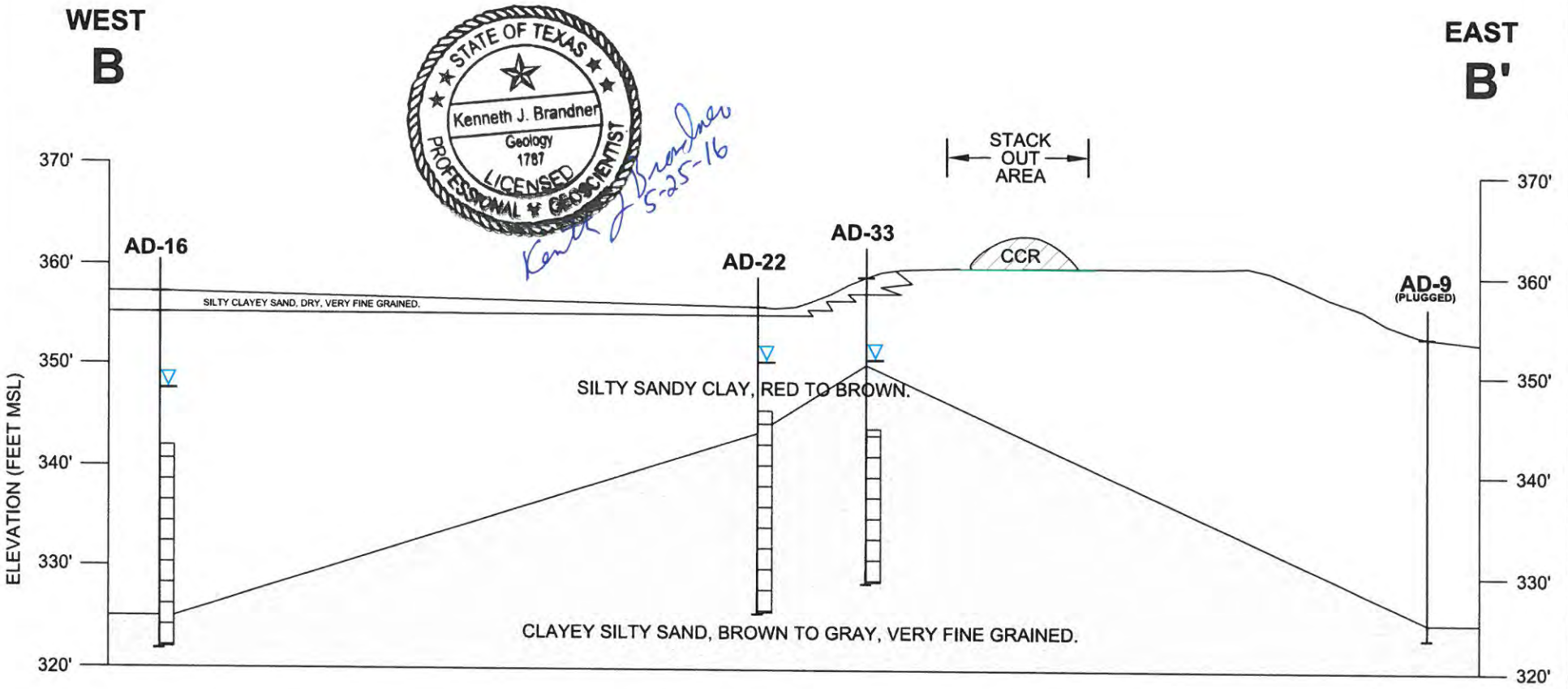
A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).
C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION A - A'

ARCADIS

FIGURE 4



LEGEND

- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

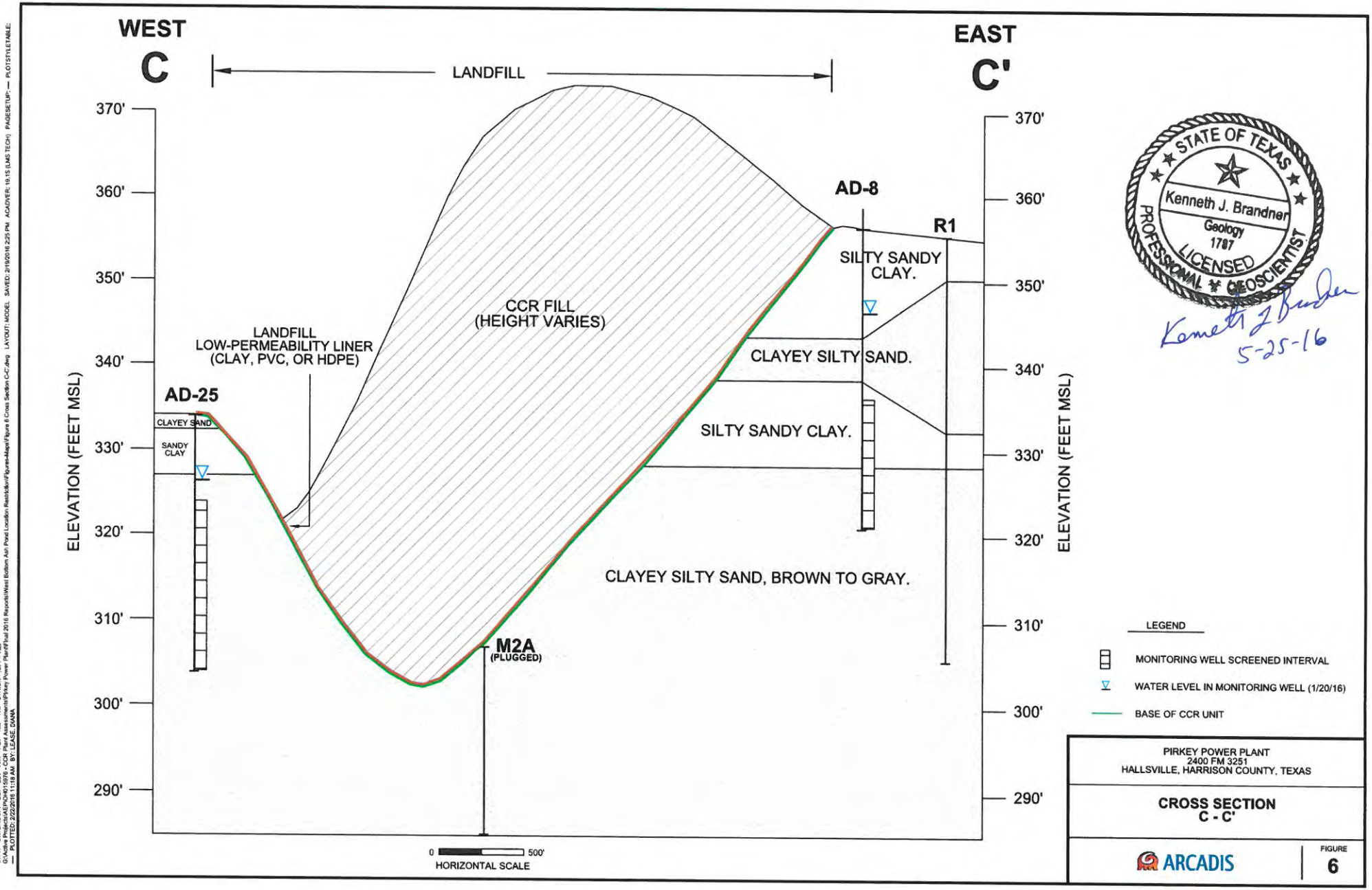
NOTES:
A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5



STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL GEOSCIENTIST

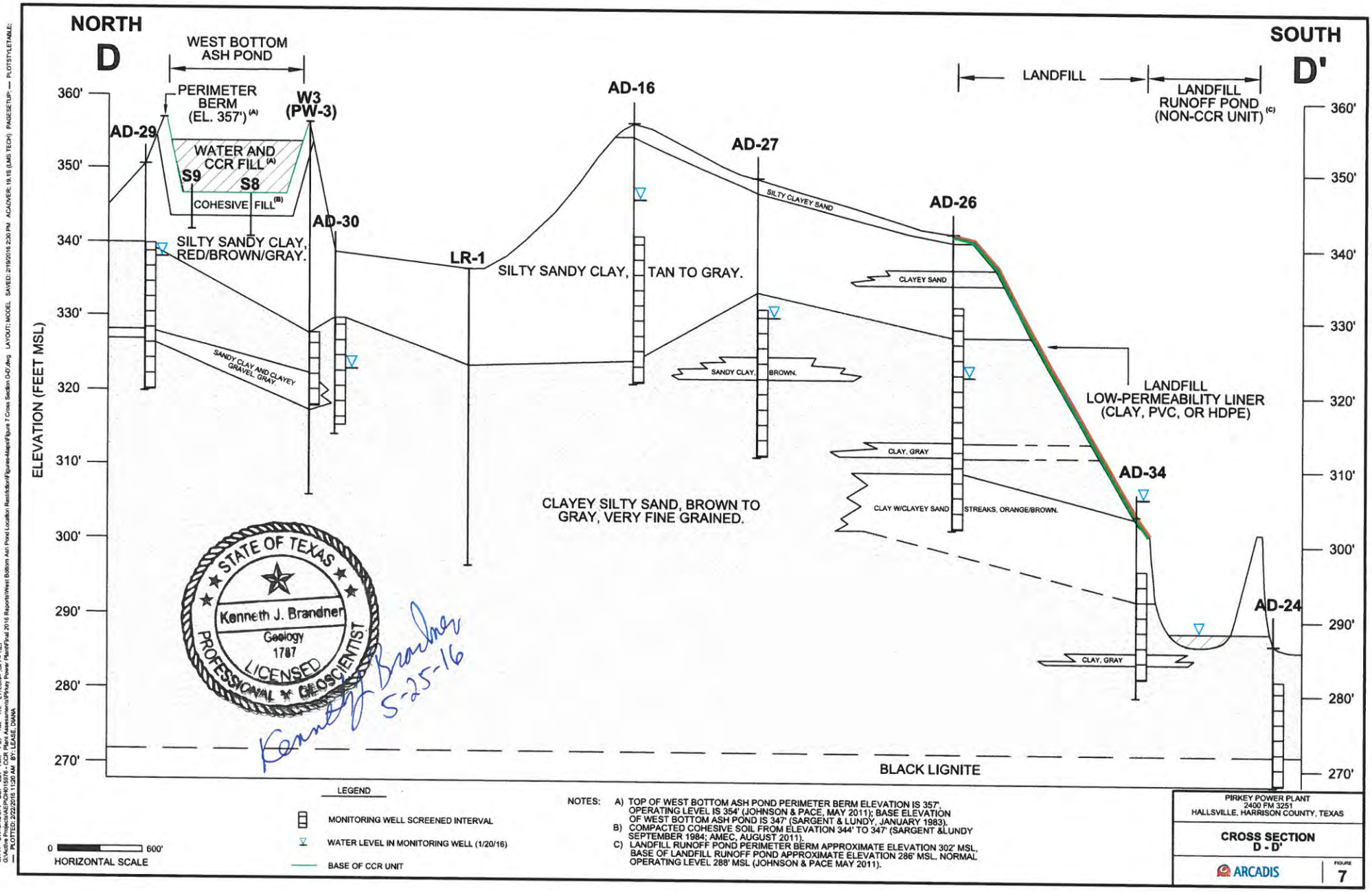
Kenneth J Brandner
5-25-16

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6



STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL GEOSCIENTIST

Kenneth J. Brandner 5-25-16

LEGEND

- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

0 600'
HORIZONTAL SCALE

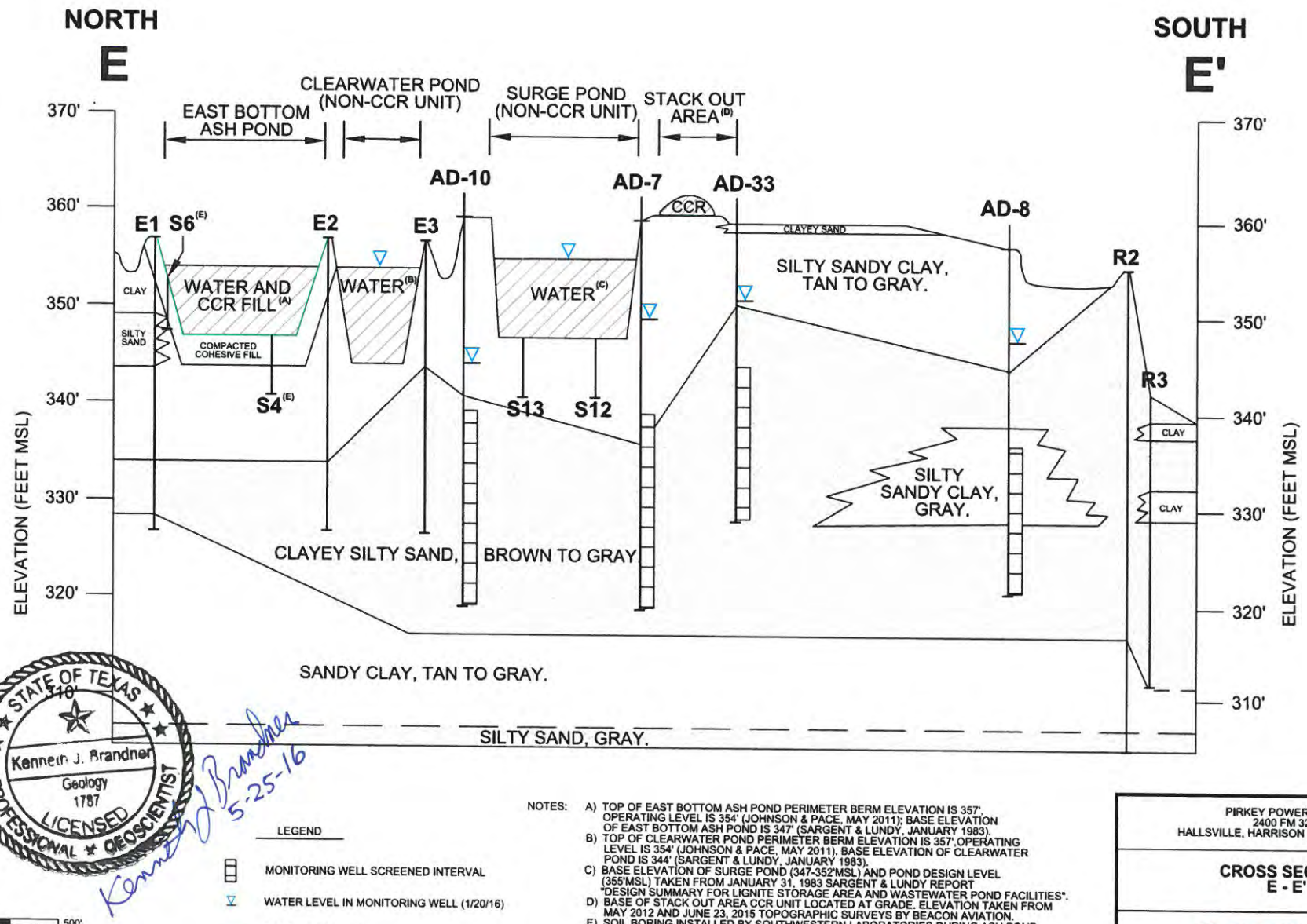
NOTES:
A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357'. OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).
C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL. BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION D - D'

ARCADIS

FIGURE 7



5-25-16

LEGEND

- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

0 500'
HORIZONTAL SCALE

NOTES:

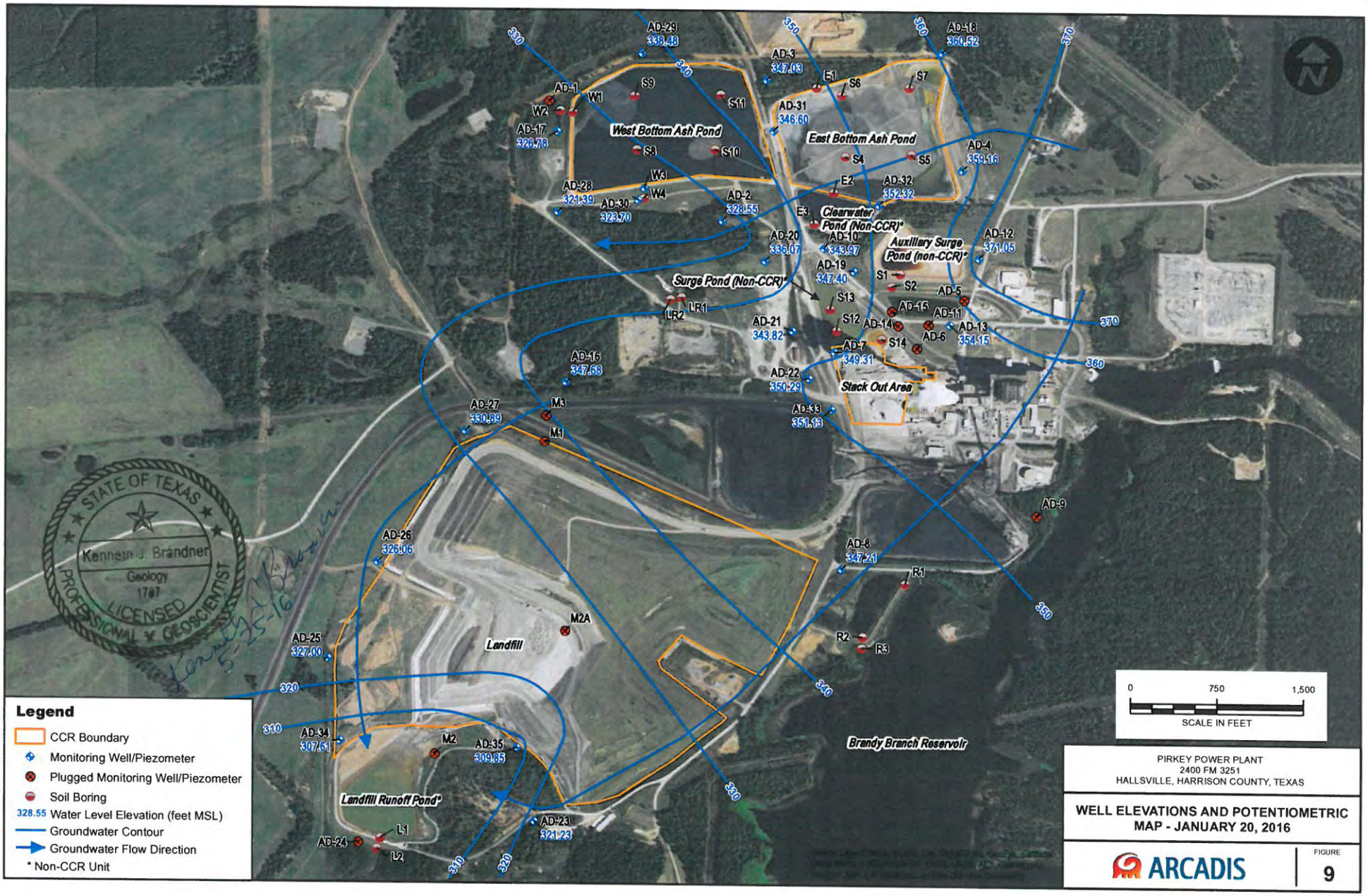
A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).
C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".
D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
8



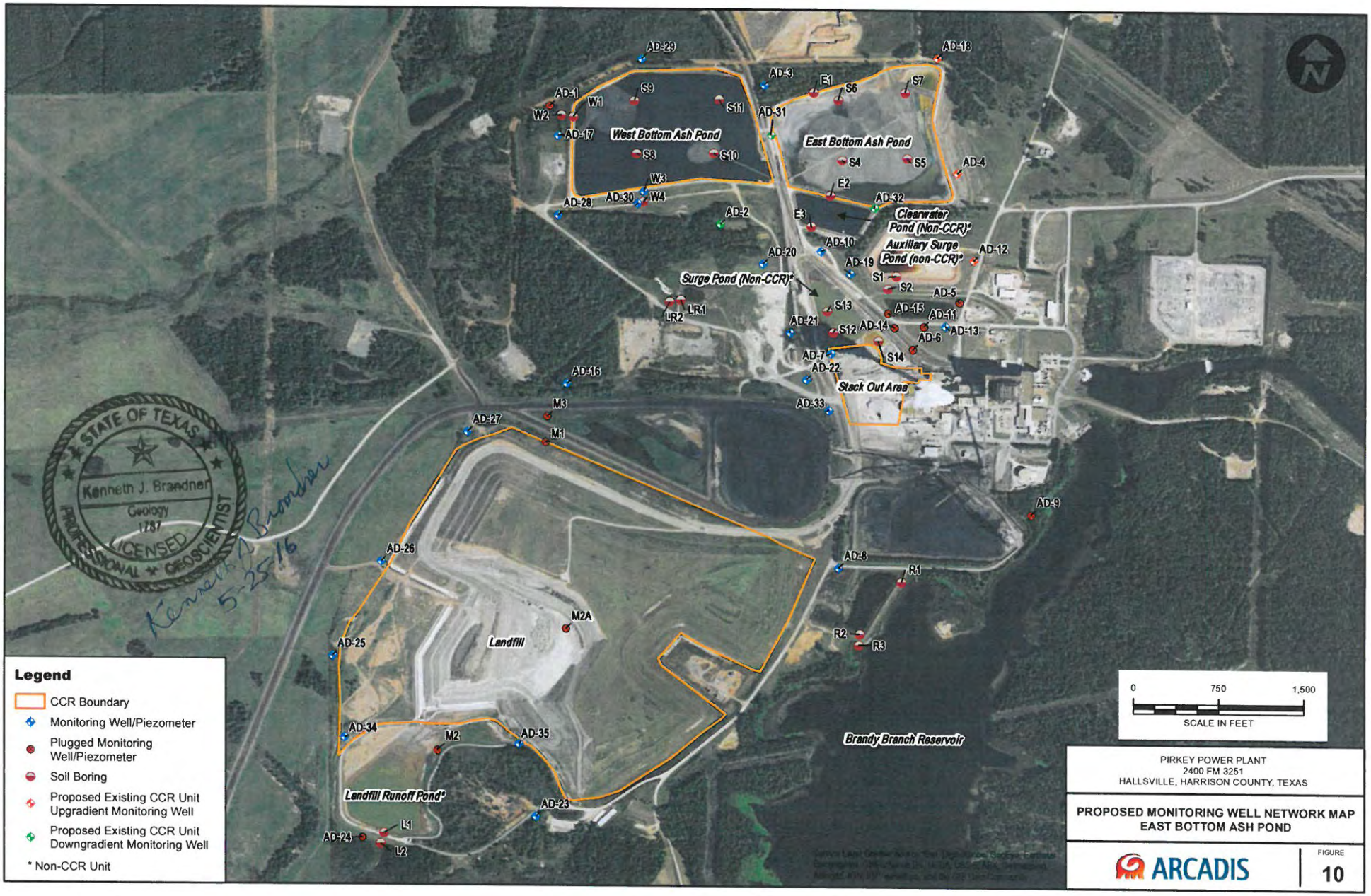
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

ARCADIS

FIGURE 9

Document Path: Z:\GIS\PROJECTS_ENVAEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



Legend

- CCR Boundary
- Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- Proposed Existing CCR Unit Upgradient Monitoring Well
- Proposed Existing CCR Unit Downgradient Monitoring Well

* Non-CCR Unit

STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL GEOSCIENTIST
Kenneth J Brandner 5-25-16

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP
EAST BOTTOM ASH POND

ARCADIS

FIGURE
10

Document Path: Z:\GIS\PROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 10 - Proposed Well Network - East Bottom Ash Pond.mxd

ARCADIS

Appendix A

Boring/Well Construction Logs

832964

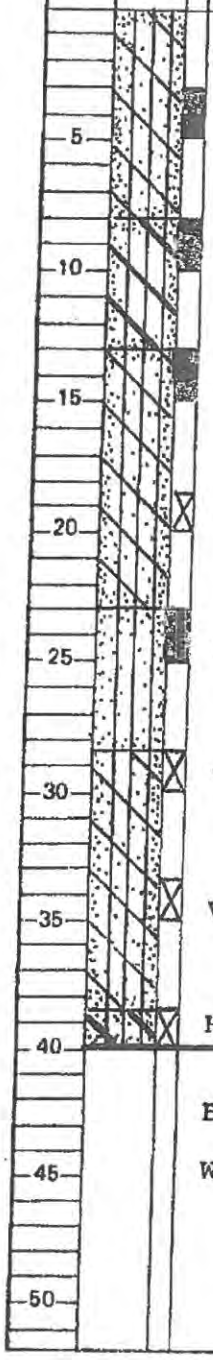
LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-2
LOCATION: Hallsville

Date: 10-7-83 Type: Auger Ground Elevation:

Legend: ■ Sample X Penetration ▼ Water



Description of Stratum
Firm tan clayey silty sand
Medium tan and grey very sandy silty clay
Dense tan and grey clayey silty sand
Dense tan clayey silty sand 10-15-16 31 B/F
Dense tan silty sand
Very dense grey clayey silty sand 15-35=12" 50 B/F
Very dense grey clayey silty sand 21-29=9" 50 B/9"
Hard grey sandy silty clay 20-30=12" 50 B/F
Bottom of boring at 40 feet.
Water encountered at 25 feet.

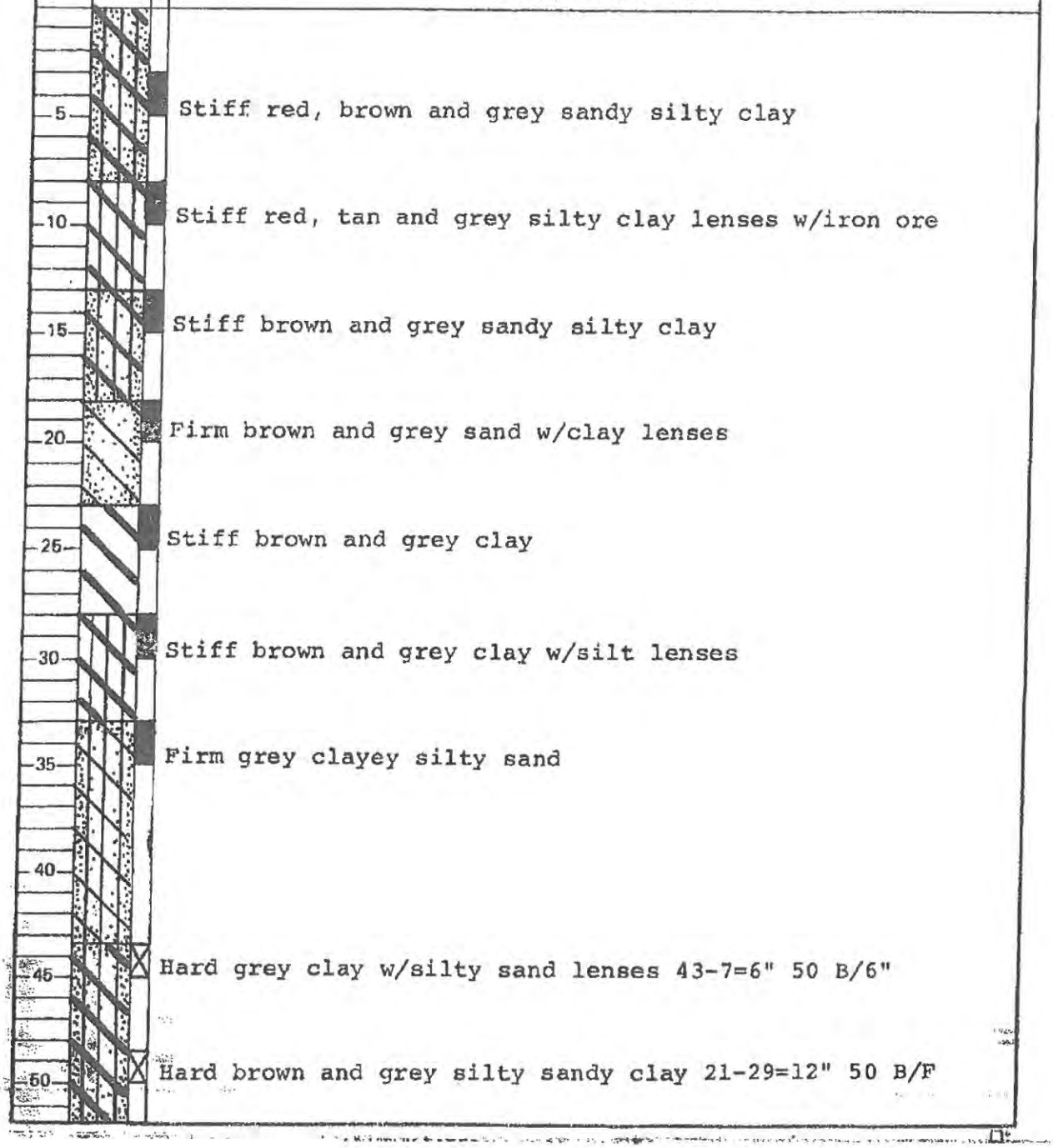
832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-3
LOCATION: Hallsville, TX

Date: 11-4-83 Type: Auger Ground Elevation:



Stiff red, brown and grey sandy silty clay

Stiff red, tan and grey silty clay lenses w/iron ore

Stiff brown and grey sandy silty clay

Firm brown and grey sand w/clay lenses

Stiff brown and grey clay

Stiff brown and grey clay w/silt lenses

Firm grey clayey silty sand

Hard grey clay w/silty sand lenses 43-7=6" 50 B/6"

Hard brown and grey silty sandy clay 21-29=12" 50 B/F

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-3
LOCATION: Hallsville, TX

Date: 11-4-83 Type: Auger Ground Elevation:

Legend: ■ Sample × Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
55		X	Hard grey silty sandy clay 28-22=10" 50 B/10"
			Bottom of boring at 57 feet.
			Water encountered at 42 feet.
60			
65			
70			
75			
80			
85			
90			
95			
100			

SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-4
LOCATION: Hallsville

Date: 10-10-83 Type: Auger Ground Elevation:

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
5			Stiff tan and grey silty sandy clay w/iron ore
10			Very stiff tan and grey clay
15			Very stiff tan and grey clay w/iron ore seam
20			Stiff tan and grey silty sandy clay lenses
25			Firm grey silty sand
30			Very dense grey silty sand 30-20=12" 50 B/F
35			Hard grey silty sandy clay 30-20=8" 50 B/8"
40			Hard grey silty sandy clay 25-25=8" 50 B/8"
45			Hard grey silty sandy clay 25-25=10½" 50 B/10½"
50			Bottom of boring at 46 feet.

832964

LOG OF BORING

PROJECT: Monitor Wells at Metal Cleaning Waste Pond BORING NO.: MW-12
CLIENT: Southwestern Electric Power Company LOCATION: Hallsville, TX

Date: 1/30/86 Type: Rotary N 6+13.25; W-6+90.36 Ground Elevation: 378.41

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
5			Brown and tan sandy clay
10			Brown, tan and gray sandy clay
15			Tan and gray sandy clay
20			Brown and tan sandy clay
25			Gray and tan sandy clay
30			Brown and gray clay
35			Brown and gray clay
40			Gray silty sand
45			Gray silty sand
50			Gray silty sand

Water encountered at 27.5 feet.
Bottom of Boring at 51 feet.

SOUTHWESTERN LABORATORIES

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ____ ■ MONITOR WELL MONITOR WELL NUMBER: AD-18

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 1/3/2011

PREPARED BY: Jeff Sammons LOGGED BY: Matt Lyon/Jeff Sammons

LATTITUDE: N 32°28.154' Datum: WGS-84 WELL LOCATION: Northeast of Bottom Ash Pond #1
LONGITUDE: W94°29.108'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1-7				0-7	SM	Sandy Silt, some clay, very fine grained, gray, light brown, light brownish red, yellowish brown	None	Dry
8-16				7-16	CL	Clay, some sand, light gray, reddish gray, stiff, yellowish brown -iron oxide fracture at 9.5'	None	Dry
						-increasing sand content at 14', thin lenses of iron-oxide cemented sand at 14.5', 15', 15.5', stiff		Moist
17-25			▽	16-25	SM	Silty sand, some clay, gray, yellowish brown, dense, abundant gypsum crystals, abundant iron oxide cemented sandstone	None	Moist to V. Moist
						gravel in layers, saturated 19-21'	None	Saturated
						-dark gray at 21'	None	
						-clayey at 21-23'		
						-greenish gray, trace clay, at 23'	None	
						-clay lense, hard, dry, (shale), at 24.5-25'	None	Dry
26-40						Boring Terminated at 25'		

Cement Bentonite Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 25 feet
Filter Sand (Size/Interval): 13-25'
Grout (Type/Interval): Grout from 0-2', Bentonite from 2-13'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-15'
Screen Interval: 15-25'
Water level:
3'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: AD-31

STATE OF TEXAS — JEFFREY D. SAMMONS — GEOLOGY #10070 — LICENSED PROFESSIONAL GEOSCIENTIST — 1-21-16

PROJECT INFORMATION

PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-04-1821
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/08/2015
DEVELOPMENT:	12/16/2015
SITE LOCATION:	3400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

DRILLING INFORMATION

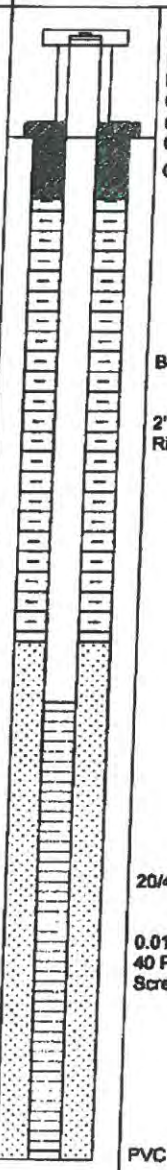
DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	60089
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	360.76 (Top of Casing)
HOLE DIAMETER:	8.25"
LATITUDE	32 28' 2.48"
LONGITUDE	94 29' 20.90"

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	DEPTH	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
SANDY CLAY AND GRAVEL: dark reddish brown, moist	CH	0						
FAT CLAY WITH SAND: some laminations of very fine to fine sand, reddish brown and light gray	CH	2–4		22	81	51	15	36
FAT CLAY: some silt with trace very fine to fine sand laminations, reddish brown, yellowish brown and light gray	CH	6–11						
- light gray with laminations of light reddish brown silt and very fine sand at 11'		11–12	▼	28	95	68	31	37
CLAYEY SAND: very fine to fine sand, light reddish brown and light gray, very moist to saturated	SC	13–18	▽					
- dark gray and gray clay with thin seams of light reddish brown very fine sand at 22' to 23'		20–21		26	44	36	21	15
SILTY SAND: fine to very fine sand, some clay lenses and thin layers of partially cemented sandstone, gray and dark gray with light reddish brown, very moist to saturated - dark gray and reddiswh brown at 29', saturated - trace clay, light brown at 30'	SM	28–32		24	5	24	NP	
CLAYEY SAND: very fine sand, dark gray, very moist to saturated	SC	32–36						

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

Hydrox ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: AD-32

PROJECT INFORMATION

PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-04-1021
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/11/2015
DEVELOPMENT:	12/16/2015
SITE LOCATION:	2400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

DRILLING INFORMATION

DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	60089
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	359.18 (Top of Casing)
HOLE DIAMETER:	8.25"
LATITUDE	32 27' 58.20" LONGITUDE 94 29' 11.88"

STATE OF TEXAS — JEFFREY D. SAMMONS — GEOLOGY #10070 — LICENSED PROFESSIONAL GEOSCIENTIST — JDS 1-21-16

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

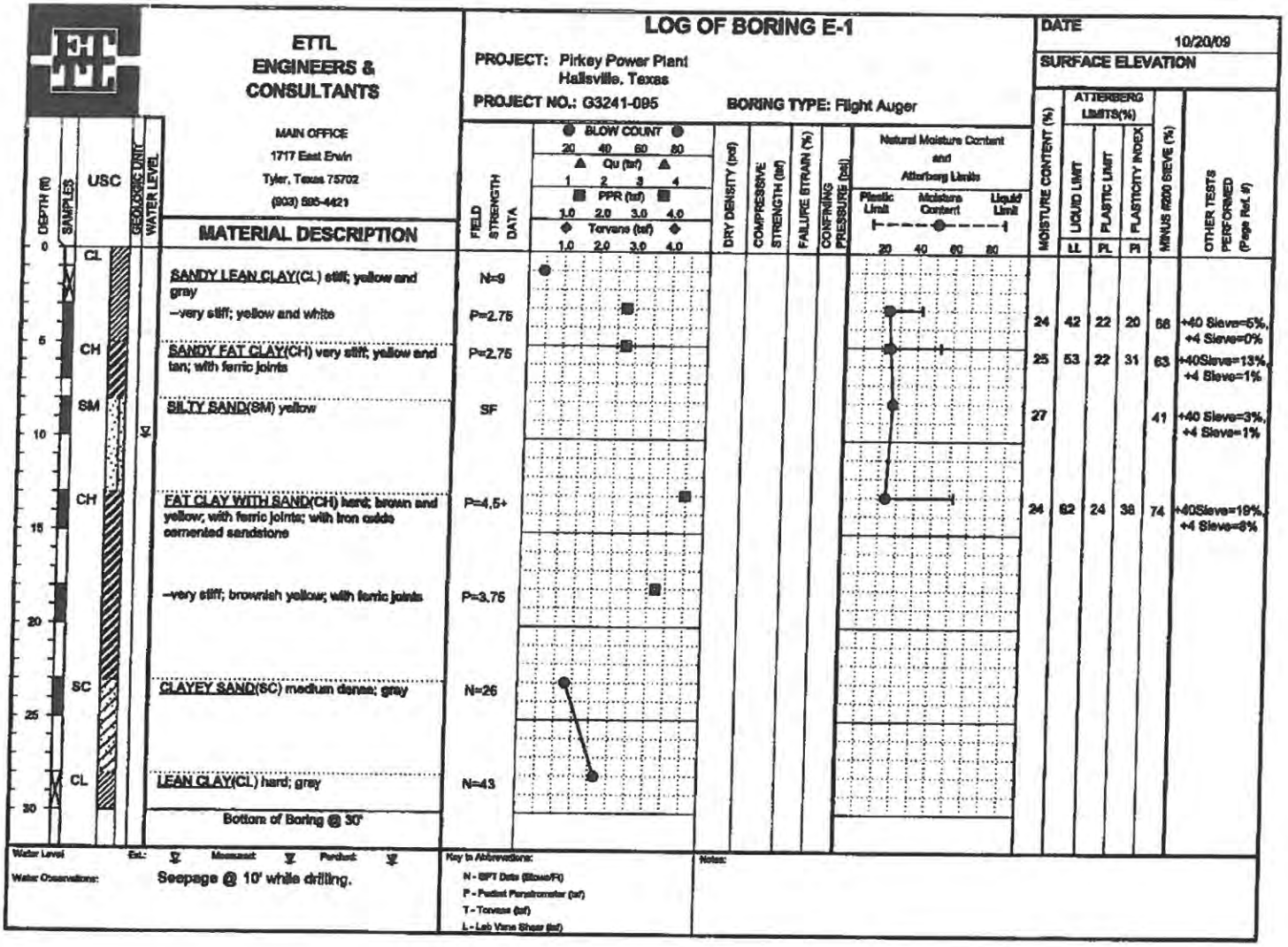
TBPG No. 50027

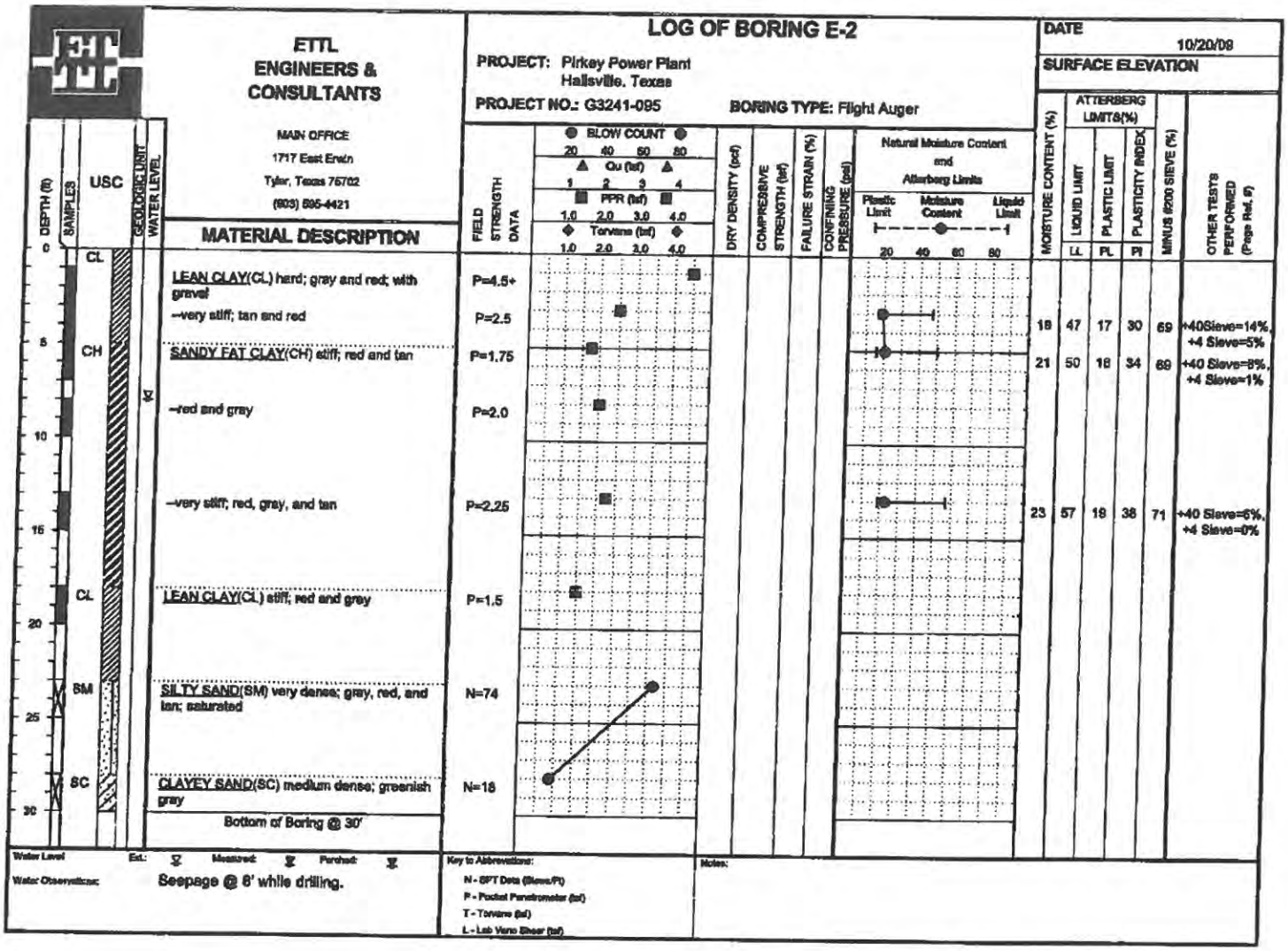
DESCRIPTION	USCS	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, dark reddish brown, moist - interbeds of sand and clay, yellowish brown and light gray at 1' - reddish brown and light gray at 2' - light gray and yellowish brown at 4', - grayish brown and light gray at 6' - grayish brown, light gray, and reddish brown at 7'	SC	25	46	35	22	13	
		26	44	37	20	17	
SANDY LEAN CLAY: some gravel seams and thin interbeds of cemented sand, light yellowish brown and light gray, moist to saturated within gravel seams - some iron ore gravel at 16', very moist to saturated	CL	28	54	37	22	15	
SILTY SAND: very fine to fine sand, trace clay, brownish gray and dark brownish gray, saturated - reddish brown and brown at 20'	SM						
SANDY LEAN CLAY: gray and dark gray, very moist	CL	26	51	37	24	13	
CLAYEY SAND: fine to very fine sand, gray and dark gray, very moist to saturated	SC	26	47	41	22	19	
SANDY LEAN CLAY: gray and dark gray, very moist	CL	26	59	35	21	14	

WELL CONSTRUCTION

- Locking Well Casing Cover
- Locking Well Cap
- Protective Well Casing
- Concrete Pad
- Ground Surface
- Cement
- Bentonite
- 2" Sch. 40 PVC Riser
- 20/40 Silica Sand
- 0.010" Slotted Sch. 40 PVC Well Screen
- PVC Bottom Cap

NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.


ETTL
ENGINEERS & CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421
LOG OF BORING E-1
PROJECT: Pirkey Power Plant
Hallsville, Texas
PROJECT NO.: G3241-095
BORING TYPE: Flight Auger
DATE 10/20/09
SURFACE ELEVATION
DEPTH (ft)
SAMPLES
USC
GEOLOGIC UNIT
WATER LEVEL
MATERIAL DESCRIPTION
FIELD STRENGTH DATA
BLOW COUNT
Qu (tsf)
PPR (tsf)
Torvane (tsf)
DRY DENSITY (pcf)
COMPRESSIVE STRENGTH (tsf)
FAILURE STRAIN (%)
CONFINING PRESSURE (tsf)
Natural Moisture Content and Atterberg Limits
Plastic Limit
Moisture Content
Liquid Limit
MOISTURE CONTENT (%)
ATTERBERG LIMITS(%)
LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
MINUS #200 SIEVE (%)
OTHER TESTS PERFORMED (Page Ref. #)
LL
PL
PI
0
5
10
15
20
25
30
CL
CH
SM
CH
SC
CL
SANDY LEAN CLAY(CL) stiff; yellow and gray
--very stiff; yellow and white
SANDY FAT CLAY(CH) very stiff; yellow and tan; with ferric joints
SILTY SAND(SM) yellow
FAT CLAY WITH SAND(CH) hard; brown and yellow; with ferric joints; with iron oxide cemented sandstone
--very stiff; brownish yellow; with ferric joints
CLAYEY SAND(SC) medium dense; gray
LEAN CLAY(CL) hard; gray
Bottom of Boring @ 30'
N=9
P=2.75
P=2.75
SF
P=4.5+
P=3.75
N=26
N=43
24 42 22 20 56 +40 Sieve=5%, +4 Sieve=0%
25 53 22 31 63 +40Sieve=13%, +4 Sieve=1%
27 41 +40 Sieve=3%, +4 Sieve=1%
24 62 24 38 74 +40Sieve=19%, +4 Sieve=8%
Water Level
Est.:
Measured:
Perched:
Water Observations:
Seepage @ 10' while drilling.
Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Notes:



ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING E-2

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/20/09

SURFACE ELEVATION:

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		CL			LEAN CLAY(CL) hard; gray and red; with gravel	P=4.5+										
					--very stiff; tan and red	P=2.5					18	47	17	30	69	+40Sieve=14%, +4 Sieve=5%
5		CH			SANDY FAT CLAY(CH) stiff; red and tan	P=1.75					21	50	18	34	69	+40 Sieve=8%, +4 Sieve=1%
					--red and gray	P=2.0										
10																
					--very stiff; red, gray, and tan	P=2.25					23	57	19	38	71	+40 Sieve=6%, +4 Sieve=0%
15																
		CL			LEAN CLAY(CL) stiff; red and gray	P=1.5										
20																
		SM			SILTY SAND(SM) very dense; gray, red, and tan; saturated	N=74										
25																
		SC			CLAYEY SAND(SC) medium dense; greenish gray	N=18										
30					Bottom of Boring @ 30'											

Water Level — Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 6' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-4
LOCATION: Hallsville,TX

Date: 9-14-83 Type: Ground Elevation: 347.3

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
5			Red and grey sandy silty clay Red and grey sandy silty clay Red and grey sandy silty clay w/iron ore
10			Bottom of boring at 6 feet. No water encountered.
15			
20			
25			
30			
35			
40			
45			
50			

SOUTHWESTERN LABORATORIES

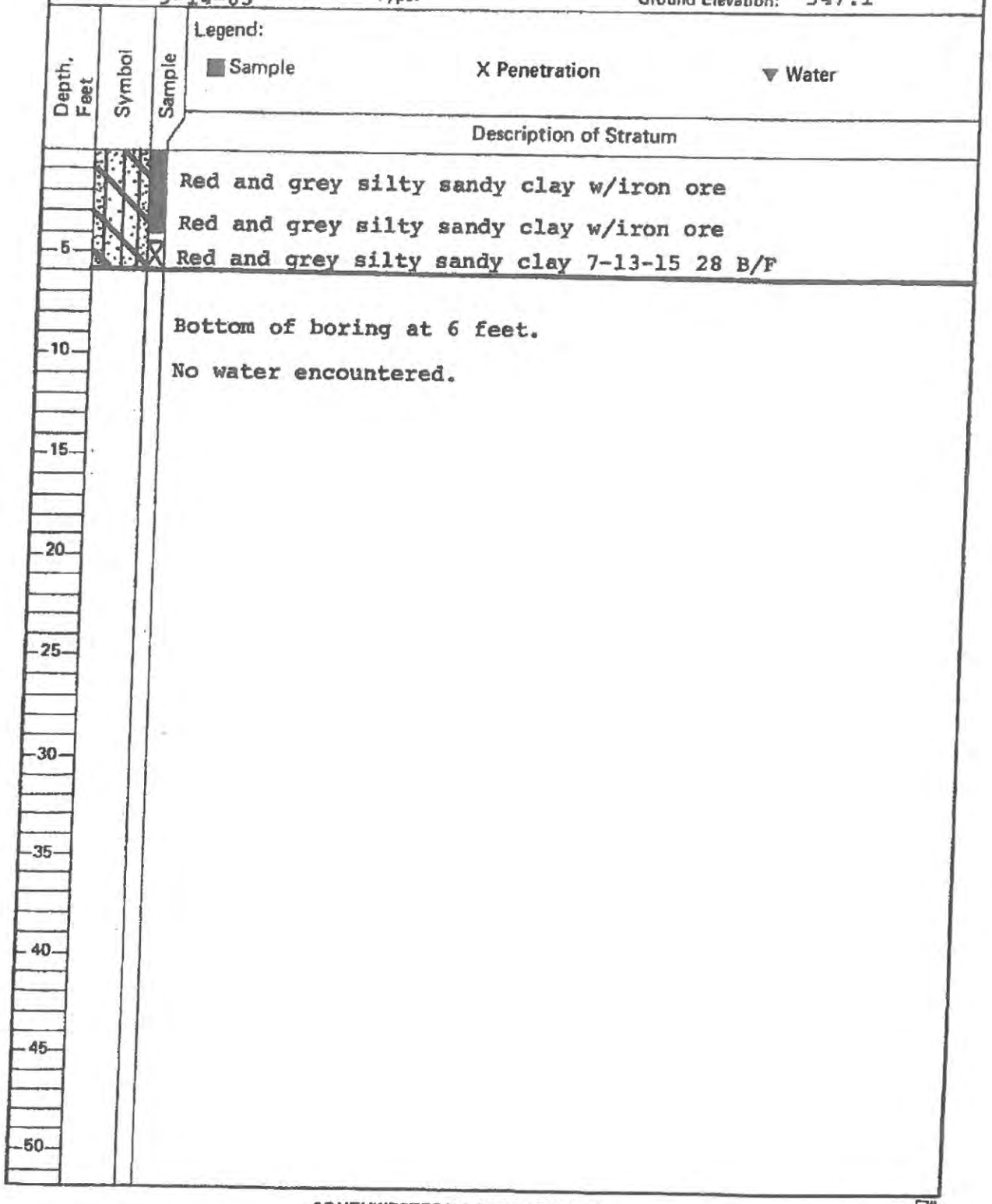
832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-5
LOCATION: Hallsville, TX

Date: 9-14-83 Type: Ground Elevation: 347.1



SOUTHWESTERN LABORATORIES

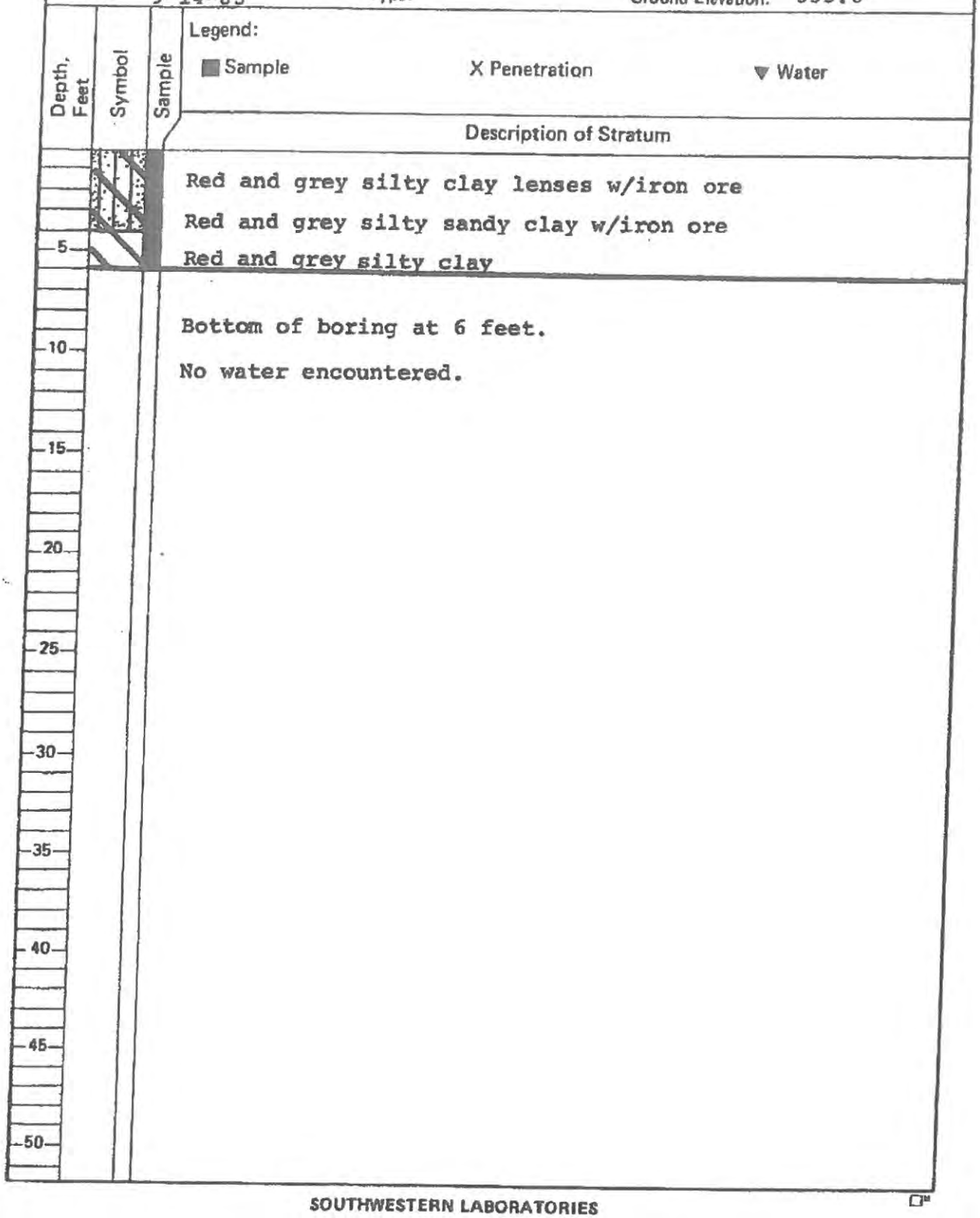
832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-6
LOCATION: Hallsville, TX

Date: 9-14-83 Type: Ground Elevation: 353.6



SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-7
LOCATION: Hallsville, TX

Date: 9-14-83 Type: Ground Elevation: 346.9

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
			Red, brown and grey silty clay
			Red, brown and grey silty clay w/silt lenses and iron ore
5			Red, brown and grey silty sandy clay
			Bottom of boring at 6 feet.
			No water encountered.
10			
15			
20			
25			
30			
35			
40			
45			
50			

SOUTHWESTERN LABORATORIES

ARCADIS

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
1	8/19/2015

Direction Photo Taken:

South

Description:

P8190374
Vegetative strip adjacent to East Ash Pond. Under new rule this potential wetland is likely non-jurisdictional.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
2	8/19/2015

Direction Photo Taken:

Description:

P8190372
AD- 4 Ground water monitoring well. East Bottom Ash Pond embankment in background.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
3	8/19/2015

Direction Photo Taken:

South

Description:

P8190378
View across East and West Botton Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
4	8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190379
Road side ditch, not considered a wetland, due to lack of hydric vegetation and connectivity.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
5	8/19/2015

Direction Photo Taken:

North

Description:

P8190380
AD-18 Ground water monitoring well.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
6	8/19/2015

Direction Photo Taken:

North

Description:

P8190381
AD-18 Ground water monitoring well.

ARCADIS
Infrastructure · Water · Environment · Buildings

Imagine the result

American Electric Power Service Corporation

West Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

May 25, 2016

ARCADIS

Kenneth Brandner, P.E., P.G.
Senior Project Engineer

Matthew J. Lamb
Project Manager

John Holm, P.E.
Professional Engineer

West Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Prepared for:
AEP

Prepared by:
ARCADIS U.S., Inc.
100 E Campus View Blvd
Suite 200
Columbus
Ohio 43235-1447
Tel 614 985 9100
Fax 614 985 9170

Our Ref.:
OH015976.0010

Date:
May 25, 2016

ARCADIS

Table of Contents

Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
PTI	Permit to Install
TDS	total dissolved solids

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the adequacy of the groundwater monitoring well network included in the Coal Combustion Residual (CCR) requirements, as specified in Code of Federal Regulations (CFR) 40 CFR 257.91, for the West Bottom Ash Pond (BAP) CCR Unit at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above and isolated from the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zone, or in an unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report summarizes the evaluation of the groundwater monitoring well network in the uppermost aquifer at the West BAP (Site). The evaluation of the location restriction criteria is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the West BAP CCR unit, as well as publically-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on all documents reviewed and will further describe the uppermost aquifer, include an evaluation of the adequacy of the existing monitoring well network, and provide recommendations for monitoring well augmentation, as necessary.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant West BAP.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The West BAP CCR unit is located at the north end of the Plant and approximately 3,000 feet northwest of Brandy Branch Reservoir (**Figures 1** and **2**).

2.2 Description of West BAP CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the West BAP.

2.2.1 Embankment Configuration

The West BAP embankments have a maximum height of approximately 25 feet and are constructed of compacted clay on a slope ranging from 2.5:1 (2.5 feet horizontal, 1 foot vertical) to 3:1 (Sargent & Lundy, 1983). The elevation at the top of the embankment around the perimeter of the West BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, 2011). The interior bottom elevation of the West BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Akron Consulting, 2012).

2.2.2 Area/Volume

The West BAP is approximately 30.9 acres in size. The design maximum ash storage capacity of the West BAP is 188 acre feet at an elevation of 354 feet amsl (normal operating level) and 216.5 acre feet at an elevation of 355 feet amsl (maximum operating level) (Sargent & Lundy, 1983; Akron Consulting, 2012).

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash,

economizer ash, flue gas desulfurization sludge) have been generated. The West BAP, which was placed into operation in 1985, receives bottom ash and economizer ash sluiced from the power plant boiler (**Figure 3**). Clear water overflow from the West BAP discharges into the Clearwater Pond located southeast of the West BAP. Bottom ash and economizer ash are periodically excavated from the West BAP and hauled by truck to either the on-site landfill for disposal, or sold for offsite beneficial re-use.

The base of the West BAP was constructed in 1983 with a compacted clay liner (Sargent & Lundy, 1983). Following installation of the compacted clay liner, soil borings S-8 through S-11 were advanced below the base of the West BAP to total depths of six feet in September 1983 (Southwestern Laboratories, 1984). The lithologic data from soil borings S-8 through S-11 confirm at least six feet of clay is present below the base of the West BAP (Sargent & Lundy, 1984).

2.2.4 Surface Water Control

Surface water elevation in the West BAP is controlled by a weir box and a manually operated gate valve on a 36-inch-diameter discharge pipe at the southeast corner of the pond. Clear water overflow from the West BAP discharges through the 36-inch-diameter pipe into the 2.7-acre Clearwater Pond located southeast of the West BAP (Figure 3). Water in the Clearwater Pond is pumped (re-circulated) back into the boiler ash hopper.

2.3 Previous Investigations

The initial soils investigation and design of the West BAP was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, and design of the West BAP. As discussed above in Section 2.2.3, the design included installation of a clay liner below the West BAP.

In September-October 1983, Southwestern Laboratories conducted a soil investigation at the Plant, including advancement of four soil borings (S-8 through S-11) below the West BAP (Southwestern Laboratories, 1984).

In 1984, Sargent & Lundy conducted an evaluation of the West BAP. This report included evaluation of soil sample geotechnical data, and concluded a low-permeability clay liner was present below the West BAP (Sargent & Lundy, 1984).

In 2009, ETTL Engineers & Consultants (ETTL) conducted a geotechnical investigation of the West BAP earthen embankment. The investigation included installation of two soil borings through the embankment (W1, W3) and two soil borings along the outer toe of the embankment (W2, W4), completion of soil borings W1 and W3 as piezometers PW-1 and PW-3, respectively, and collection of soil samples for geotechnical analyses. The report concluded the embankment was stable and the existing embankment slopes were acceptable if conditions are maintained (ETTL, 2010). The conditions to be maintained included embankment protection from erosion (vegetative cover), removal of brush and trees two feet or more in height, and control of animal burrowing.

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, 2011).

In 2011, Johnson & Pace performed a hydraulic analysis of the West BAP for a 10-year, 24-hour rainfall event in accordance with the TCEQ TPDES permit design criteria. The report concluded the storage capacity of the West BAP is hydraulically adequate (Johnson & Pace, 2011).

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of six monitoring wells (AD-30 through AD-35) (Auckland Consulting, 2016).

2.4 Hydrogeologic Setting

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of approximately 100 feet (Broom, 1966).

These features are further illustrated on five lines of cross section that were prepared through the West BAP area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A') through **Figure 8** (E-E').

2.4.1 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1° Fahrenheit (F) in January to 83.8°F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.2 Regional and Local Geologic Setting

The central and northern portions of the Plant, including the West BAP, are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

Figure 9 is a potentiometric surface map based on January 2016 water level data for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figure 9**, shallow

groundwater flow direction in the area of the West BAP is west-southwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The West BAP is located approximately 3,000 feet northwest of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figure 9**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow groundwater in the area of the West BAP does not discharge into Brandy Branch Reservoir.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled approximately 500 feet southeast (side gradient) of the West BAP in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 350 to 430 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled approximately ¼-mile south (side gradient) of the West BAP for NFR Energy in 2008 for use as a rig supply well. The water well was screened from 250 to 310 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (up gradient) of the Pirkey Power Plant.

3. Groundwater Monitoring Well Network Evaluation

The existing monitoring well network present at the Site was evaluated to determine if any of the wells were viable for continued use as part of the groundwater monitoring well network or also retained as part of a larger groundwater hydraulic monitoring well

network. The hydrogeologic conditions were also evaluated to determine if the uppermost aquifer unit has an effective well network. The evaluation was completed in accordance with 40 CFR 257.91 to have an established monitoring well network that effectively monitors the uppermost aquifer up gradient and down gradient of the Site. The up gradient wells represent background groundwater quality and the down gradient wells are to be located down gradient of the CCR unit boundary to monitor water quality.

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost aquifer in the area of the West BAP is a very fine to fine grained clayey and silty sand stratum with an average thickness of approximately 15 feet that is located between an elevation of approximately 325 and 340 feet amsl (**Appendix A**). The base of the West BAP is at an elevation of 347 feet amsl. Therefore the separation distance between the uppermost aquifer and the base of the West BAP is approximately seven feet. This separation distance is further illustrated on cross section A-A' (**Figure 4)** and cross section D-D' (**Figure 7)**.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness (approximately 15 feet), the yield of the uppermost aquifer is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Available groundwater elevations are summarized on **Table 1** for 2011 through 2016. The most recent comprehensive groundwater data set from January 20, 2016 is depicted on **Figure 9**. The groundwater flow is west-southwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

Per 40 CFR 257.60(a), new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five ft) above the upper limit of the uppermost aquifer, or must demonstrate there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high conditions).

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as 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 groundwater surface to which the aquifer rises during the wet season.

3.2.1.1 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the area of the West BAP is the clayey and silty sand stratum that is located between an elevation of approximately 325 and 340 feet amsl.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 19, 2015 to review existing well network conditions and locations. A well construction table that

summarizes the location, ground surface elevation, borehole depth, installation date, and associated well construction details of the monitoring well network is included as **Table 2**. Photo documentation of the located wells during the August 19, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-3, AD-12, AD-17, AD-18, AD-28, and AD-29 were previously installed at the Site to monitor the uppermost aquifer (clayey and silty sand stratum) associated with the West BAP. As discussed above in Section 3.1.1, the uppermost aquifer below the West BAP is approximately 15 feet thick and is located between an elevation of approximately 325 and 340 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on Geologic Cross Section A-A' (**Figure 4**), existing monitoring well AD-3 is screened in the uppermost aquifer upgradient (east) of the West BAP, and existing monitoring well AD-17 is screened in the uppermost aquifer downgradient (west) of the West BAP. Existing monitoring wells AD-3, AD-12 and AD-18 (also located east of the West BAP) will be utilized as upgradient monitoring wells for the West BAP. Existing monitoring wells AD-17 and AD-28 (also located west of the West BAP) will be utilized as downgradient monitoring wells for the West BAP.

As shown on **Figure 9**, shallow groundwater flow direction in the area of the West BAP is west-southwesterly. Two existing monitoring wells (AD-17, AD-28) were located hydraulically downgradient of the West BAP during the August 19, 2015 site visit, and three downgradient monitoring wells are required to monitor groundwater quality downgradient of a CCR unit. This data gap was addressed by installation of new downgradient monitoring well AD-30 along the south central side of the West BAP during December 2015 as shown on **Figure 9** and **10**. With the addition of monitoring well AD-30, there are no gaps remaining in the groundwater monitoring network for the West BAP.

4. Recommended Monitoring Network and PE Certification

The recommended existing groundwater monitoring well network is intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the West BAP (up gradient or down gradient), well depth, and well construction. The recommended network would provide an improved understanding of groundwater quality, hydraulics, and groundwater flow at the West BAP.

4.1 Recommended Monitoring Well Network Distribution

Three up gradient well locations (existing monitoring wells AD-3, AD-12, and AD-18) and three down gradient well locations (existing monitoring wells AD-17, AD-28, and AD-30) are recommended to establish a groundwater quality monitoring well network for the West BAP. In addition, existing side gradient monitoring well AD-29 may be utilized as a piezometer to obtain additional groundwater flow direction and gradient data for the West BAP.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the West BAP is summarized on **Table 3** and illustrated on **Figure 10.**

4.1.2 Depth

The screen depths for the monitoring wells recommended for inclusion in the monitoring well network are within the shallow saturated sand stratum (uppermost aquifer) that occurs between an elevation of approximately 325 and 340 feet amsl as shown on Geologic Cross Sections A-A' (**Figure 4**) and D-D' (**Figure 7**). The screen elevations are presented in **Table 3**.

4.1.3 Well Construction

As discussed above in Section 3.3.2, the gap in the monitoring well network for the uppermost aquifer at the West BAP was addressed by installation of monitoring well AD-30 during December 2015. Monitoring well AD-30 was installed by a Texas Department of Licensing and Regulation (TDLR)-licensed water well driller. Well construction data for the monitoring well network are summarized on **Tables 2** and **3**, and the monitoring well completion diagrams are provided in **Appendix A**.

4.2 Professional Engineer's Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, the proposed groundwater monitoring system will be adequate to meet the requirements of 40 CFR Part 257.91.

Kenneth J. Brandner
Printed Name of Registered Professional Engineer

Kenneth J Brandner
Signature

69586	Texas	5-25-16
Registration No.	Registration State	Date

5. References

Akron Consulting, LLC, "West BAP August 2012 As-Built Plan & Profile", August 2012.

AMEC, "Report of Dam Safety Assessment of Coal Combustion Surface Impoundments, American Electric Power (AEP) and Southwest Electric Power Company (SWEPCO) H.W. Pirkey Power Plant, Hallsville, TX", August 2011.

Apex Geoscience Inc., "USWAG Monitoring Wells and Groundwater Evaluation, AEP Pirkey Power Station, Hallsville, Texas", March 2011.

Auckland Consulting LLC, "Monitoring Well Installation – 2015, Pirkey Generating Station, Hallsville, Texas", January 26, 2016.

Banks Information Solutions, "Water Well Report, Pirkey Power Plant, 2400 FM 3251, Hallsville, Texas, Harrison County", October 8, 2015.

Broom, M.E., and B. N. Myers, "Ground-Water Resources of Harrison County, Texas", Texas Water Development Board Report 27, August 1966.

ETTL Engineers & Consultants Inc., "Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas", October 2010.

Fetter, C.W., "Applied Hydrogeology", University of Wisconsin – Oshkosh, 1980.

Flawn, Peter T., "Geologic Atlas of Texas, Tyler Sheet", The University of Texas at Austin Bureau of Economic Geology, March 1965.

George, Peter G., et. al., "Aquifers of Texas", Texas Water Development Board Report 380, July 2011.

Johnson & Pace Incorporated, "Hydrology & Hydraulic Report, North Surge Pond, East & West Ash Ponds, Secondary Ash Pond, Landfill Pond, H.W. Pirkey Power Plant, Hallsville, Texas", May 2011.

Sargent & Lundy, "Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities", January 31, 1983.

Sargent & Lundy, "Henry W. Pirkey Power Plant Unit 1, Wastewater Ponds – Liner Verification & Monitoring Wells", September 14, 1984.

Southwestern Laboratories, "Subsurface Exploration, Waste Water Ponds, Pirkey Power Plant, Hallsville, Texas", September 7, 1984.

Texas Commission on Environmental Quality, "Groundwater Classification, RG-366/TRRP-8", March 2010.

USGS, Aquifers and Groundwater. 2015. Available online at www.usgs.gov.

USGS, "Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin", Open-File Report 88-450K, 1988.

USGS, "Texas Seismic Hazard Map", 2014.

ARCADIS

Tables

ARCADIS

Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[a]	Top of Casing Elevation[a]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen[b]		Bottom of Screen[b]		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																					
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48
AD-30[d]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70
AD-31[d]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60
AD-32[d]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32
AD-33[d]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13
AD-34[d]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61
AD-35[d]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85
Piezometers[c]																					
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	NM	NM	NM	NM	NM	NM	NM	NM	NM

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
NM - Not Measured

ARCADIS

Table 2
Well Construction Details
AEP Pirkey Power Plant - CCR Units
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[a]	Top of Casing Elevation[a]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen[b]		Bottom of Screen[b]	
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
Monitoring Wells																
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	18	323	40	301	20	321.25	40	301.25
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	35	338	57	316	37	335.76	57	315.76
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	24	340	46	318	26	337.69	46	317.69
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	18	342	40	320	20	339.61	40	319.61
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	18	339	35	322	20	336.92	35	321.92
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	18	341	40	319	20	339.48	40	319.48
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	29	350	51	328	31	347.84	51	327.84
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	17.5	344.5	40.5	321.5	30.5	331.48	40.5	321.48
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	13	344	35	322	15.0	341.81	35.0	321.81
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	8	335	30	313	10.0	332.65	30.0	312.65
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	13	347	25	335	15.0	345.48	25.0	335.48
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	8	352	30	330	10.0	349.50	30.0	329.50
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	13	339	35	317	15.0	337.30	35.0	317.30
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	8	339	30	317	10.0	337.23	30.0	317.23
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	8	348	30	326	10.0	345.57	30.0	325.57
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	13	334	35	312	15.0	331.72	35.0	311.72
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	3	285	20	268	5.0	282.68	20.0	267.68
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	8	326	30	304	10.0	324.15	30.0	304.15
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	8	334	40	302	10.0	332.41	40.0	302.41
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	15.5	334.3	37.5	312.3	17.5	332.33	37.5	312.33
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	13	323	35	301	15.0	320.92	35.0	300.92
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	8	342	30	320	10.0	340.21	30.0	320.21
AD-30[d]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	8	331	25	314	10.0	329.04	25.0	314.04
AD-31[d]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	18	340	35	323	20.0	337.75	35.0	322.75
AD-32[d]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	11	346	33	324	13.0	344.23	33.0	324.23
AD-33[d]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	12	347	30	329	15.0	344.30	30.0	329.30
AD-34[d]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	8	297	25	280	10.0	294.64	25.0	279.64
AD-35[d]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	2.5	313.5	20	296	3.0	313.01	18.0	298.01
Piezometers[c]																
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	26	330	38	318	28.0	328.30	38.0	318.30

General Note:
Elevations in feet above mean sea level.

Footnotes:
(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011). Top of sand pack estimated 2 feet above top of screened interval.
(c) Souce: EETL (October 2010).
(d) Source: Aukland Consulting LLC (January 26, 2016).
Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

Table 3
Proposed Well Network
AEP Pirkey Power Plant - West Bottom Ash Pond
Hallsville, Harrison County, Texas

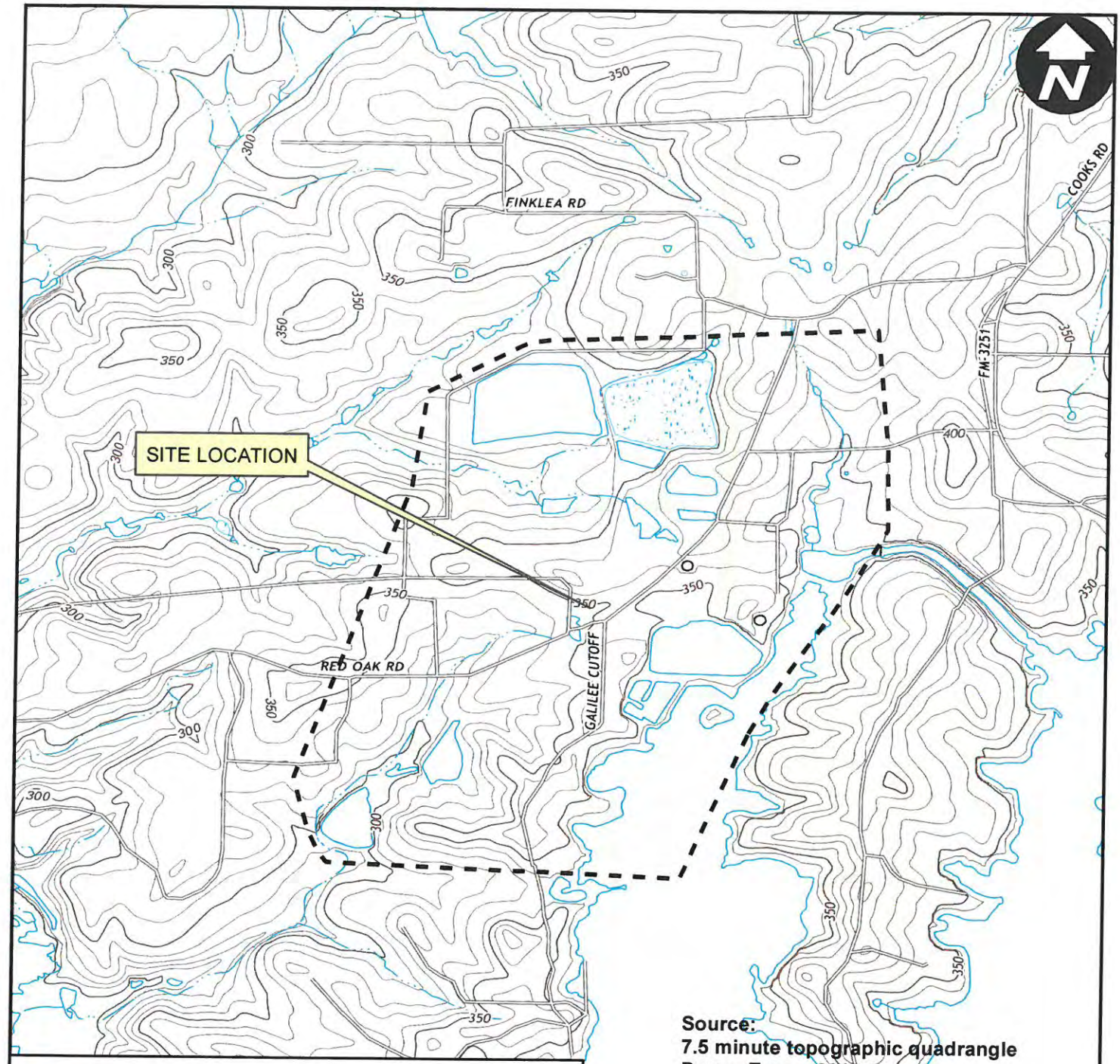
Well ID	Exisiting/ Proposed	Hydrostratigraphic Unit Target	Location Description		Screen Top Target Elevation[(a)] (ft amsl)	Screen Bottom Target Elevation[(a)] (ft amsl)	Screen Length (ft)	Comments
Upgradient								
AD-3	Exisiting	Uppermost Water-Bearing Unit	East of West Bottom Ash Pond	Upgradient	335.8	315.8	20	Existing well installed in 1983; well will be utilitzed to establish backgroud water quality
AD-12	Exisiting	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilitzed to establish backgroud water quality
AD-18	Exisiting	Uppermost Water-Bearing Unit	East of West Bottom Ash Pond	Upgradient	345.5	335.5	10	Existing well installed in 2011; well will be utilitzed to establish backgroud water quality
Downgradient								
AD-17	Existing	Uppermost Water-Bearing Unit	West of West Bottom Ash Pond	Down gradient	332.7	312.7	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to the West Bottom Ash Pond - downgradient
AD-28	Existing	Uppermost Water-Bearing Unit	Southwest of West Bottom Ash Pond	Down gradient	320.9	300.9	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to the West Bottom Ash Pond - downgradient
AD-30	Existing	Uppermost Water-Bearing Unit	South of West Bottom Ash Pond	Down gradient	329.0	314.0	15	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to the West Bottom Ash Pond - downgradient
Piezometers								
AD-29	Exisiting	Uppermost Water-Bearing Unit	North of West Bottom Ash Pond	Side gradient	340.2	320.2	20	Existing well installed in 2011; and utilitzed to obtain water level data for uppermost water-bearing unit

Footnotes:
a. Target elevations are an estimated range.

Acronyms and Abbreviations:
U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

ARCADIS

Figures



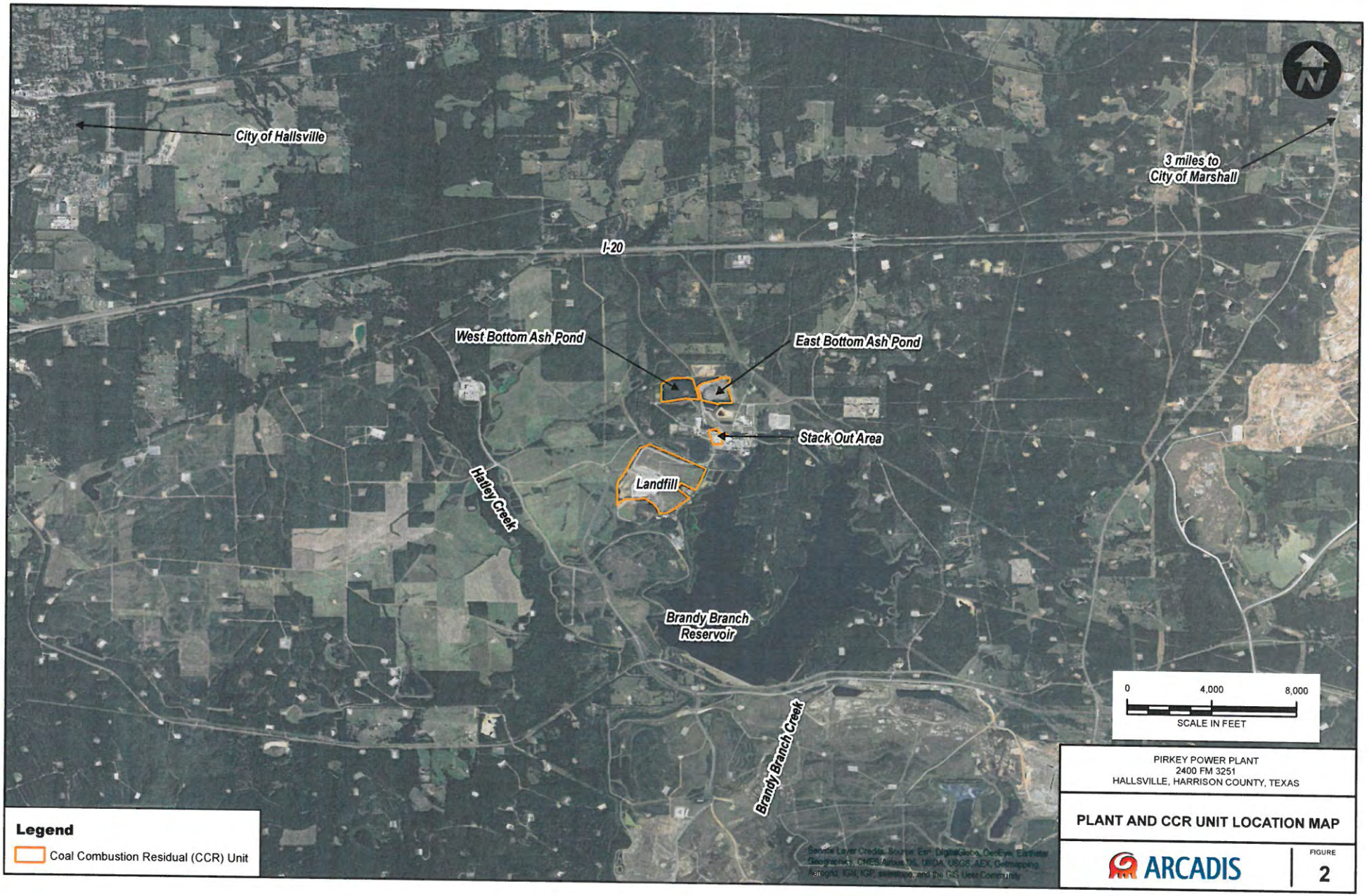
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

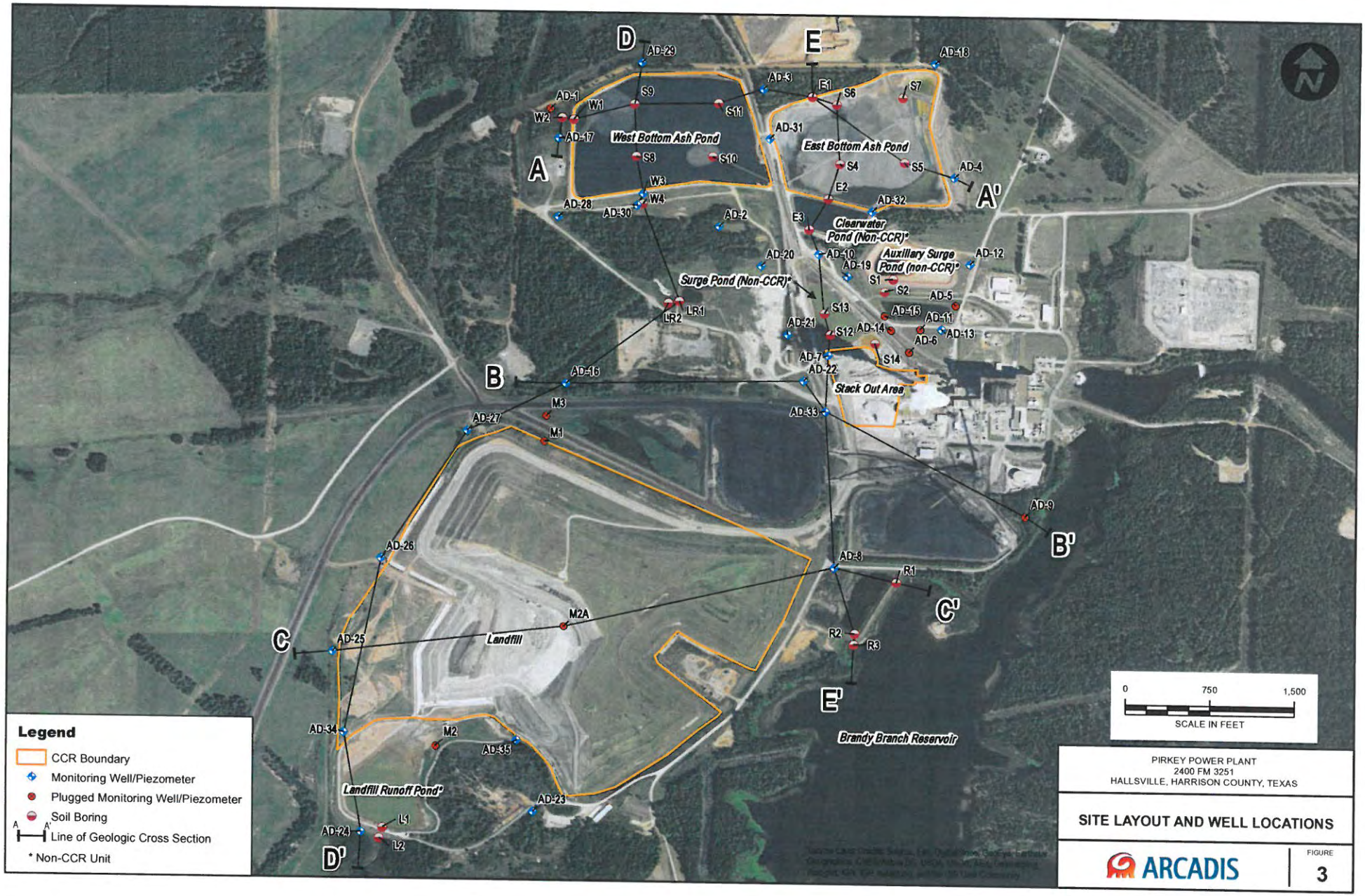
SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENVAEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd


City of Hallsville
3 miles to City of Marshall
I-20
West Bottom Ash Pond
East Bottom Ash Pond
Stack Out Area
Landfill
Hatley Creek
Brandy Branch Reservoir
Brandy Branch Creek
Legend
Coal Combustion Residual (CCR) Unit
0
4,000
8,000
SCALE IN FEET
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS
PLANT AND CCR UNIT LOCATION MAP
ARCADIS
FIGURE
2
Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



Legend

- CCR Boundary
- Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- A — A' Line of Geologic Cross Section
- * Non-CCR Unit

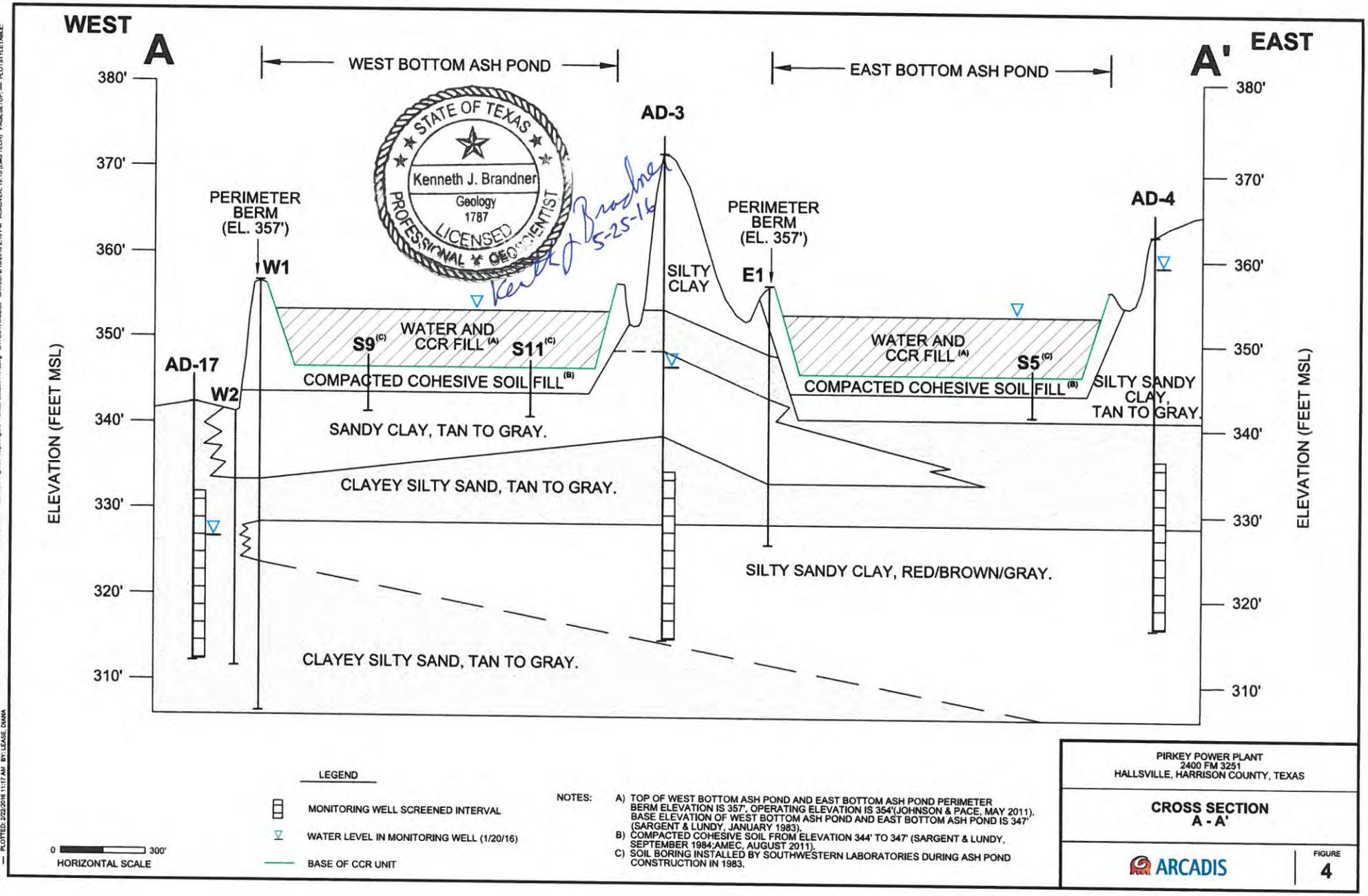
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

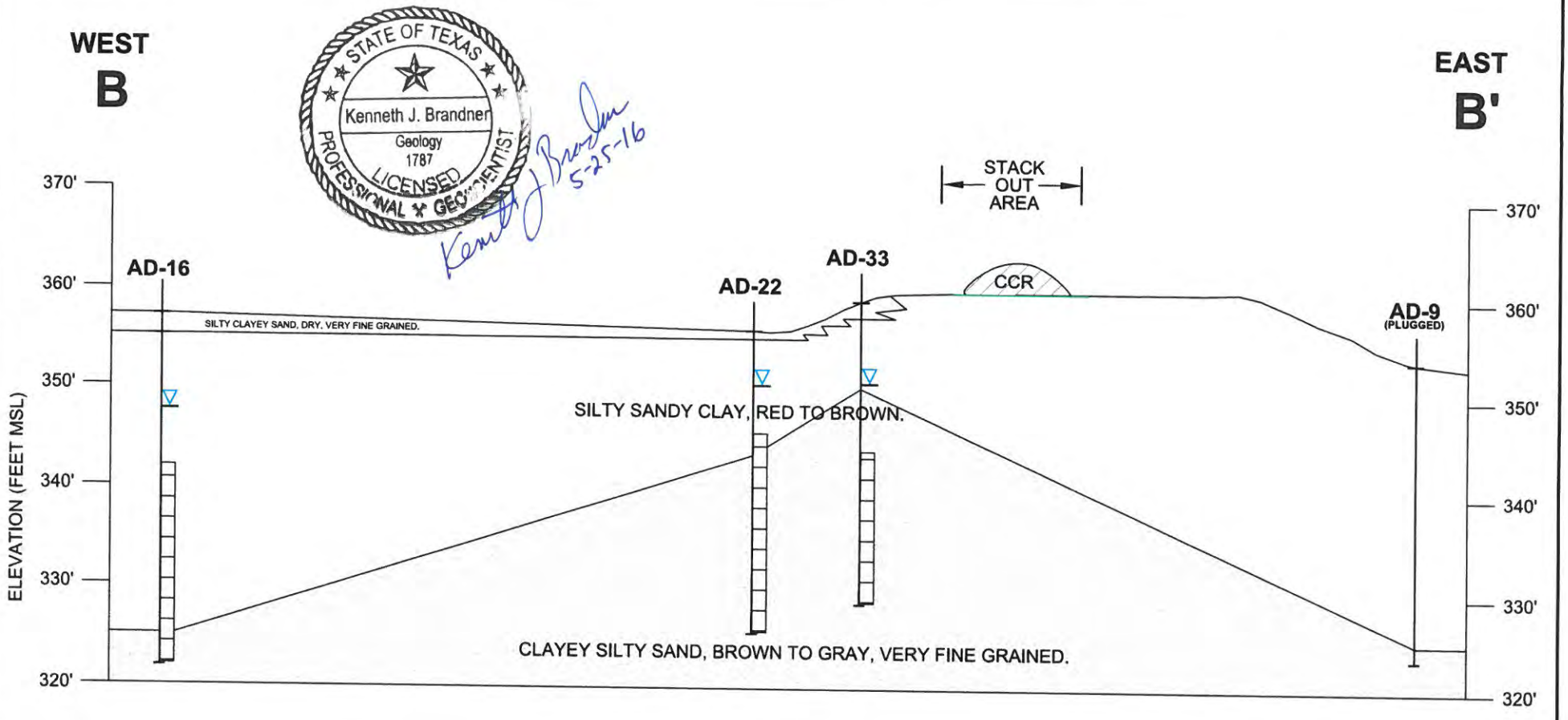
SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE 3

Document Path: Z:\GIS\PROJECTS_ENVAEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd





LEGEND

- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

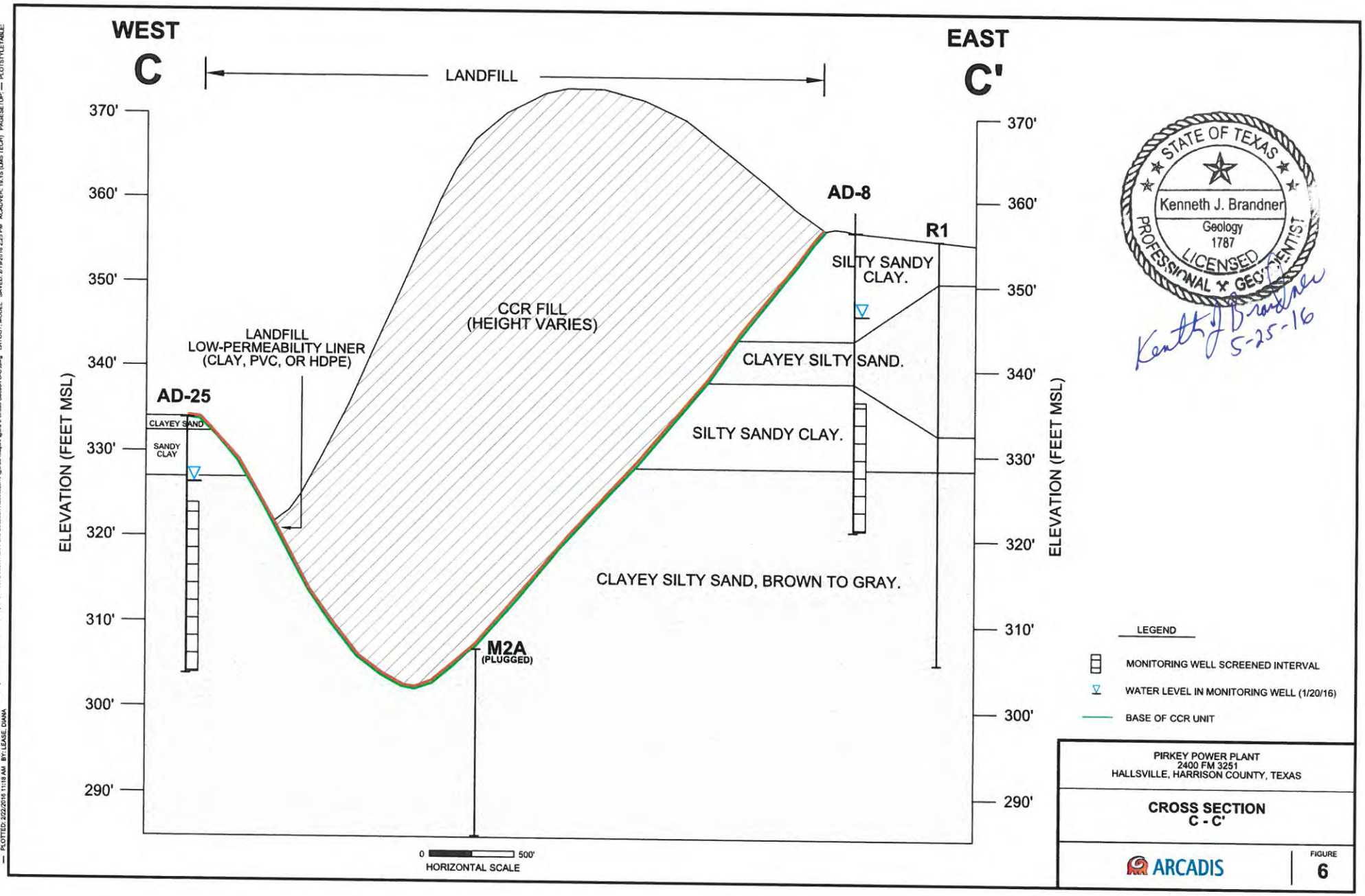
NOTES:
A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE, ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION B - B'

ARCADIS

FIGURE 5



STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL GEOSCIENTIST

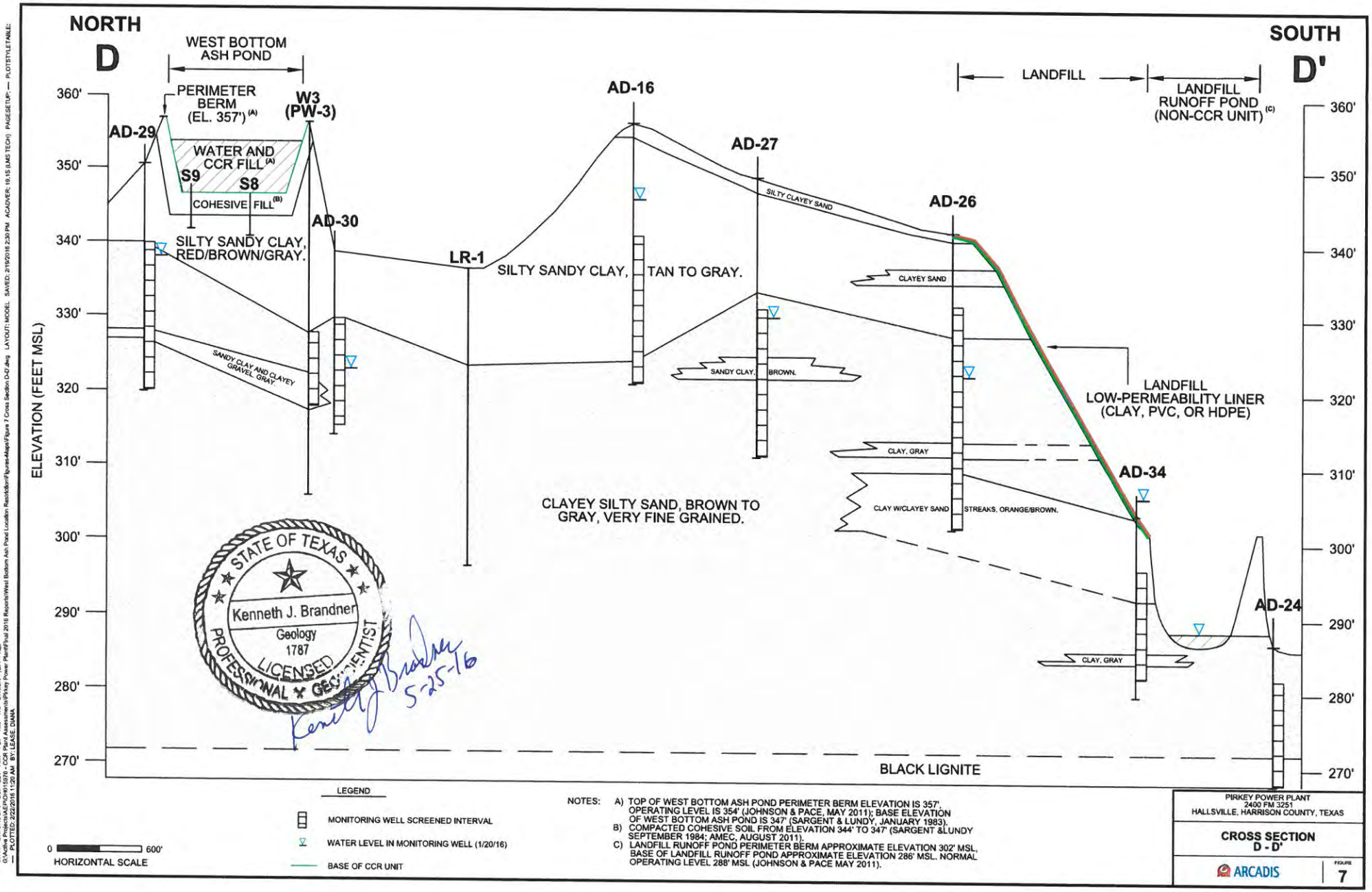
Kenneth J Brandner 5-25-16

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6



STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL GEOSCIENTIST

5-25-16

LEGEND

- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

0 600'
HORIZONTAL SCALE

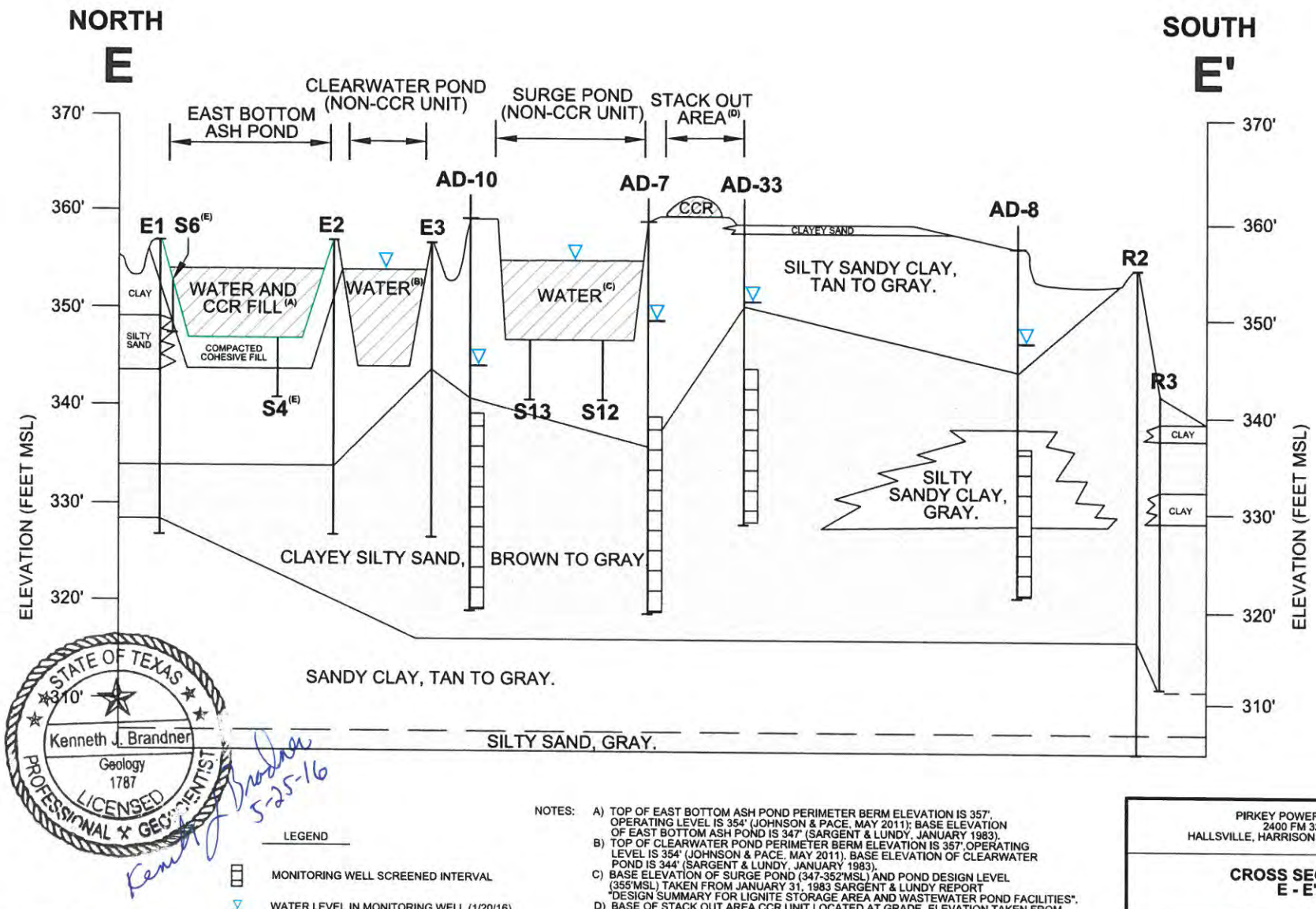
NOTES:
A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).
C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL. BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
D - D'

ARCADIS

FIGURE 7



STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL GEOSCIENTIST

5-25-16

LEGEND

- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

0 500'
HORIZONTAL SCALE

NOTES:

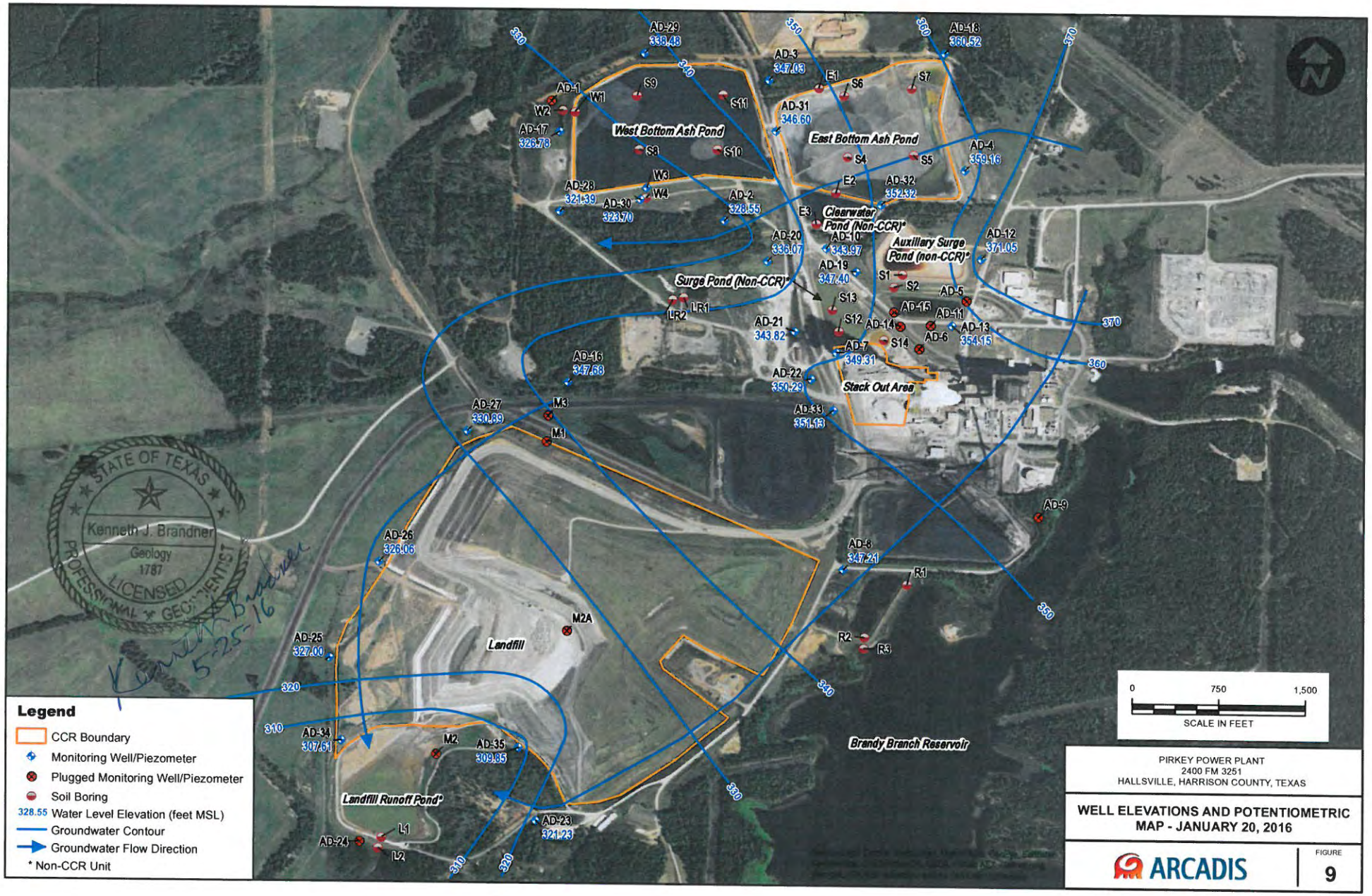
A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).
C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".
D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
8



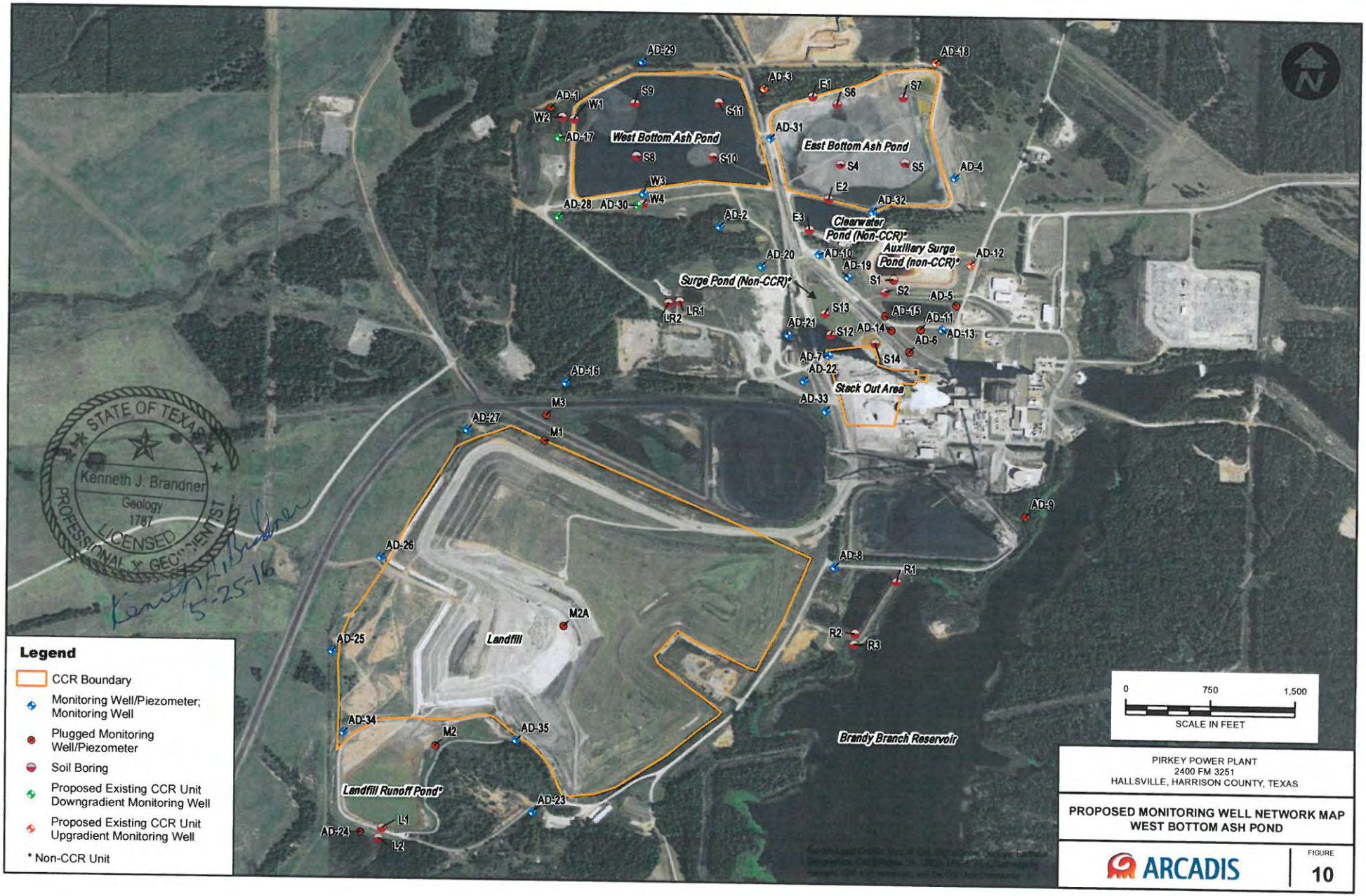
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

ARCADIS

FIGURE 9

Document Path: Z:\GIS\PROJECTS_ENVAEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



Document Path: Z:\GIS\PROJECTS_ENVAEP\Pirkey Plant\MXD\Figure 10 - Proposed Well Network - West Bottom Ash Pond.mxd

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP
WEST BOTTOM ASH POND

ARCADIS

FIGURE
10

ARCADIS

Appendix A

Boring/Well Construction Logs

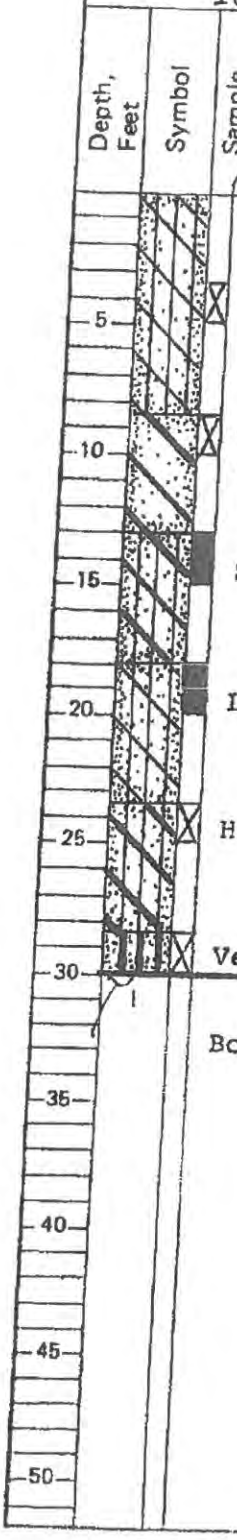
832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-1
LOCATION: Hallsville

Date: 10-6-83 Type: Auger Ground Elevation:



Legend: ■ Sample X Penetration ▼ Water

Description of Stratum

Very dense brown and grey clayey silty sand w/clay seam 33-17=7" 50 B/7"

Very stiff tan and grey very sandy clay w/iron ore 6-9-21 30 B/F

Stiff grey silty sandy clay

Loose grey clayey silty sand

Hard grey silty sandy clay lenses 30-20=11" 50 B/11"

Very dense grey clayey sandy silt 19-31=11½" 50 B/11½"

Bottom of boring at 30 feet.

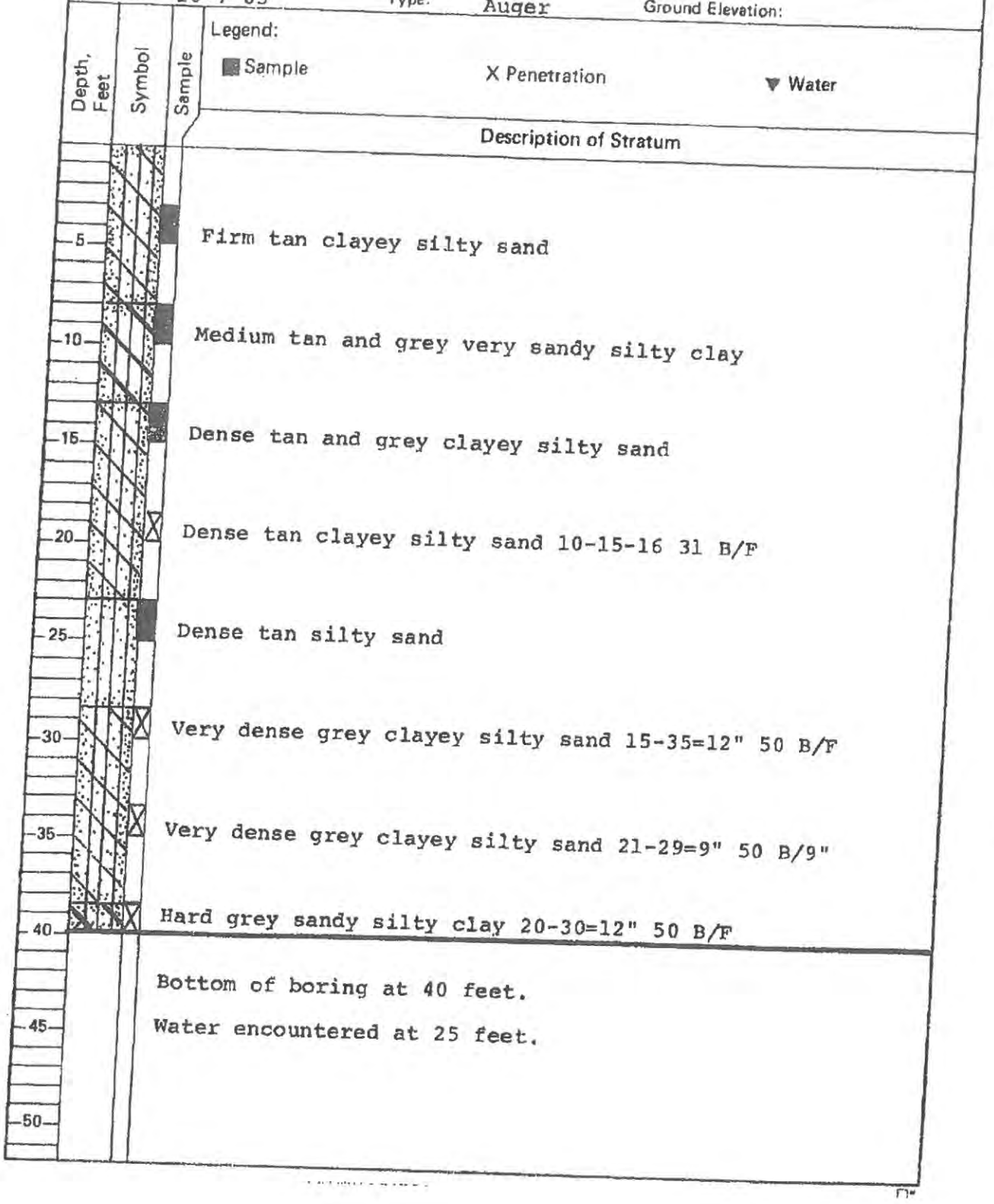
832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-2
LOCATION: Hallsville

Date: 10-7-83 Type: Auger Ground Elevation:



832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-3
LOCATION: Hallsville, TX

Date: 11-4-83 Type: Auger Ground Elevation:

Legend:
■ Sample X Penetration ▼ Water

Description of Stratum

Stiff red, brown and grey sandy silty clay

Stiff red, tan and grey silty clay lenses w/iron ore

Stiff brown and grey sandy silty clay

Firm brown and grey sand w/clay lenses

Stiff brown and grey clay

Stiff brown and grey clay w/silt lenses

Firm grey clayey silty sand

Hard grey clay w/silty sand lenses 43-7=6" 50 B/6"

Hard brown and grey silty sandy clay 21-29=12" 50 B/F

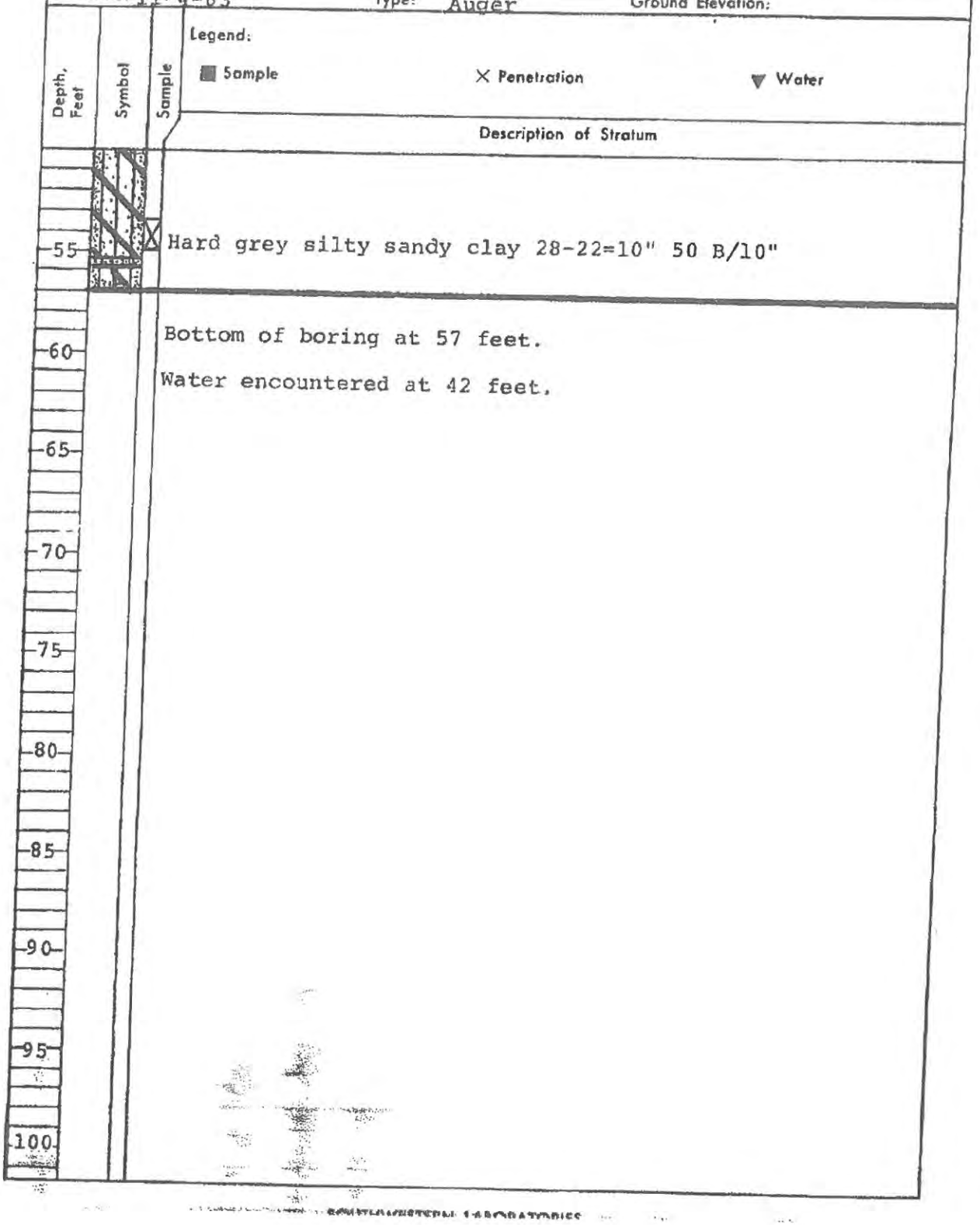
832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-3
LOCATION: Hallsville, TX

Date: 11-4-83 Type: Auger Ground Elevation:



832964

LOG OF BORING

PROJECT: Monitor Wells at Metal Cleaning Waste Pond BORING NO.: MW-12
CLIENT: Southwestern Electric Power Company LOCATION: Hallsville, TX

Date: 1/30/86 Type: Rotary N 6+13.25; W-6+90.36
Ground Elevation: 378.41

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
5			Brown and tan sandy clay
10			Brown, tan and gray sandy clay
15			Tan and gray sandy clay
20			Brown and tan sandy clay
25			Gray and tan sandy clay
30			Brown and gray clay
35			Brown and gray clay
40			Gray silty sand
45			Gray silty sand
50			Gray silty sand

Water encountered at 27.5 feet.
Bottom of Boring at 51 feet.

SOUTHWESTERN LABORATORIES

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ____ ■ MONITOR WELL MONITOR WELL NUMBER: AD-17

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/30/2010

PREPARED BY: Jeff Sammons LOGGED BY: Matt Lyon/Jeff Sammons

LATTITUDE: N 32°28.039 Datum: WGS-84 WELL LOCATION: West of Bottom Ash Pond #2

LONGITUDE: W94°29.659'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1-5			0-5.5	SM	Silty sand, trace clay, reddish brown, brown, light gray, loose to dense -clayey at 0.5-1.5'	None	Moist
6-10			5.5-10	SC	Clayey sand, reddish brown, yellowish brown, laminated iron ore, iron ore concretions	None	Moist
11-18			10-18.5	SM	Silty sand, light reddish brown, yellowish brown, dense, some clay -trace clay, yellowish brown, 15-16' -iron ore concretions at 16' -light yellowish brown, light gray at 17' -laminated iron ore at 18.5'	None	V. Moist
19-30			18.5-30	SC	Clayey sand, yellowish brown, light gray, saturated sand lenses -gravelly at 21' -laminated ironstone at 22.5' -very dense, gray, light gray at 25' -some clay at 27.5, greenish gray, gray, to boring termination	None	Saturated Dry to Moist
31-40					Boring Terminated at 30'		

▽ Water Level

Cement Bentonite Filter Sand

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: 23.26
3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ____ ■ MONITOR WELL MONITOR WELL NUMBER: AD-18

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 1/3/2011

PREPARED BY: Jeff Sammons LOGGED BY: Matt Lyon/Jeff Sammons

LATTITUDE: N 32°28.154' Datum: WGS-84 WELL LOCATION: Northeast of Bottom Ash Pond #1
LONGITUDE: W94°29.108'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1-7				0-7	SM	Sandy Silt, some clay, very fine grained, gray, light brown, light brownish red, yellowish brown	None	Dry
8-16				7-16	CL	Clay, some sand, light gray, reddish gray, stiff, yellowish brown -iron oxide fracture at 9.5'	None	Dry
						-increasing sand content at 14', thin lenses of iron-oxide cemented sand at 14.5', 15', 15.5', stiff		Moist
17-25			▽	16-25	SM	Silty sand, some clay, gray, yellowish brown, dense, abundant gypsum crystals, abundant iron oxide cemented sandstone gravel in layers, saturated 19-21'	None None	Moist to V. Moist Saturated
						-dark gray at 21' -clayey at 21-23'	None	
						-greenish gray, trace clay, at 23'	None	
						-clay lense, hard, dry, (shale), at 24.5-25'	None	Dry
26-40						Boring Terminated at 25'		

Cement Bentonite Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 25 feet
Filter Sand (Size/Interval): 13-25'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-15'
Screen Interval: 15-25'
Water level: ____
3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ____ ■ MONITOR WELL MONITOR WELL NUMBER: AD-28

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/28/2010

PREPARED BY: Jeff Sammons LOGGED BY: Jeff Sammons

LATTITUDE: N 32°27.926' Datum: WGS-84 WELL LOCATION: Southwest of Primary Bottom Ash Pond #2

LONGITUDE: W94°29.658'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1				0-0.5 SM	Silty sand, light brown, very fine grained, loost	None	Moist
2 3 4 5 6 7 8 9 10				0.5-10 CL	Sandy clay, reddish brown, yellowish brown, stiff, hard, some iron ore gravel at .5-1.5' -light gray, dark reddish brown at 5' -iron oxide cemented stone at 6.5'	None	Dry
11 12 13 14 15 16				10-16 SM	Silty sand, very fine grained, some clay, light yellowish brown, light gray, medium dense -light yellowish brown at 11.5'	None	Moist to V. Moist
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40			▽	16-40 SC	Clayey sand, dark gray, medium dense -dark gray at 20' -cemented sandstone at 21' -no recovery from 22' to 35' -1.5" layer of cemented sandstone at 35'	None	Moist V. Moist to Saturated Dry to Moist
					Boring Terminated at 40'		

Cement Bentonite Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 40 feet Riser Interval: +3 (ags)-15'

Filter Sand (Size/Interval): 13-35' Screen Interval: 15-35'

Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13' Water level: 19.98'

Surface Completion ☐ Flush ■ Above Ground 3.5'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ____ ■ MONITOR WELL MONITOR WELL NUMBER: AD-29

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 1/3/2011

PREPARED BY: Jeff Sammons LOGGED BY: Jeff Sammons

LATTITUDE: N 32°28.139' Datum: WGS-84 WELL LOCATION: North of Bottom Ash Pond #2
LONGITUDE: W94°29.534

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1				0-0.5 SM	Silty sand, brown, light brown, very fine grained	None	Moist
2 3 4 5				0.5-5 CL	Clay, some sand, red, reddish brown, light gray, stiff	None	Dry
6 7 8 9 10				5-10 CL	Sandy clay, light gray, light red -abundant iron ore, yellowish brown, yellow, dry	None	Dry
11 12 13 14 15 16 17 18				10-18 SC	Clayey sand, yellowish brow, reddish brown, light gray, medium dense -light gray, yellow, at 11' -4" saturated sand seam, trace clay at 13' -purple, yellowish brown, reddish brown, medium dense to loose	None	Moist
19 20 21			▽	18-22 SM	Silty sand, reddish brown to red -some iron ore gravel, some clay, saturated, gypsum crystals, at 20'	None	V. Moist
22				22-22.5 CL	Sandy clay, dark gray, stiff	None	Dry
23 24 25 26 27 28				22.5-28 SM	Silty sand, saturated, greenish gray, loose	None	Dry to Moist
29 30				28-30 SC	Clayey sand, greenish gray, dark gray, dark brown, dry, very dense, slightly cemented	None	Dry to Moist
31 32 33 34 39 40					Boring Terminated at 30'		

Cement Bentonite Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: ____
3'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-30**

PROJECT INFORMATION

PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-04-1021
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/08/2015
DEVELOPMENT:	12/16/2015
SITE LOCATION:	2400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

DRILLING INFORMATION

DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	50089
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	342.02 (Top of Casing)
HOLE DIAMETER:	6.25"
LATITUDE	32 27' 56.48" LONGITUDE 94 29' 32.53"

STATE OF TEXAS — JEFFREY D. SAMMONS — GEOLOGY #10070 — LICENSED PROFESSIONAL GEOSCIENTIST — 1-21-16

▽ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

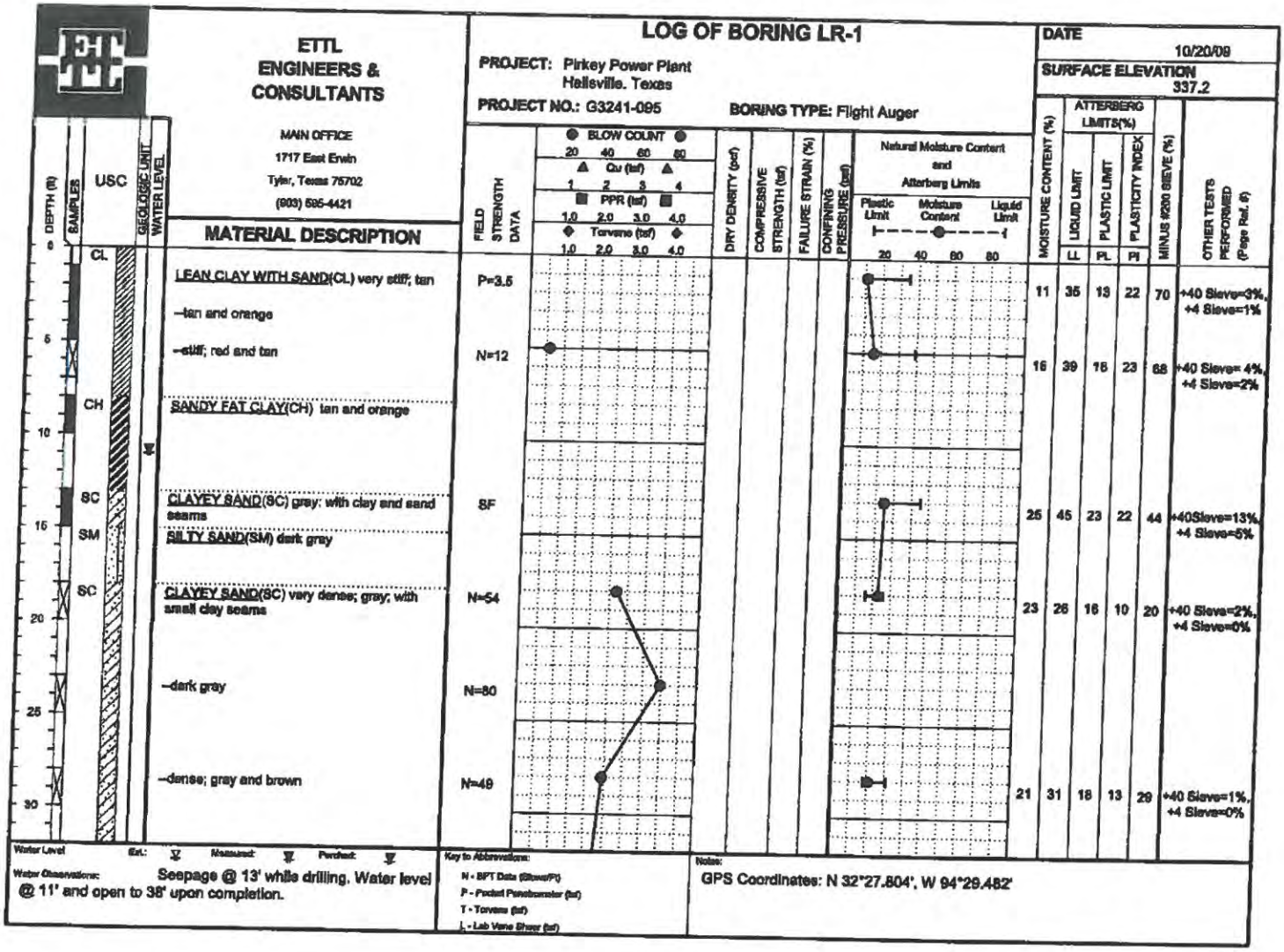
TBPG No. 50027

DESCRIPTION	USCS	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
SANDY LEAN CLAY: light reddish brown and light gray	CL						
- trace sand and silt at 3.0' to 3.5', light reddish brown			17	64	24	17	7
- some iron ore gravel at 7', light gray, reddish brown, light reddish brown, increasing sand content with depth			14	53	38	24	14
CLAYEY SILTY SAND: very fine to fine sand, reddish brown, light brown, and light gray	SM-SC						
SILTY SAND: very fine to fine sand, some lenses of clay and partially cemented sand, reddish brown and light gray, moist	SM		10	13	28	NP	-
CLAYEY SAND: very fine to fine sand with some fine to coarse iron ore gravel and partially cemented sand, reddish brown and light gray, moist	SC		20	26	34	24	10
SILTY SAND: very fine to fine sand, some clay, light gray and reddish brown, saturated	SM						
- some iron ore gravel at 19', gray and reddish brown, increasing clay content with depth, very moist							
SILTY CLAYEY SAND: fine to very fine sand, some clay lenses, gray and dark gray, moist	SM-SC		20	49	30	22	8

WELL CONSTRUCTION

- Locking Well Casing Cover
- Locking Well Cap
- Protective Well Casing
- Concrete Pad
- Ground Surface
- Cement
- Bentonite
- 2" Sch. 40 PVC Riser
- 20/40 Silica Sand
- 0.010" Slotted Sch. 40 PVC Well Screen
- PVC Bottom Cap

NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.



ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING LR-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

SURFACE ELEVATION 337.2

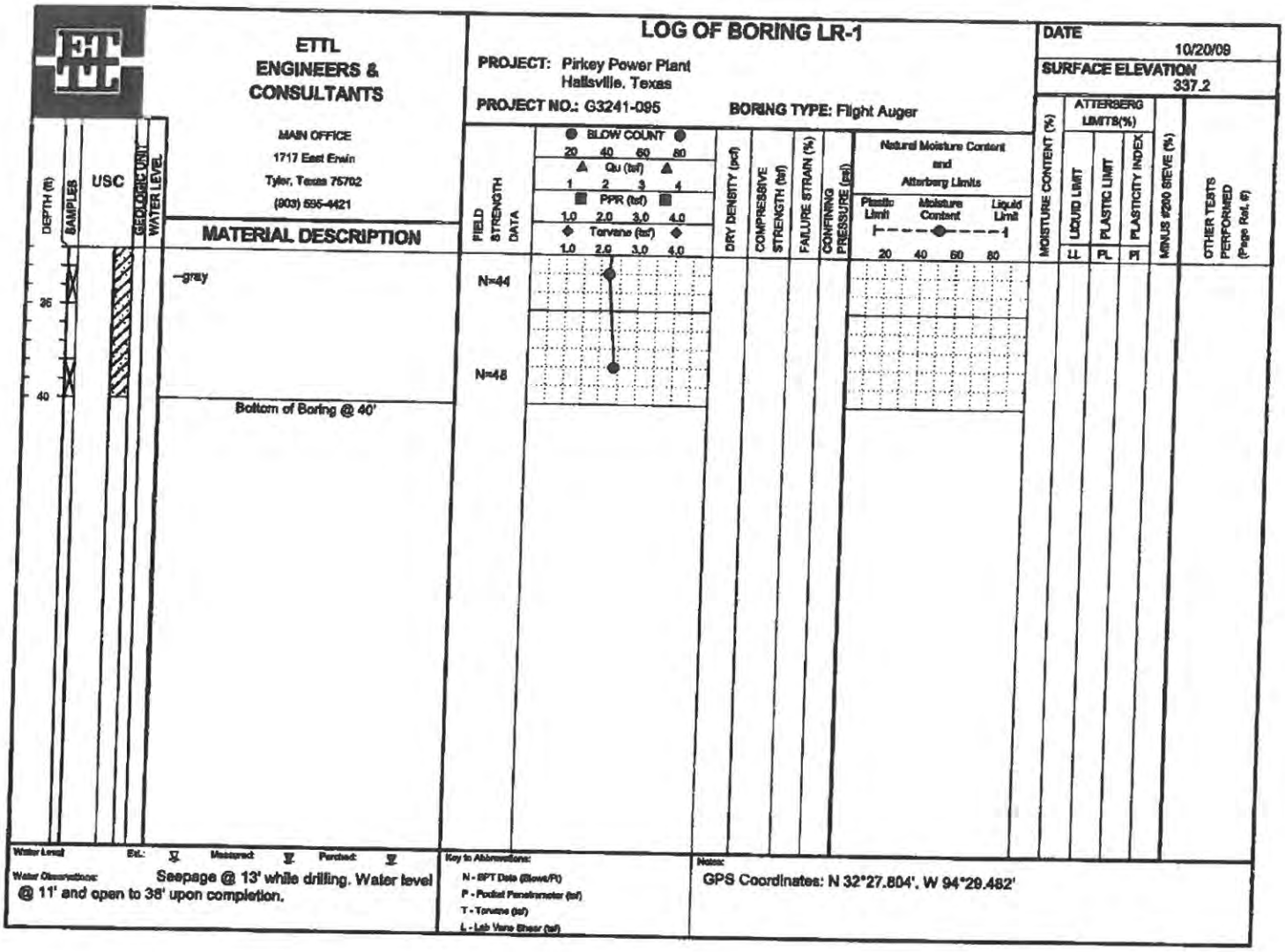
DEPTH (ft)	SAMPLES	USC	GEOLOGIC LIMIT / WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psf)	Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		CL		LEAN CLAY WITH SAND(CL) very stiff; tan	P=3.5						11	35	13	22	70	+40 Sieve=3%, +4 Sieve=1%
5				–tan and orange	N=12						16	39	16	23	68	+40 Sieve= 4%, +4 Sieve=2%
10		CH		–stiff; red and tan SANDY FAT CLAY(CH) tan and orange												
15		SC SM		CLAYEY SAND(SC) gray; with clay and sand seams SILTY SAND(SM) dark gray	SF						25	45	23	22	44	+40Sieve=13%, +4 Sieve=5%
20		SC		CLAYEY SAND(SC) very dense; gray; with small clay seams	N=54						23	26	16	10	20	+40 Sieve=2%, +4 Sieve=0%
25				–dark gray	N=80											
30				–dense; gray and brown	N=49						21	31	18	13	29	+40 Sieve=1%, +4 Sieve=0%

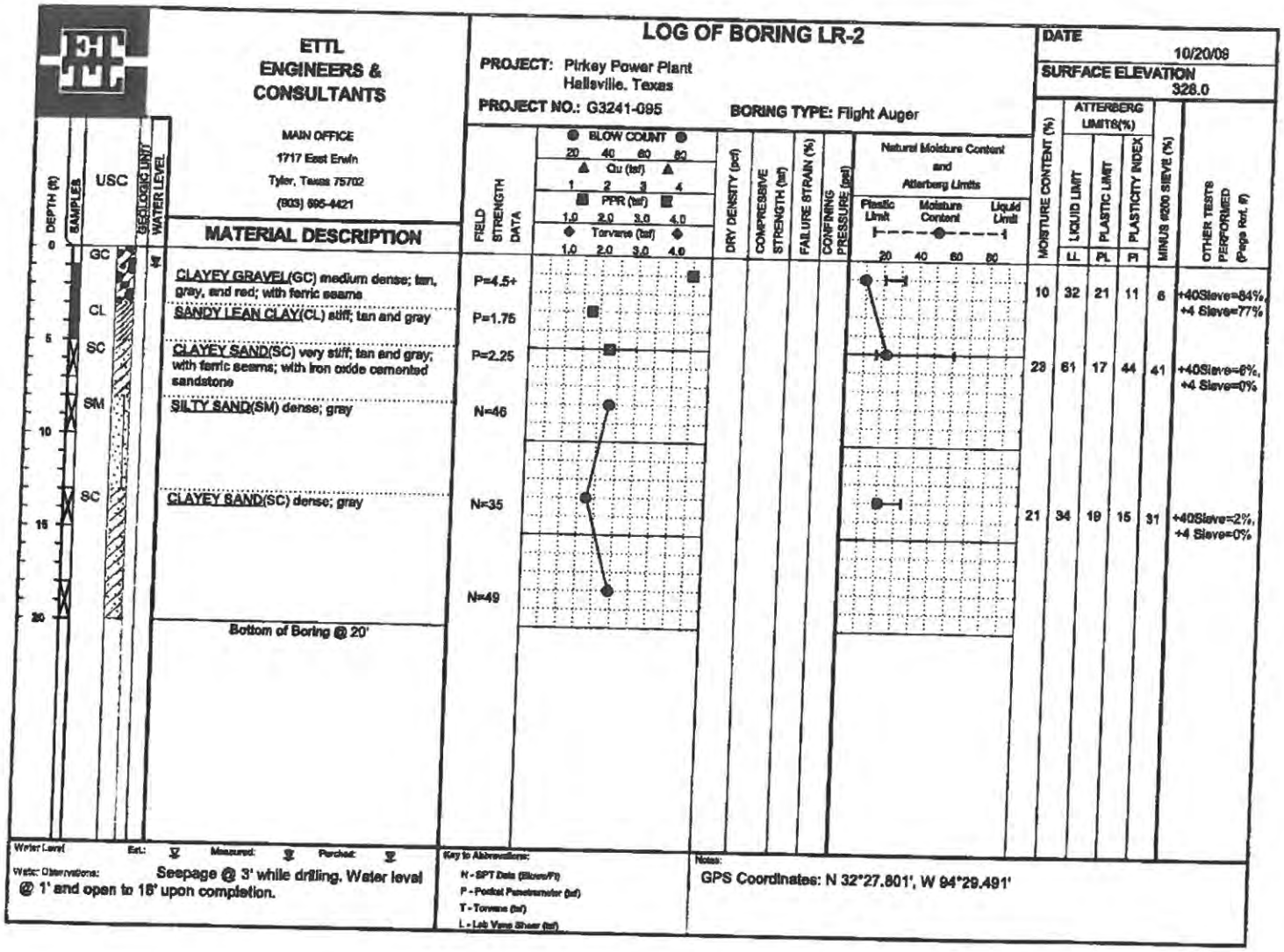
Water Level Est.: ▽ Measured: ▽ Perched: ▽

Water Observations: Seepage @ 13' while drilling. Water level @ 11' and open to 38' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.804', W 94°29.482'


ETTL
ENGINEERS & CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421
LOG OF BORING LR-1
PROJECT: Pirkey Power Plant
Hallsville, Texas
PROJECT NO.: G3241-095
BORING TYPE: Flight Auger
DATE
10/20/09
SURFACE ELEVATION
337.2
DEPTH (ft)
SAMPLES
USC
GEOLOGIC UNIT
WATER LEVEL
MATERIAL DESCRIPTION
FIELD STRENGTH DATA
BLOW COUNT
Qu (tsf)
PPR (tsf)
Torvane (tsf)
DRY DENSITY (pcf)
COMPRESSIVE STRENGTH (tsf)
FAILURE STRAIN (%)
CONFINING PRESSURE (psi)
Natural Moisture Content and Atterberg Limits
Plastic Limit
Moisture Content
Liquid Limit
MOISTURE CONTENT (%)
ATTERBERG LIMITS(%)
LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
MINUS #200 SIEVE (%)
OTHER TESTS PERFORMED (Page Ref. #)
–gray
N=44
N=48
Bottom of Boring @ 40'
Water Level
Est.:
Measured:
Perched:
Water Observations:
Seepage @ 13' while drilling. Water level @ 11' and open to 38' upon completion.
Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Notes:
GPS Coordinates: N 32°27.804', W 94°29.482'



ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING LR-2

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/08

SURFACE ELEVATION 328.0

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		GC			CLAYEY GRAVEL(GC) medium dense; tan, gray, and red; with ferric seams	P=4.5+										
		CL			SANDY LEAN CLAY(CL) stiff; tan and gray	P=1.75										
5		SC			CLAYEY SAND(SC) very stiff; tan and gray; with ferric seams; with iron oxide cemented sandstone	P=2.25										
		SM			SILTY SAND(SM) dense; gray	N=46					10	32	21	11	6	+40Sieve=84%, +4 Sieve=77%
10											29	61	17	44	41	+40Sieve=6%, +4 Sieve=0%
		SC			CLAYEY SAND(SC) dense; gray	N=35										
15											21	34	19	15	31	+40Sieve=2%, +4 Sieve=0%
						N=49										
20					Bottom of Boring @ 20'											

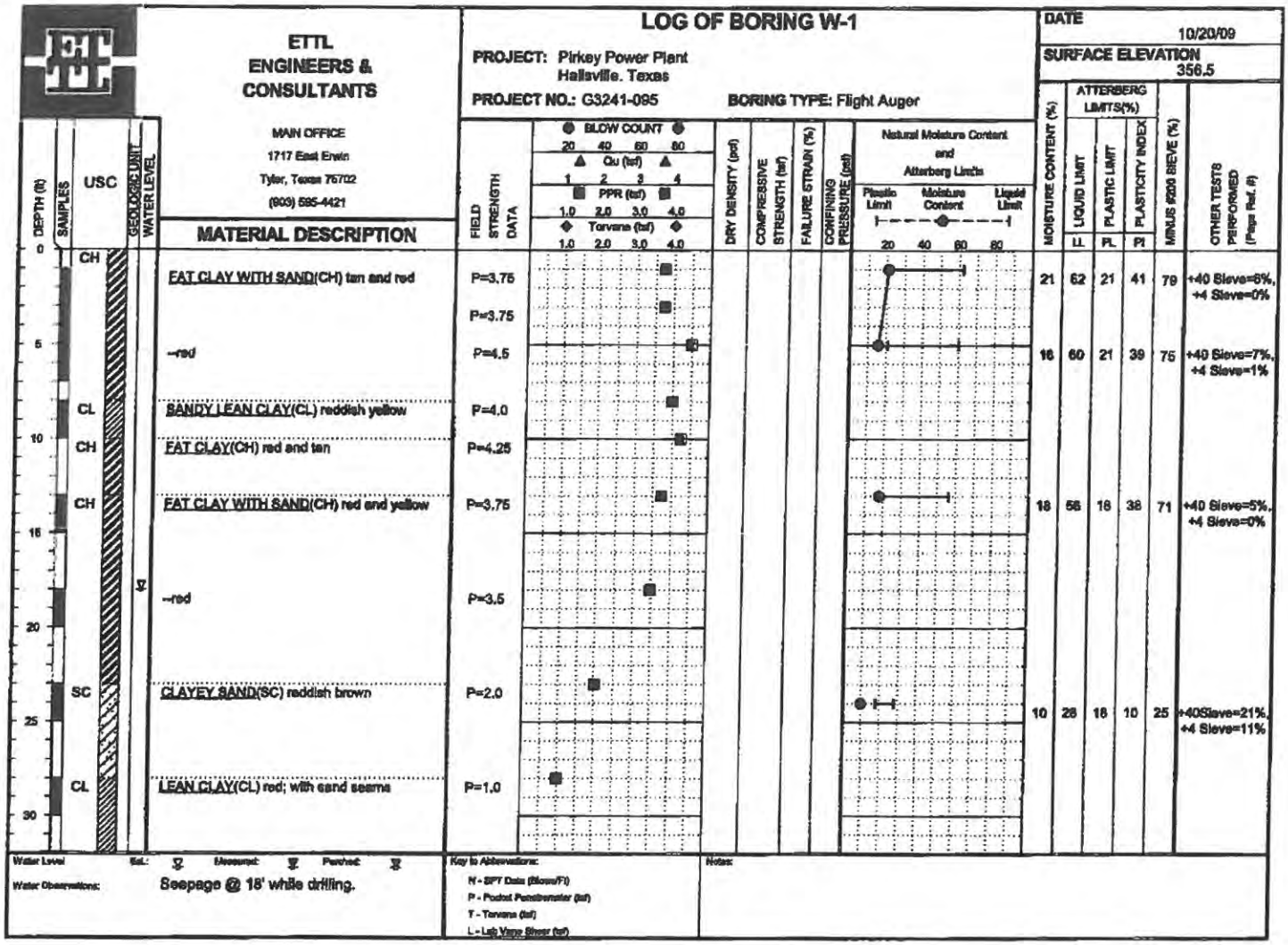
Natural Moisture Content and Atterberg Limits: Plastic Limit | Moisture Content | Liquid Limit (20 40 60 80)

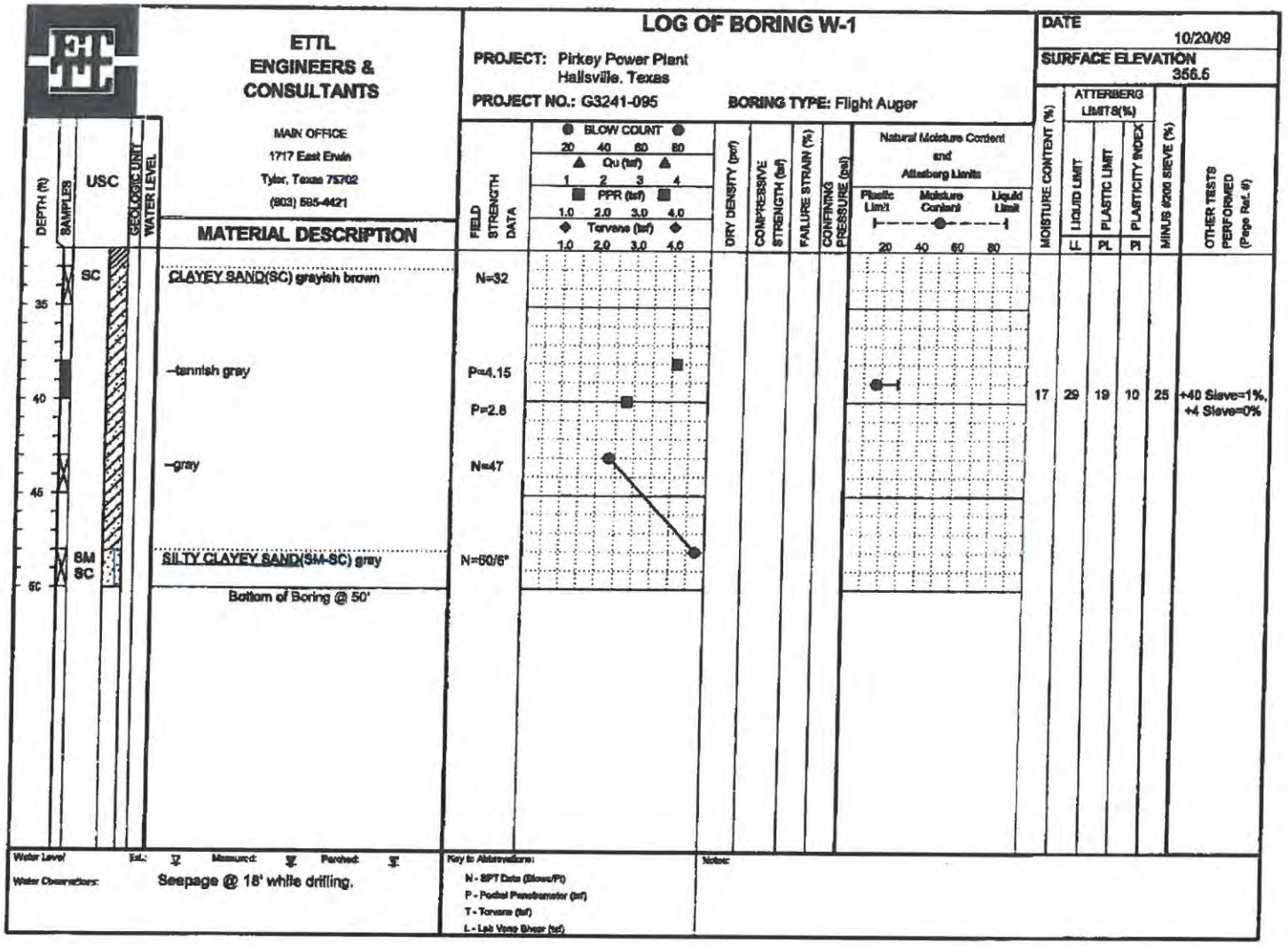
Water Level: Est.: ▽ Measured: ▽ Perched: ▽

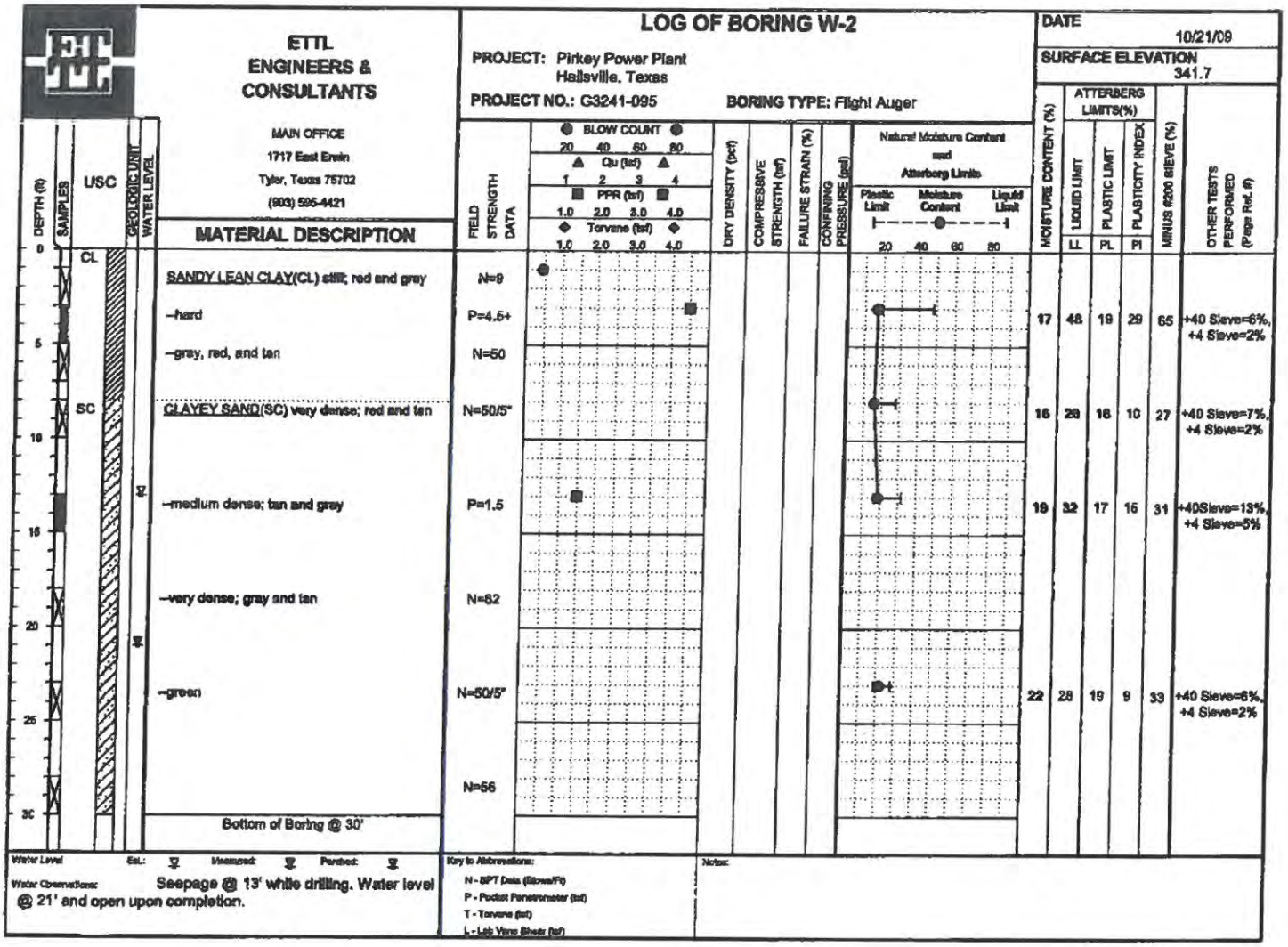
Water Observations: Seepage @ 3' while drilling. Water level @ 1' and open to 18' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.801', W 94°29.491'


ETTL
ENGINEERS & CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421
LOG OF BORING W-1
PROJECT: Pirkey Power Plant
Hallsville, Texas
PROJECT NO.: G3241-095
BORING TYPE: Flight Auger
DATE
10/20/09
SURFACE ELEVATION
356.5
DEPTH (ft)
SAMPLES
USC
GEOLOGIC UNIT
WATER LEVEL
MATERIAL DESCRIPTION
FIELD STRENGTH DATA
BLOW COUNT
Qu (tsf)
PPR (tsf)
Torvane (tsf)
DRY DENSITY (pcf)
COMPRESSIVE STRENGTH (tsf)
FAILURE STRAIN (%)
CONFINING PRESSURE (psf)
Natural Moisture Content and Atterberg Limits
Plastic Limit
Moisture Content
Liquid Limit
MOISTURE CONTENT (%)
ATTERBERG LIMITS(%)
LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
MINUS #200 SIEVE (%)
OTHER TESTS PERFORMED (*Page Ref. #)
0
5
10
15
20
25
30
CH
FAT CLAY WITH SAND(CH) tan and red
P=3.75
P=3.75
--red
P=4.5
CL
SANDY LEAN CLAY(CL) reddish yellow
P=4.0
CH
FAT CLAY(CH) red and tan
P=4.25
CH
FAT CLAY WITH SAND(CH) red and yellow
P=3.75
--red
P=3.5
SC
CLAYEY SAND(SC) reddish brown
P=2.0
CL
LEAN CLAY(CL) red; with sand seams
P=1.0
21 62 21 41 79 +40 Sieve=6%, +4 Sieve=0%
16 60 21 39 75 +40 Sieve=7%, +4 Sieve=1%
18 56 18 38 71 +40 Sieve=5%, +4 Sieve=0%
10 28 18 10 25 +40Sieve=21%, +4 Sieve=11%
Water Level
Est.:
Measured:
Perched:
Water Observations:
Seepage @ 18' while drilling.
Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Notes:


ETTL
ENGINEERS &
CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421
LOG OF BORING W-1
PROJECT: Pirkey Power Plant
Hallsville, Texas
PROJECT NO.: G3241-095
BORING TYPE: Flight Auger
DATE
10/20/09
SURFACE ELEVATION
356.5
DEPTH (ft)
SAMPLES
USC
GEOLOGIC UNIT
WATER LEVEL
MATERIAL DESCRIPTION
FIELD STRENGTH DATA
BLOW COUNT
Qu (tsf)
PPR (tsf)
Torvane (tsf)
DRY DENSITY (pcf)
COMPRESSIVE STRENGTH (tsf)
FAILURE STRAIN (%)
CONFINING PRESSURE (psi)
Natural Moisture Content and Atterberg Limits
Plastic Limit
Moisture Content
Liquid Limit
MOISTURE CONTENT (%)
ATTERBERG LIMITS(%)
LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
MINUS #200 SIEVE (%)
OTHER TESTS PERFORMED (Page Ref. #)
SC
CLAYEY SAND(SC) grayish brown
N=32
–tannish gray
P=4.15
P=2.8
–gray
N=47
SM
SC
SILTY CLAYEY SAND(SM-SC) gray
N=50/6"
Bottom of Boring @ 50'
17
29
19
10
25
+40 Sieve=1%,
+4 Sieve=0%
Water Level
Est.:
Measured:
Perched:
Water Observations:
Seepage @ 18' while drilling.
Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Notes:



ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-2

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/21/09

SURFACE ELEVATION: 341.7

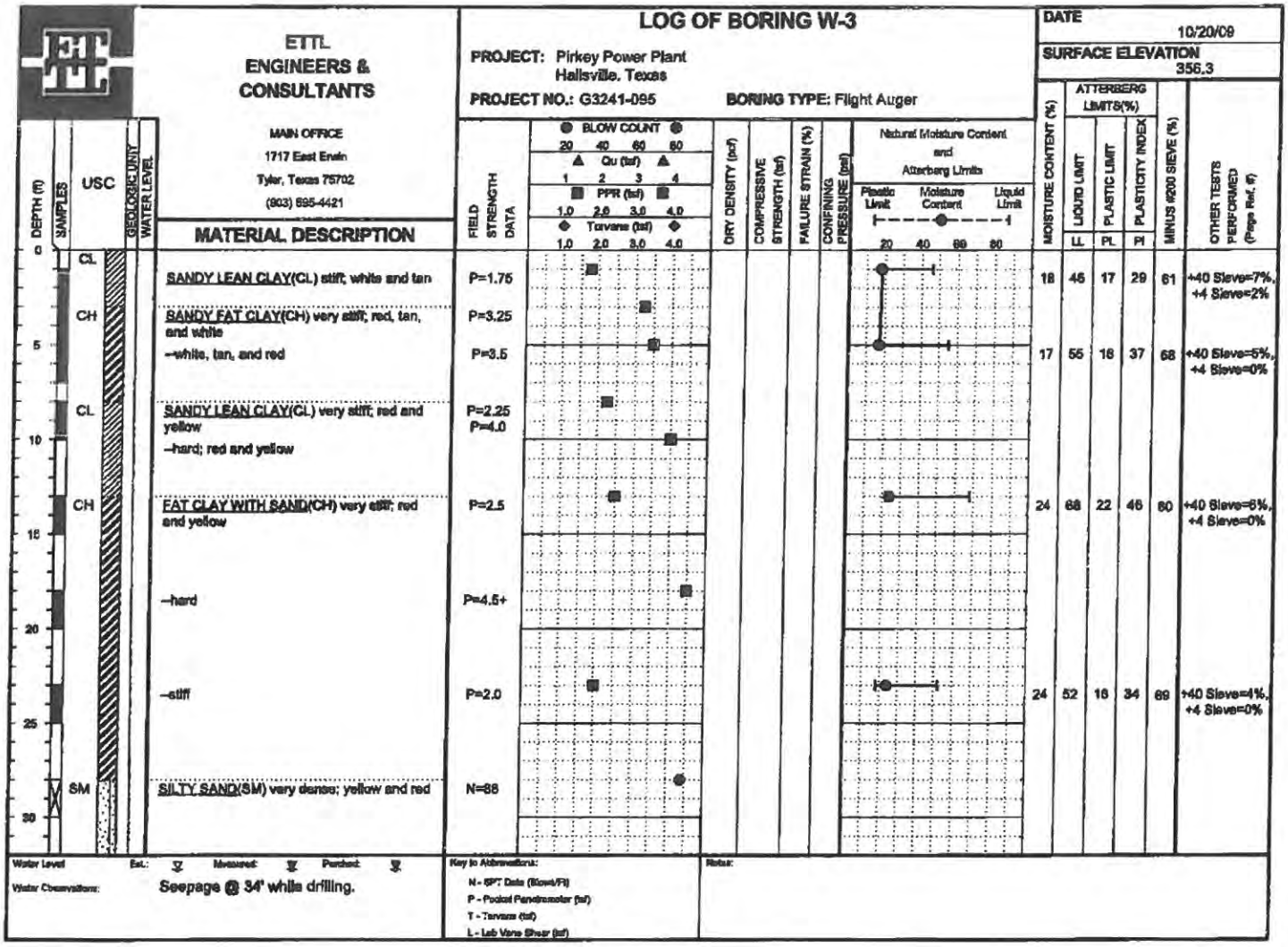
DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		CL			SANDY LEAN CLAY(CL) stiff; red and gray	N=9											
					–hard	P=4.5+						17	48	19	29	65	+40 Sieve=6%, +4 Sieve=2%
5					–gray, red, and tan	N=50											
		SC			CLAYEY SAND(SC) very dense; red and tan	N=50/5"						16	28	18	10	27	+40 Sieve=7%, +4 Sieve=2%
10					–medium dense; tan and gray	P=1.5						19	32	17	15	31	+40Sieve=13%, +4 Sieve=5%
15					–very dense; gray and tan	N=62											
20					–green	N=50/5"						22	28	19	9	33	+40 Sieve=6%, +4 Sieve=2%
25						N=56											
30					Bottom of Boring @ 30'												

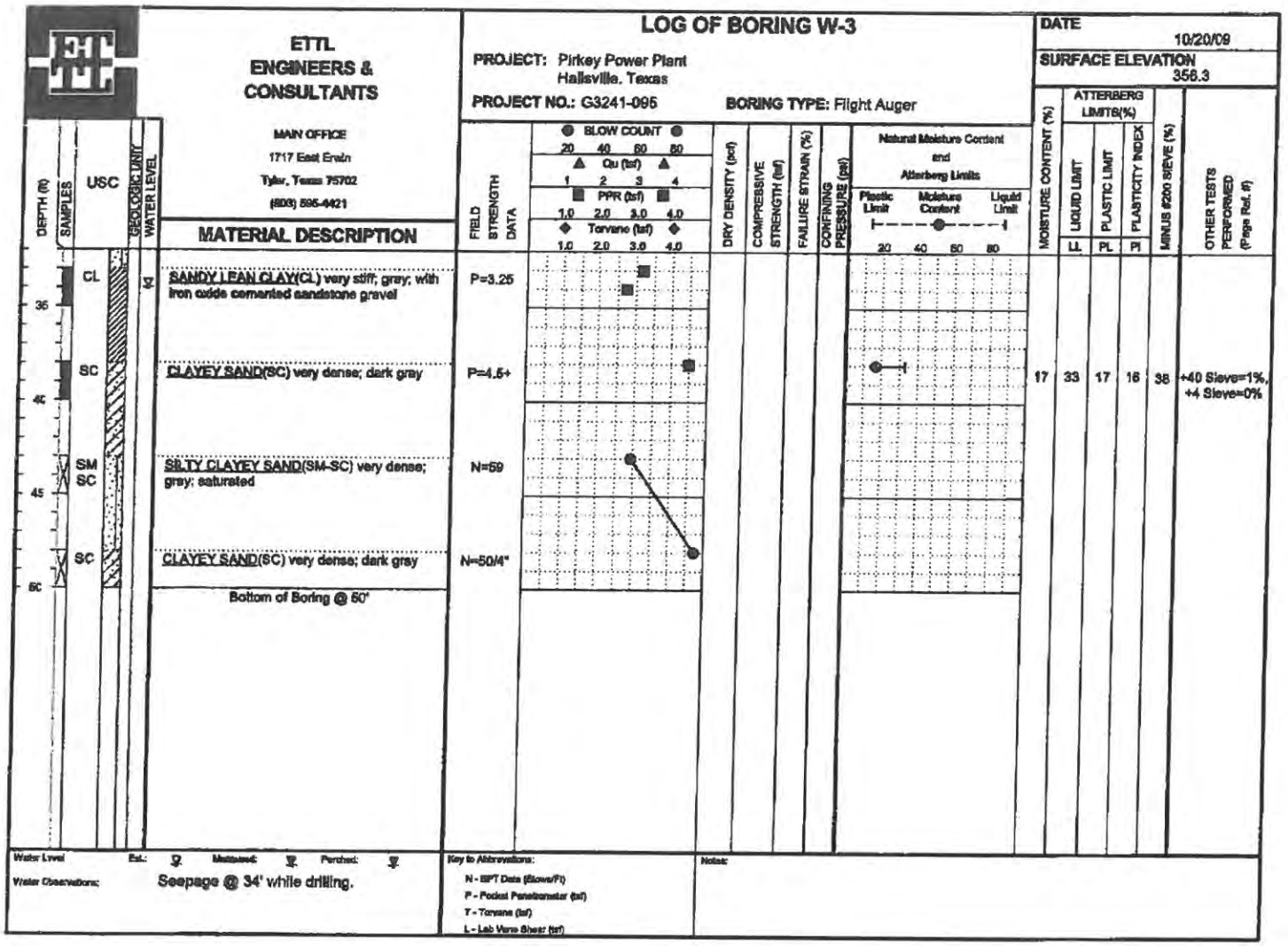
Water Level — Est.: ▽ Measured: ▽ Perched: ▽

Water Observations: Seepage @ 13' while drilling. Water level @ 21' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:


ETTL
ENGINEERS & CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421
LOG OF BORING W-3
PROJECT: Pirkey Power Plant
Hallsville, Texas
PROJECT NO.: G3241-095
BORING TYPE: Flight Auger
DATE 10/20/09
SURFACE ELEVATION 356.3
DEPTH (ft)
SAMPLES
USC
GEOLOGIC UNIT
WATER LEVEL
MATERIAL DESCRIPTION
FIELD STRENGTH DATA
BLOW COUNT
Qu (tsf)
PPR (tsf)
Torvane (tsf)
DRY DENSITY (pcf)
COMPRESSIVE STRENGTH (tsf)
FAILURE STRAIN (%)
CONFINING PRESSURE (psi)
Natural Moisture Content and Atterberg Limits
Plastic Limit
Moisture Content
Liquid Limit
MOISTURE CONTENT (%)
ATTERBERG LIMITS(%)
LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
MINUS #200 SIEVE (%)
OTHER TESTS PERFORMED (Page Ref. #)
CL
SANDY LEAN CLAY(CL) stiff; white and tan
P=1.75
18 46 17 29 61 +40 Sieve=7%, +4 Sieve=2%
CH
SANDY FAT CLAY(CH) very stiff; red, tan, and white
P=3.25
--white, tan, and red
P=3.5
17 55 18 37 68 +40 Sieve=5%, +4 Sieve=0%
CL
SANDY LEAN CLAY(CL) very stiff; red and yellow
P=2.25
P=4.0
--hard; red and yellow
CH
FAT CLAY WITH SAND(CH) very stiff; red and yellow
P=2.5
24 68 22 46 80 +40 Sieve=6%, +4 Sieve=0%
--hard
P=4.5+
--stiff
P=2.0
24 52 18 34 69 +40 Sieve=4%, +4 Sieve=0%
SM
SILTY SAND(SM) very dense; yellow and red
N=88
Water Level
Est.:
Measured:
Perched:
Water Observations:
Seepage @ 34' while drilling.
Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Notes:



ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-3

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/20/09

SURFACE ELEVATION: 356.3

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		CL			SANDY LEAN CLAY(CL) very stiff; gray; with iron oxide cemented sandstone gravel	P=3.25										
40		SC			CLAYEY SAND(SC) very dense; dark gray	P=4.5+					17	33	17	16	38	+40 Sieve=1%, +4 Sieve=0%
45		SM SC			SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated	N=59										
50		SC			CLAYEY SAND(SC) very dense; dark gray	N=50/4"										
					Bottom of Boring @ 50'											

Water Level Est.: ▽ Measured: ▽ Perched: ▽

Water Observations: Seepage @ 34' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ENVIRONMENTAL LOG

Client: Pirkey Power Plant

Project No: G3241-095 **Phase** **Task**

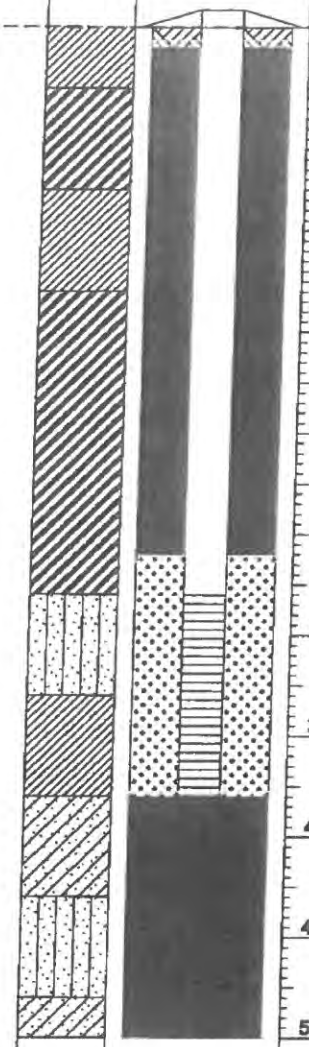
Well No. PW-3 (W3)

Location Hallsville, Texas

Surface Elev.

Depth Feet	Sampler	Overburden/Lithologic Description
0		**Ground Surface**
		SANDY LEAN CLAY(CL) stiff; white and tan
5		SANDY FAT CLAY(CH) very stiff; red, tan, and white
		–white, tan, and red
10		SANDY LEAN CLAY(CL) very stiff; red and yellow
		–hard; red and yellow
15		FAT CLAY WITH SAND(CH) very stiff; red and yellow
20		
25		
30		SILTY SAND(SM) very dense; yellow and red
35		SANDY LEAN CLAY(CL) very stiff; grey; with iron oxide cemented sandstone gravel
40		CLAYEY SAND(SC) very dense; dark gray
45		SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated
50		CLAYEY SAND(SC) very dense; dark gray
		Bottom of Boring @ 50'

FID (ppm) | Graphic Log | Well Construction Graphics



Depth Feet	Well Construction Details
0	T.O.C. Elev. .
5	
10	
15	
20	
25	
30	
35	
40	
45	
50	

Driller Doug Hinds

Logged By Blake Hobbs

Drilling Started 10/20/09

Drilling Completed

Construction Completed

Development Completed

Type of Well

Drilling Method Flight Augers

Borehole Diameter 6.5"

Well Casing 2.0" **Dia.** 0.0' **to** 28.0'

Casing Type PVC

Well Screen 2.0" **Dia.** 28.0' **to** 38.0'

Screen Type Slotted

Slot Size 0.010"

Grout Type Bentonite

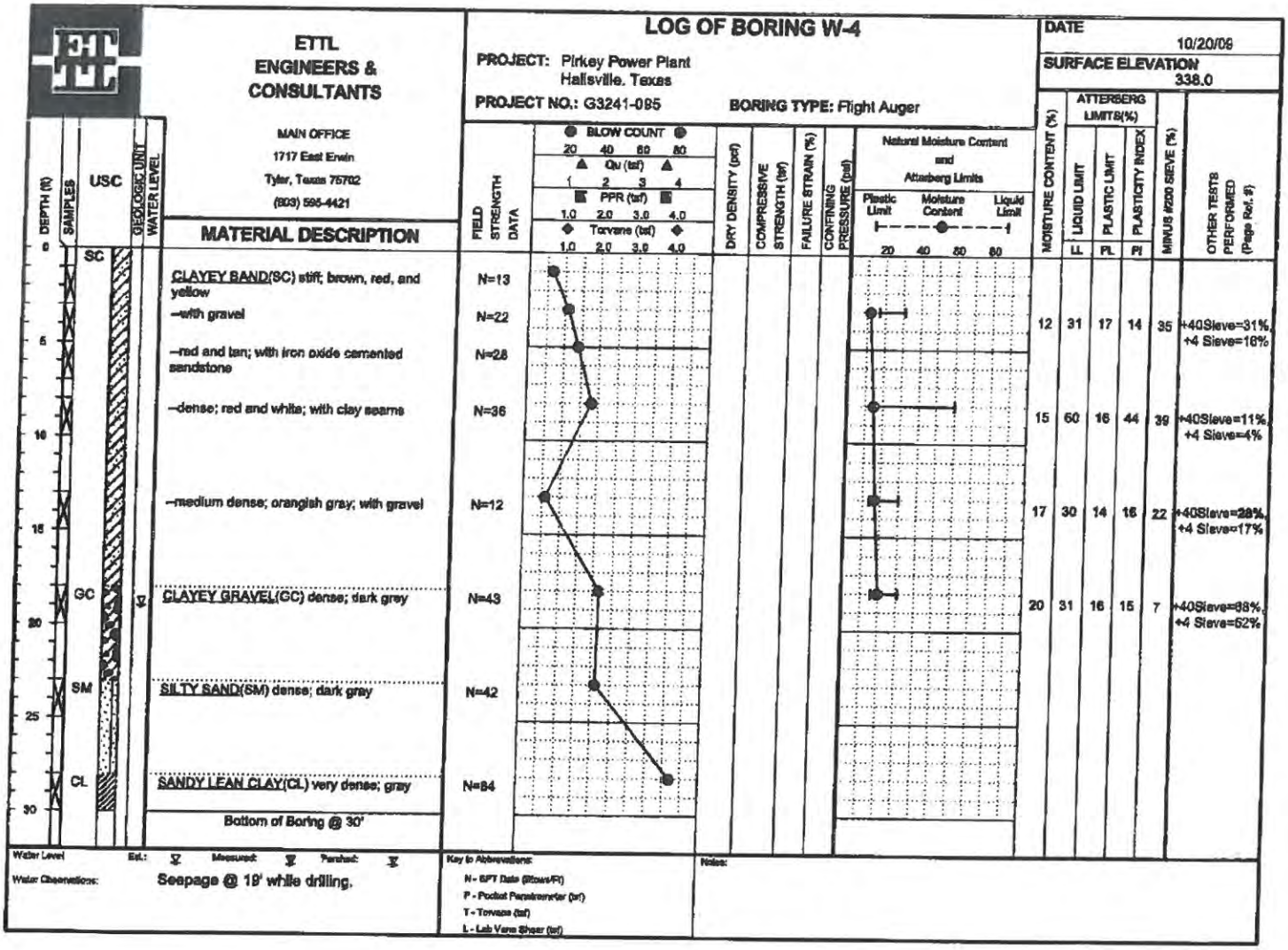
Bentonite Seal 1-26' & 38-50'

Filter Pack Qty. 26-38'

Filter Pack Type 20/40 Sand

Static Water Level

Notes:



ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-4

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-085

BORING TYPE: Flight Auger

DATE: 10/20/09

SURFACE ELEVATION: 338.0

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		SC			CLAYEY SAND(SC) stiff; brown, red, and yellow	N=13										
					--with gravel	N=22					12	31	17	14	35	+40Sieve=31%, +4 Sieve=16%
5					--red and tan; with iron oxide cemented sandstone	N=28										
					--dense; red and white; with clay seams	N=36					15	60	16	44	39	+40Sieve=11%, +4 Sieve=4%
10																
					--medium dense; orangish gray; with gravel	N=12					17	30	14	16	22	+40Sieve=28%, +4 Sieve=17%
15																
		GC			CLAYEY GRAVEL(GC) dense; dark grey	N=43					20	31	16	15	7	+40Sieve=68%, +4 Sieve=62%
20																
		SM			SILTY SAND(SM) dense; dark gray	N=42										
25																
		CL			SANDY LEAN CLAY(CL) very dense; gray	N=84										
30					Bottom of Boring @ 30'											

FIELD STRENGTH DATA: BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0)

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20, 40, 60, 80)

Water Level — Est.: ▽ Measured: ▽ Perched: ▽

Water Observations: Seepage @ 19' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-8
LOCATION: Hallsville,TX

Date: 9-15-83 Type: Ground Elevation: 347.1

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
5			Red and brown slightly sandy silty clay Red and brown silty clay with silt lenses Red and brown silty sandy clay
10			Bottom of boring at 6 feet. No water encountered.
15			
20			
25			
30			
35			
40			
45			
50			

SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-9
LOCATION: Hallsville,TX

Date: 9-15-83 Type: Ground Elevation: 348.1

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
5			Red and grey silty clay with silty sand Red and grey silty sandy clay Red and grey silty sandy clay
10			Bottom of boring at 6 feet. No water encountered.
15			
20			
25			
30			
35			
40			
45			
50			

SOUTHWESTERN LABORATORIES

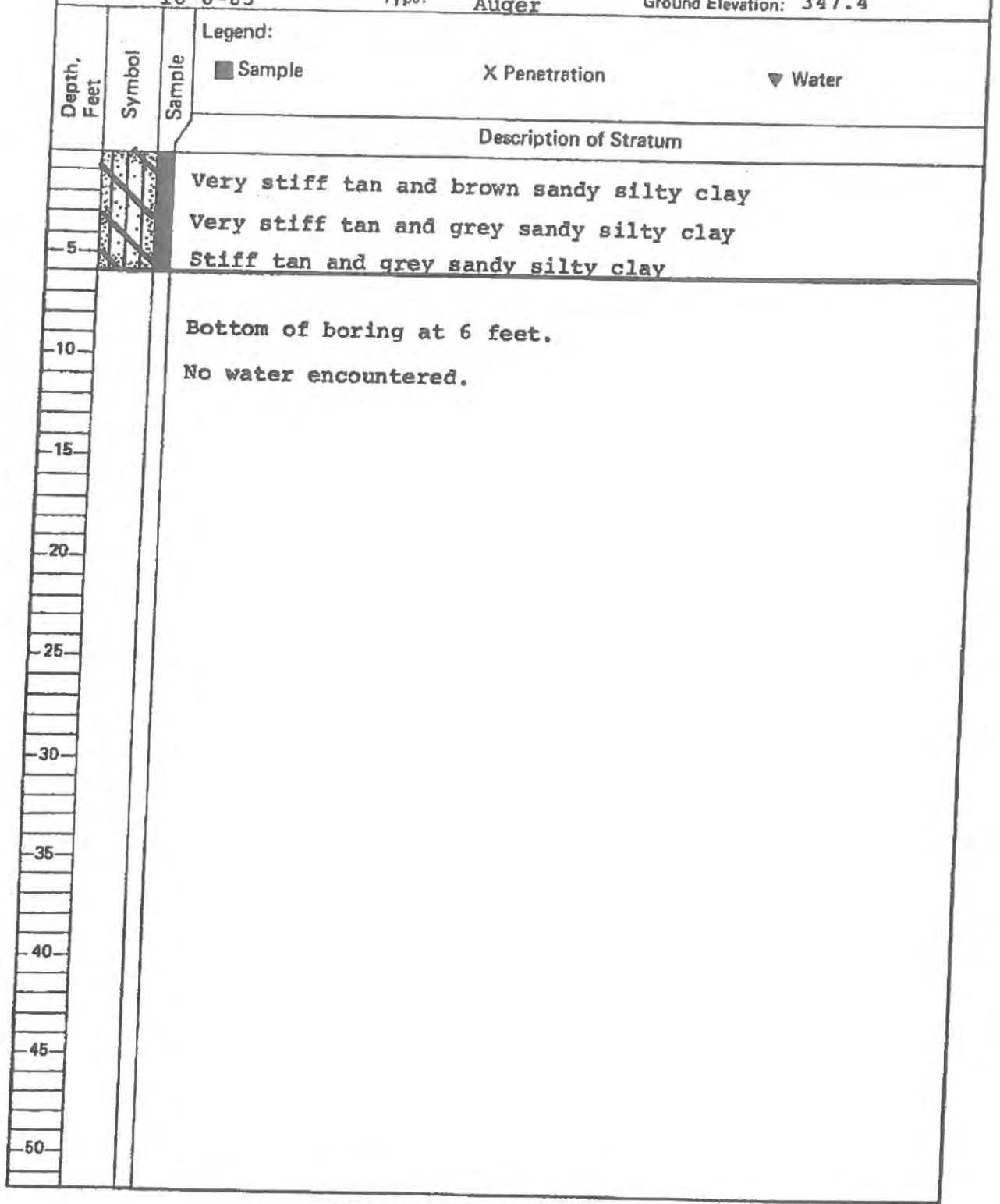
832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-10
LOCATION: Hallsville

Date: 10-6-83 Type: Auger Ground Elevation: 347.4



SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-11
LOCATION: Hallsville

Date: 10-6-83 Type: Auger Ground Elevation: 347.0

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
5			Very stiff tan and grey sandy silty clay lenses Very stiff tan and grey silty clay lenses Very stiff tan and grey silty clay lenses
10			Bottom of boring at 6 feet. No water encountered.
15			
20			
25			
30			
35			
40			
45			
50			

SOUTHWESTERN LABORATORIES

ARCADIS

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
1	8/19/2015

Direction Photo Taken:

South

Description:

P8190378
View across East and West Botton Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
2	8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190379
Road side ditch, not considered a wetland, due to lack of hydric vegetation and connectivity.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
3	8/19/2015

Direction Photo Taken:

Northeast

Description:

P8190383
Upland forest bordering north of West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
4	8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190385
Pizometer along West Bottom Ash Pond perimeter embankment road.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
5	8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190386
Pizometer along West Bottom Ash Pond perimeter embankment road.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
6	8/19/2015

Direction Photo Taken:

North

Description:

P8190387

AD-3 in the wooded area east of West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
7	8/19/2015

Direction Photo Taken:

Description:

P8190390
Dry (non-wetland) ditch adjacent to railroad and West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
8	8/19/2015

Direction Photo Taken:

West Northwest

Description:

P8190392
West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
9	8/19/2015

Direction Photo Taken:

East Southeast

Description:

P8190396
West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
10	8/19/2015

Direction Photo Taken:

Northeast

Description:

P8190399
Upland drainage at the toe of the West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
11	8/19/2015

Direction Photo Taken:

Northeast

Description:

P8190403
Vegetated strip around culvert that drains East and West BAPs. This potential wetland may be jurisdictional and is associated with an intermittent stream.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
12	8/19/2015

Direction Photo Taken:

Southwest

Description:

P8190411
Small vegetated strip adjacent to access road south of southeast corner of West Botton Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
13	8/19/2015

Direction Photo Taken:

West Northwest

Description:

P8190414
Looking across West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
14	8/19/2015

Direction Photo Taken:

South Southeast

Description:

P8190417
West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
15	8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190419
Small vegetated strip in outside corner of access road south of southeast corner of West Botton Ash Pond.

ARCADIS
Infrastructure · Water · Environment · Buildings

Imagine the result

American Electric Power Service Corporation

Stack Out Area - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

May 25, 2016

ARCADIS

Kenneth Brandner, P.E., P.G.
Senior Project Engineer

Matthew J. Lamb
Project Manager

John Holm, P.E.
Professional Engineer

Stack Out Area - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Prepared for:
AEP

Prepared by:
ARCADIS U.S., Inc.
100 E Campus View Blvd
Suite 200
Columbus
Ohio 43235-1447
Tel 614 985 9100
Fax 614 985 9170

Our Ref.:
OH015976.0010

Date:
May 25, 2016

Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
PTI	Permit to Install
TDS	total dissolved solids

ARCADIS

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the adequacy of the groundwater monitoring well network included in the Coal Combustion Residual (CCR) requirements, as specified in Code of Federal Regulations (CFR) 40 CFR 257.91, for the Stack Out Area CCR Unit at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above and isolated from the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zone, or in an unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report summarizes the evaluation of the groundwater monitoring well network in the uppermost aquifer at the Stack Out Area. The evaluation of the location restriction criteria is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the Stack Out Area CCR unit, as well as publically-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on all documents reviewed and will further describe the uppermost aquifer, include an evaluation of the adequacy of the existing monitoring well network, and provide recommendations for monitoring well augmentation, as necessary.

ARCADIS

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant Stack Out Area.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The Stack Out Area CCR unit is located in the central portion of the Plant, and approximately 1,200 feet northwest of Brandy Branch Reservoir (**Figures 1** and **2**).

2.2 Description of Stack Out Area CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the Stack Out Area.

2.2.1 Stack Out Area Configuration

The Stack Out Area is an approximate 7-acre storage area for stabilized flue gas desulfurization (FGD) sludge. As shown on **Figure 3**, the Stack Out Area is located directly south of the Surge Pond, directly west of Thickener Tanks 1A and 1B, and directly east of a road that runs south to the on-site Landfill. The dimensions of the Stack Out Area are approximately 650 feet from north to south by 450 feet from east to west.

Stabilized FGD sludge is temporarily stockpiled directly above natural ground surface (native clay) in the Stack Out Area using a radial stacker. The maximum height of the stabilized FGD sludge piles are approximately 41 feet above ground surface. There are no solids retention structures in the Stack Out Area. The stabilized FGD sludge piles are located no closer than approximately 50 feet from the perimeter of the Stack Out Area, thereby preventing the stabilized FGD sludge from migrating beyond the boundaries of the Stack Out Area.

2.2.2 Area/Volume

The Stack Out Area is approximately 7 acres in size. However, as discussed above in Section 2.2.1, the CCR piles in the Stack Out Area are located no closer than approximately 50 feet from the perimeter of the Stack Out Area, therefore the effective storage area of the Stack Out Area is approximately 4.4 acres (550 feet by 350 feet),

ARCADIS

and the maximum CCR storage volume based on a maximum CCR pile height of 41 feet is 180 acre feet.

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, FGD sludge) have been generated. The Stack Out Area receives stabilized FGD sludge (**Figure 3**). Prior to storing the FGD sludge in the Stack Out Area, the FGD sludge is dewatered using belt presses, and the dewatering fluid is routed to the Surge Pond for reuse as FGD makeup water. The stabilized FGD sludge is then stockpiled in the Stack Out Area using a radial stacker with an approximate 3-foot-wide by 120-foot-long conveyor belt.

The stabilized FGD sludge is temporarily stored at the Stack Out Area. The stabilized FGD sludge is removed using front-end loaders or similar equipment, placed into trucks, and disposed of at the on-site Landfill CCR Unit located near the south end of the Plant.

Lithologic data from soil borings and monitoring wells confirm the native soils underling the Stack Out Area consist of low-permeability clay. As shown on Geologic Cross Sections B-B' (**Figure 5**) and E-E' (**Figure 8**), the native clay directly below the Stack Out Area extends from the surface to an average depth of approximately 20 feet. Therefore, as shown on **Figures 5** and **8**, the separation distance between the base of the Stack Out Area and uppermost aquifer exceeds 5 feet.

2.2.4 Surface Water Control

The Stack Out Area contains dewatered FGD sludge that is stockpiled using a radial stacker, therefore no sluice water is present in the Stack Out Area. Storm water in the Stack Out Area follows surface topography via gravity sheet flow. The ground surface elevation in the Stack Out Area ranges from approximately 360 to 365 feet amsl (Akron Consulting, 2015). Storm water flow in the Stack Out Area is in a general northerly direction to the Surge Pond, which is a below-grade (incised) non-CCR unit.

2.3 Previous Investigations

The initial soils investigation and design of the Plant was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, including the Stack Out Area.

ARCADIS

In 2009, ETTL Engineers & Consultants (ETTL) conducted geotechnical investigations of earthen embankments associated with several ponds at the Plant. The Stack Out Area was not included in this evaluation because there are no earthen embankments in the Stack Out Area (ETTL, 2010).

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, 2011).

In 2011, Johnson & Pace performed hydraulic analysis of several ponds at the Plant. The Stack Out Area was not included in this evaluation because there is no impounded water in the Stack Out Area (Johnson & Pace, May 2011).

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of six monitoring wells (AD-30 through AD-35) (Auckland Consulting, 2016).

2.4 Hydrogeologic Setting

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of approximately 100 feet (Broom, 1966).

These features are further illustrated on five lines of cross section that were prepared through the Stack Out Area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A') through **Figure 8** (E-E').

ARCADIS

2.4.1 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1° Fahrenheit (F) in January to 83.8°F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.2 Regional and Local Geologic Setting

The central and northern portions of the Plant, including the Stack Out Area, are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

Figure 9 is a potentiometric surface map based on January 2016 water level data for the uppermost aquifer at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figure 9**, shallow groundwater flow direction in the Stack Out Area is northwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The Stack Out Area is located approximately 1,200 feet northwest of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figure 9**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow groundwater in the Stack Out Area does not discharge into Brandy Branch Reservoir.

ARCADIS

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled approximately 1,000 feet north of the Stack Out Area in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 350 to 430 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled approximately ¼-mile west (downgradient) of the Stack Out Area for NFR Energy in 2008 for use as a rig supply well. The water well was screened from 250 to 310 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (upgradient) of the Pirkey Power Plant.

ARCADIS

3. Groundwater Monitoring Well Network Evaluation

The existing monitoring well network present at the Site was evaluated to determine if any of the wells were viable for continued use as part of the groundwater monitoring well network or also retained as part of a larger groundwater hydraulic monitoring well network. The hydrogeologic conditions were also evaluated to determine if the uppermost aquifer unit has an effective well network. The evaluation was completed in accordance with 40 CFR 257.91 to have an established monitoring well network that effectively monitors the uppermost aquifer up gradient and down gradient of the Site. The up gradient wells represent background groundwater quality and the down gradient wells are to be placed down gradient of the CCR unit boundary to monitor water quality.

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost aquifer in the Stack Out Area is a very fine to fine grained clayey and silty sand stratum with an average thickness of approximately 20 feet that is located between an elevation of approximately 320 and 340 feet amsl (**Appendix A**). The base of the Stack Out Area is at an elevation of 360 feet amsl. The separation distance between the uppermost aquifer and the base of the Stack Out Area ranges from approximately 10 to 20 feet. This separation distance is further illustrated on cross section B-B' (**Figure 5)** and cross section E-E' (**Figure 8)**.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer unit (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness in the Stack Out Area (approximately 20 feet), the yield of the uppermost aquifer is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Available groundwater elevations are summarized on **Table 1** for 2011 through 2016. The most recent comprehensive groundwater data set from January 20, 2016 is depicted on **Figure 9**. The groundwater flow direction in the Stack Out Area is northwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

ARCADIS

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

Per 40 CFR 257.60(a), new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five ft) above the upper limit of the uppermost aquifer, or must demonstrate there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high conditions).

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as 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 groundwater surface to which the aquifer rises during the wet season.

3.2.1.1 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the Stack Out Area is the clayey and silty sand stratum that is located between an elevation of approximately 320 and 340 feet amsl.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 19, 2015 to review existing well network conditions and locations. A well construction table that summarizes the location, ground surface elevation, borehole depth, installation date, and associated well construction details of the monitoring well network is included as

ARCADIS

Table 2. Photo documentation of the located wells during the August 19, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-7, AD-12, AD-13, and AD-22 were previously installed at the Site to monitor the uppermost water-bearing unit (clayey and silty sand stratum) associated with the Stack Out Area. As discussed above in Section 3.1.1, the uppermost water-bearing unit below the Stack Out Area is approximately 20 feet thick and is located between an elevation of approximately 320 and 340 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on Geologic Cross Sections B-B' (**Figure 5**) and E-E' (**Figure 8**), existing monitoring wells AD-7 and AD-22 are screened in the uppermost water-bearing unit downgradient (northwest) of the Stack Out Area, and will be utilized as downgradient monitoring wells for the Stack Out Area. Existing monitoring wells AD-12 and AD-13 are screened in the uppermost water-bearing unit up gradient (east) of the Stack Out Area, and will be utilized as up gradient monitoring wells for the Stack Out Area.

As shown on **Figure 9**, shallow groundwater flow direction in the Stack Out Area is northwesterly. Two existing monitoring wells (AD-7 and AD-22) were located hydraulically downgradient of the Stack Out Area during the August 19, 2015 site visit, and three downgradient monitoring wells are required to monitor groundwater quality downgradient of a CCR unit. This data gap was addressed by installation of new downgradient monitoring well AD-33 during December 2015 as shown on **Figure 9** and **Figure 10**. With the addition of monitoring well AD-33 on the west side of the Stack Out Area, there are no gaps remaining in the groundwater monitoring network for the Stack Out Area.

ARCADIS

4. Recommended Monitoring Network and PE Certification

The recommended existing groundwater monitoring well network is intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the Stack Out Area (up gradient or down gradient), well depth, and well construction. The recommended network would provide an improved understanding of groundwater quality, hydraulics, and groundwater flow at the Stack Out Area.

4.1 Recommended Monitoring Well Network Distribution

Two up gradient well locations (existing monitoring wells AD-12 and AD-13) and three down gradient well locations (existing monitoring wells AD-7, AD-22, and AD-33) are recommended to establish a groundwater quality monitoring well network for the Stack Out Area.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the Stack Out Area is summarized on **Table 3** and illustrated on **Figure 10.**

4.1.2 Depth

The screen depths for the monitoring wells recommended for inclusion in the monitoring network are within the shallow saturated sand stratum (uppermost aquifer) that occurs between an elevation of approximately 320 and 340 feet amsl as shown on Geologic Cross Sections B-B' (**Figure 5**) and E-E' (**Figure 8**). The screen elevations are presented in **Table 3**.

4.1.3 Well Construction

As discussed above in Section 3.3.2, the gap in the monitoring well network for the uppermost aquifer at the Stack Out Area was addressed by installation of monitoring well AD-33 during December 2015. Monitoring well AD-33 was installed by a Texas Department of Licensing and Regulation (TDLR)-licensed water well driller. Well construction data for the monitoring well network are summarized on **Tables 2** and **3**, and the monitoring well completion diagrams are provided in **Appendix A.**

ARCADIS

4.2 Professional Engineer's Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, the proposed groundwater monitoring system will be adequate to meet the requirements of 40 CFR Part 257.91.

Kenneth J. Brandner

Printed Name of Registered Professional Engineer

Kenneth J Brandner

Signature

69586	Texas	5-25-16
Registration No.	Registration State	Date

ARCADIS

5. References

Akron Consulting, Ltd., "October 2015 Stackout Aerial", October 2015.

AMEC, "Report of Dam Safety Assessment of Coal Combustion Surface Impoundments, American Electric Power (AEP) and Southwest Electric Power Company (SWEPCO) H.W. Pirkey Power Plant, Hallsville, TX", August 2011.

Apex Geoscience Inc., "USWAG Monitoring Wells and Groundwater Evaluation, AEP Pirkey Power Station, Hallsville, Texas", March 2011.

Auckland Consulting, LLC, "Monitoring Well Installation – 2015, Pirkey Generating Station, Hallsville, Texas", January 26, 2016.

Banks Information Solutions, "Water Well Report, Pirkey Power Plant, 2400 FM 3251, Hallsville, Texas, Harrison County", October 8, 2015.

Broom, M.E., and B. N. Myers, "Ground-Water Resources of Harrison County, Texas", Texas Water Development Board Report 27, August 1966.

ETTL Engineers & Consultants Inc., "Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas", October 2010.

Fetter, C.W., "Applied Hydrogeology", University of Wisconsin – Oshkosh, 1980.

Flawn, Peter T., "Geologic Atlas of Texas, Tyler Sheet", The University of Texas at Austin Bureau of Economic Geology, March 1965.

George, Peter G., et. al., "Aquifers of Texas", Texas Water Development Board Report 380, July 2011.

Johnson & Pace Incorporated, "Hydrology & Hydraulic Report, North Surge Pond, East & West Ash Ponds, Secondary Ash Pond, Landfill Pond, H.W. Pirkey Power Plant, Hallsville, Texas", May 2011.

Johnson & Pace Incorporated, "East Bottom Ash Pond June 2011 As-Built Plan & Profile, H.W. Pirkey Power Plant, Hallsville, Texas", June 2011.

Sargent & Lundy, "Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities", January 31, 1983.

ARCADIS

Sargent & Lundy, "Henry W. Pirkey Power Plant Unit 1, Wastewater Ponds – Liner Verification & Monitoring Wells", September 14, 1984.

Southwestern Laboratories, "Subsurface Exploration, Waste Water Ponds, Pirkey Power Plant, Hallsville, Texas", September 7, 1984.

Texas Commission on Environmental Quality, "Groundwater Classification, RG-366/TRRP-8", March 2010.

USGS, Aquifers and Groundwater. 2015. Available online at www.usgs.gov.

USGS, "Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin", Open-File Report 88-450K, 1988.

USGS, "Texas Seismic Hazard Map", 2014.

ARCADIS

Tables

ARCADIS

Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[a]	Top of Casing Elevation[a]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen[b]		Bottom of Screen[b]		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																					
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48
AD-30[d]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70
AD-31[d]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60
AD-32[d]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32
AD-33[d]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13
AD-34[d]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61
AD-35[d]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85
Piezometers[c]																					
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	NM	NM	NM	NM	NM	NM	NM	NM	NM

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
NM - Not Measured

ARCADIS

Table 2
Well Construction Details
AEP Pirkey Power Plant - CCR Units
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[a]	Top of Casing Elevation[a]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen[b]		Bottom of Screen[b]	
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
Monitoring Wells																
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	18	323	40	301	20	321.25	40	301.25
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	35	338	57	316	37	335.76	57	315.76
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	24	340	46	318	26	337.69	46	317.69
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	18	342	40	320	20	339.61	40	319.61
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	18	339	35	322	20	336.92	35	321.92
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	18	341	40	319	20	339.48	40	319.48
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	29	350	51	328	31	347.84	51	327.84
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	17.5	344.5	40.5	321.5	30.5	331.48	40.5	321.48
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	13	344	35	322	15.0	341.81	35.0	321.81
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	8	335	30	313	10.0	332.65	30.0	312.65
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	13	347	25	335	15.0	345.48	25.0	335.48
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	8	352	30	330	10.0	349.50	30.0	329.50
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	13	339	35	317	15.0	337.30	35.0	317.30
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	8	339	30	317	10.0	337.23	30.0	317.23
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	8	348	30	326	10.0	345.57	30.0	325.57
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	13	334	35	312	15.0	331.72	35.0	311.72
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	3	285	20	268	5.0	282.68	20.0	267.68
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	8	326	30	304	10.0	324.15	30.0	304.15
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	8	334	40	302	10.0	332.41	40.0	302.41
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	15.5	334.3	37.5	312.3	17.5	332.33	37.5	312.33
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	13	323	35	301	15.0	320.92	35.0	300.92
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	8	342	30	320	10.0	340.21	30.0	320.21
AD-30[d]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	8	331	25	314	10.0	329.04	25.0	314.04
AD-31[d]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	18	340	35	323	20.0	337.75	35.0	322.75
AD-32[d]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	11	346	33	324	13.0	344.23	33.0	324.23
AD-33[d]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	12	347	30	329	15.0	344.30	30.0	329.30
AD-34[d]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	8	297	25	280	10.0	294.64	25.0	279.64
AD-35[d]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	2.5	313.5	20	296	3.0	313.01	18.0	298.01
Piezometers[c]																
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	26	330	38	318	28.0	328.30	38.0	318.30

General Note:
Elevations in feet above mean sea level.

Footnotes:
(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011). Top of sand pack estimated 2 feet above top of screened interval.
(c) Souce: EETL (October 2010).
(d) Source: Aukland Consulting LLC (January 26, 2016).
Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

Table 3
Proposed Well Network
AEP Pirkey Power Plant - Stack Out Area
Hallsville, Harrison County, Texas

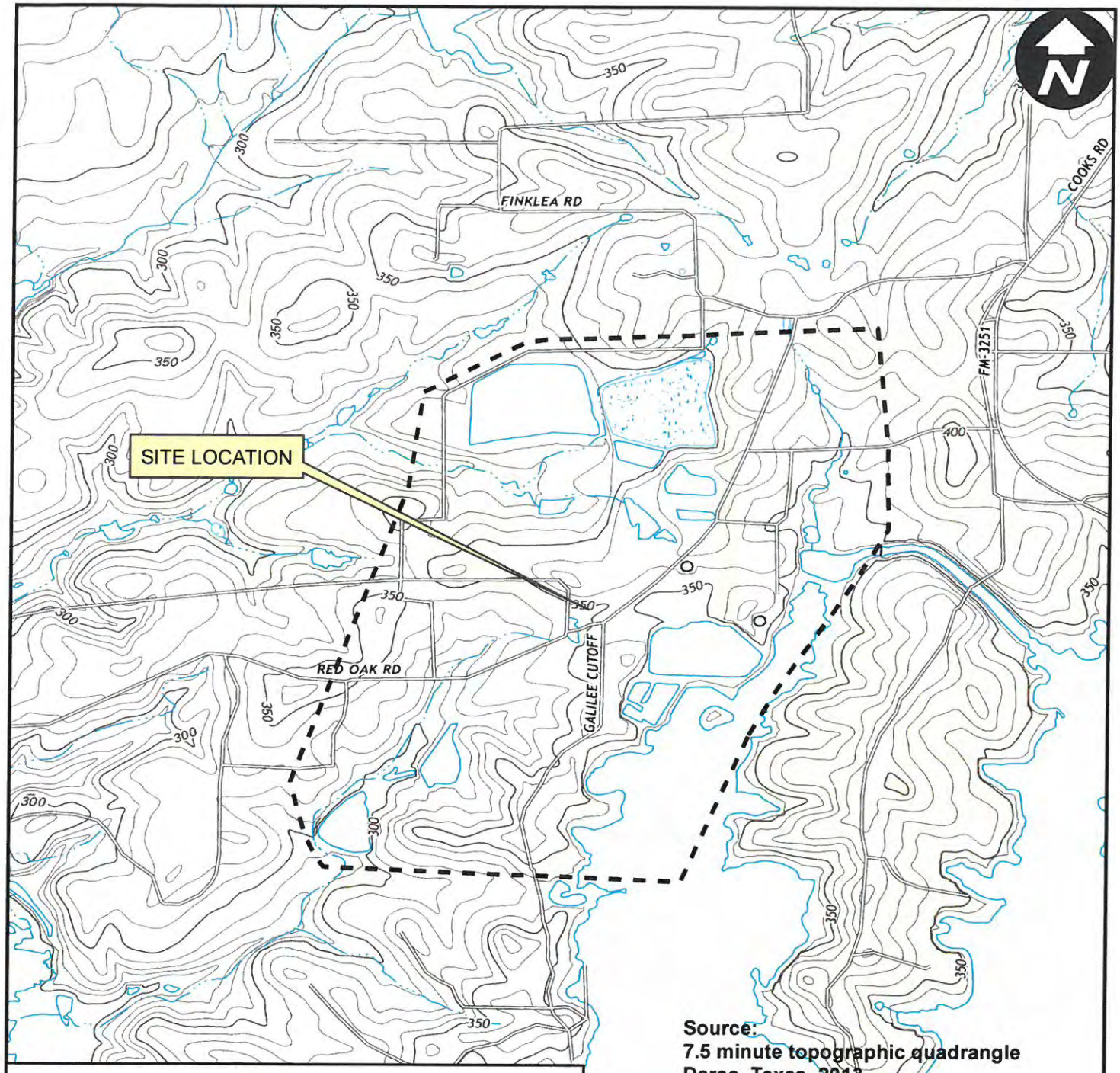
Well ID	Exisiting/ Proposed	Hydrostratigraphic Unit Target	Location Description		Screen Top Target Elevation[(a)] (ft amsl)	Screen Bottom Target Elevation[(a)] (ft amsl)	Screen Length (ft)	Comments
Upgradient								
AD-12	Exisiting	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilitzed to establish backgroud water quality
AD-13	Exisiting	Uppermost Water-Bearing Unit	East of Stack Out Area	Upgradient	331.5	321.5	10	Existing well installed in 1988; well will be utilitzed to establish backgroud water quality
Downgradient								
AD-7	Existing	Uppermost Water-Bearing Unit	Northwest of Stack Out Area	Down gradient	339.6	319.6	20	Existing well installed in 1983; uppermost shallow aquifer adjacent to Stack Out Area - downgradient
AD-22	Existing	Uppermost Water-Bearing Unit	West of Stack Out Area	Down gradient	345.6	325.6	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to Stack Out Area - downgradient
AD-33	Existing	Uppermost Water-Bearing Unit	West of Stack Out Area	Down gradient	344.3	329.3	15	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to Stack Out Area - downgradient

Footnotes:
a. Target elevations are an estimated range.

Acronyms and Abbreviations:
U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

ARCADIS

Figures



Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

0 2,000 4,000

SCALE IN FEET

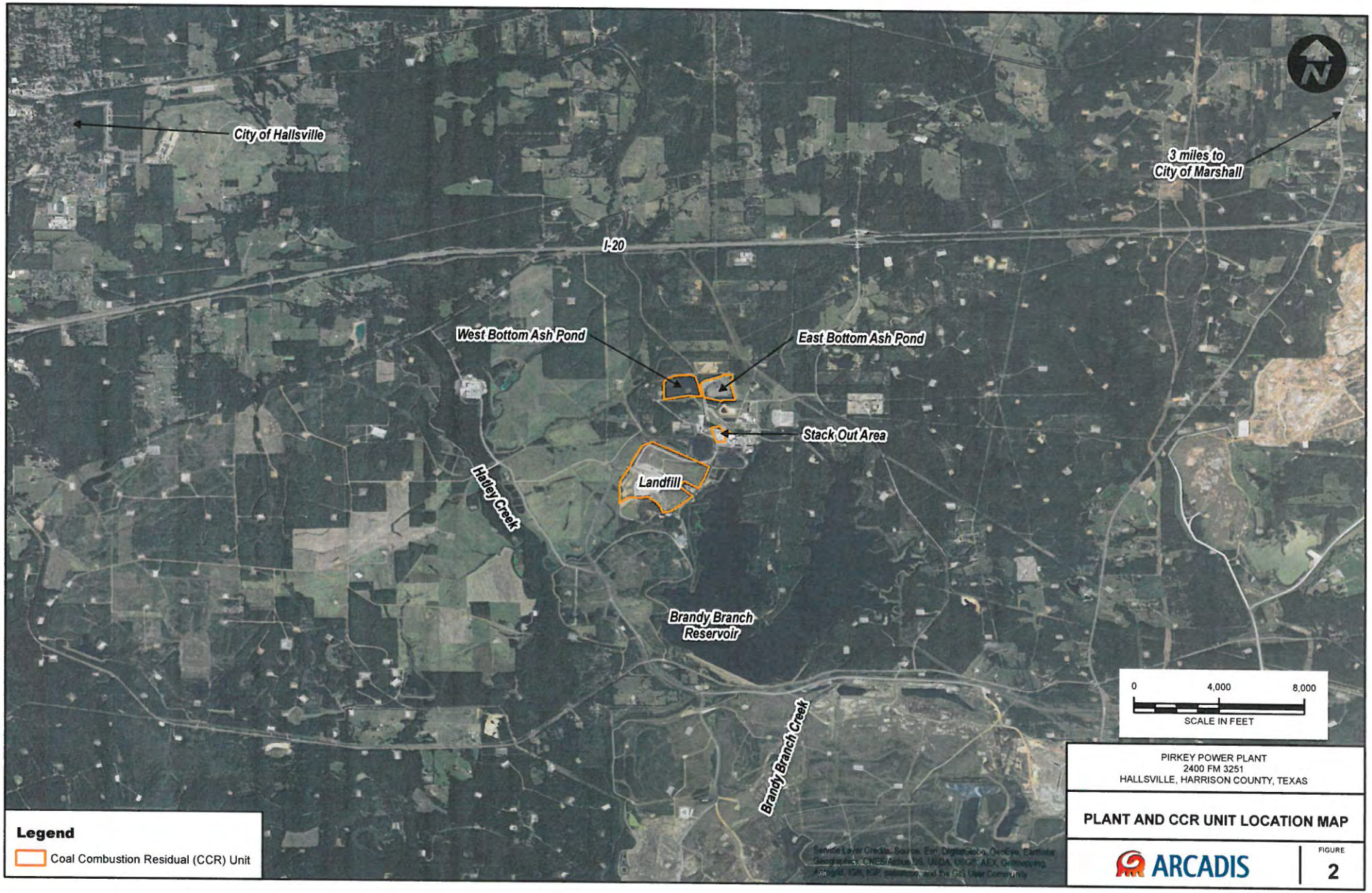
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

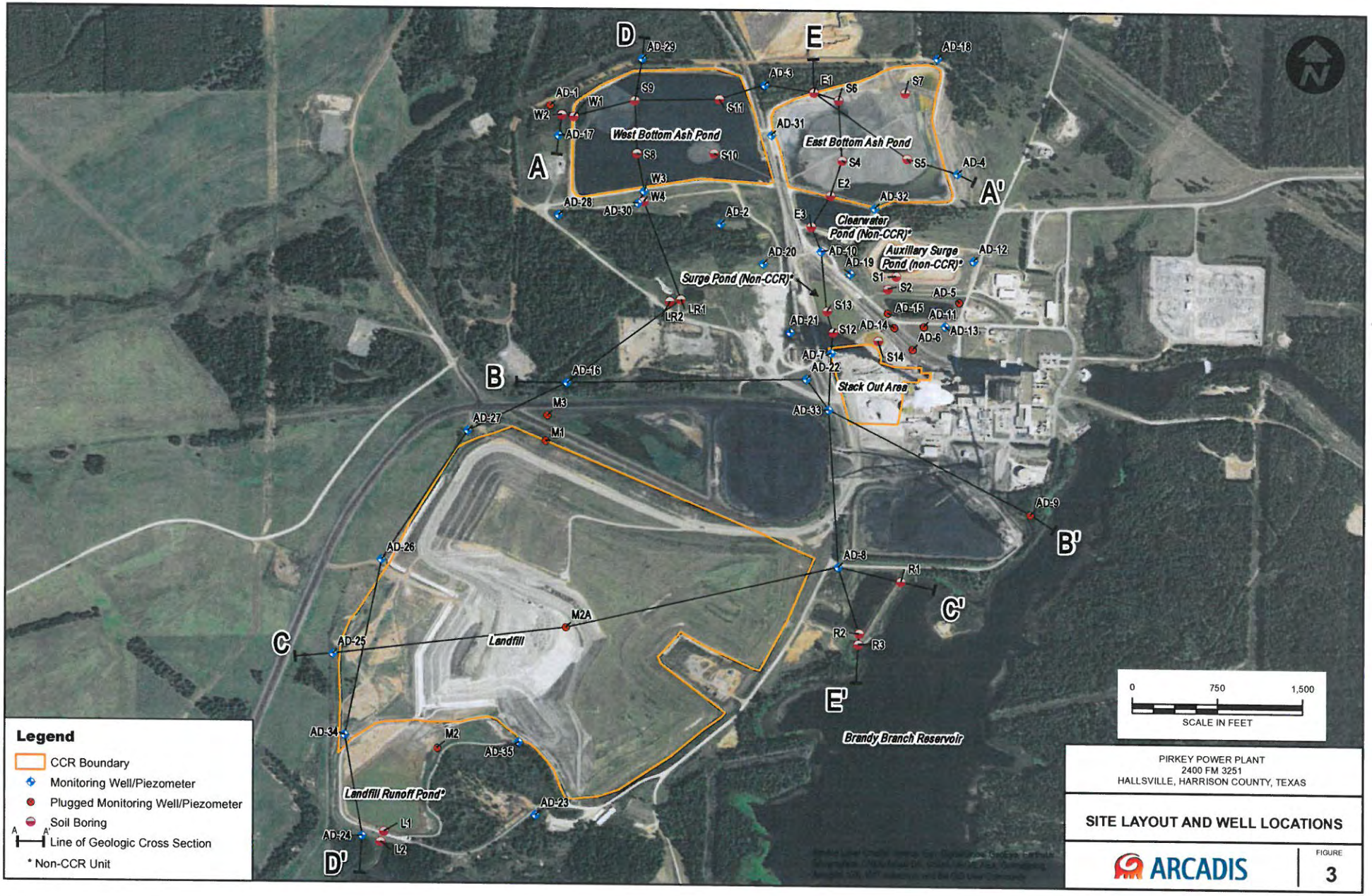
SITE LOCATION MAP

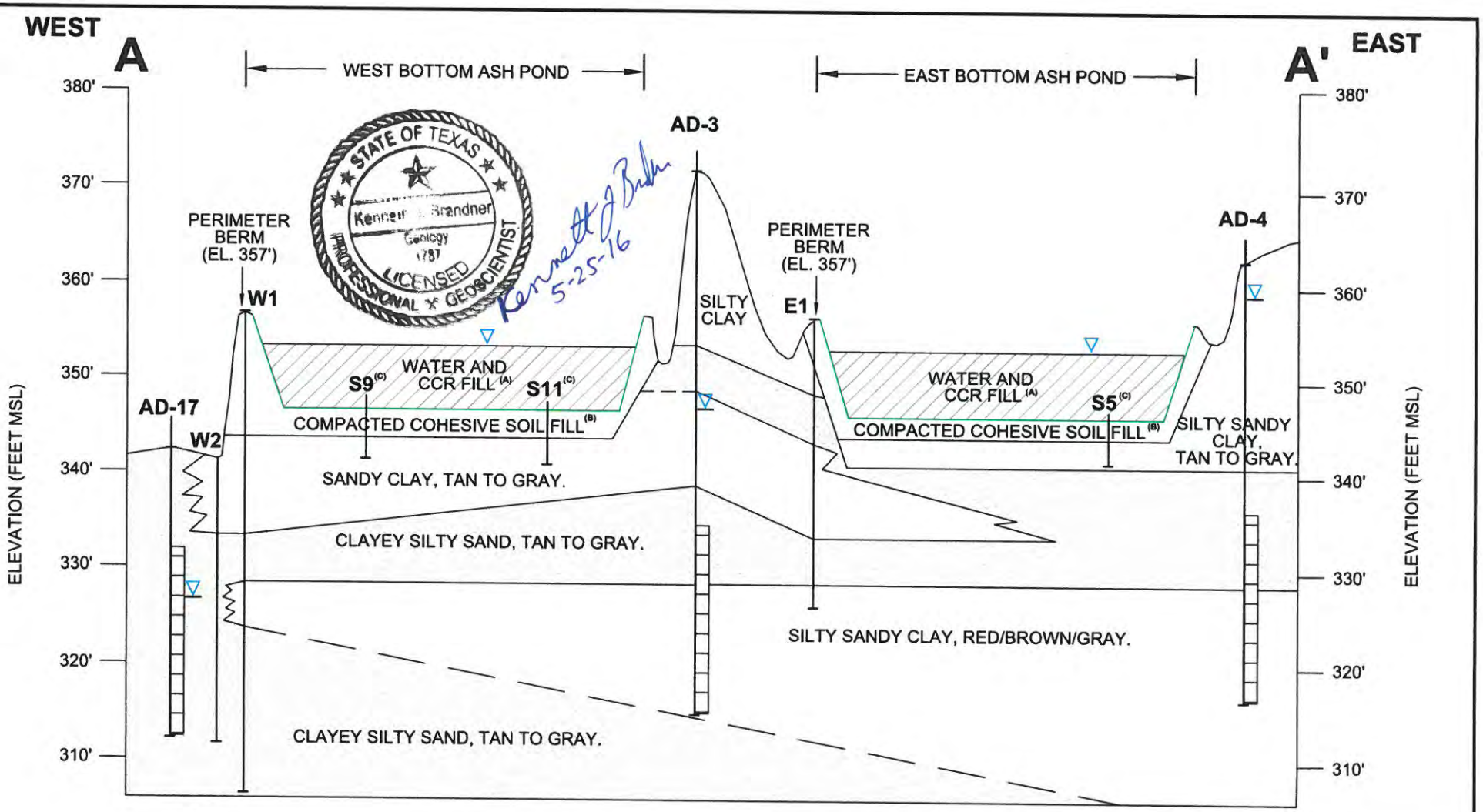
ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENVAEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd


City of Hallsville
3 miles to City of Marshall
I-20
West Bottom Ash Pond
East Bottom Ash Pond
Stack Out Area
Landfill
Hatley Creek
Brandy Branch Reservoir
Brandy Branch Creek
N
0
4,000
8,000
SCALE IN FEET
Legend
Coal Combustion Residual (CCR) Unit
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS
PLANT AND CCR UNIT LOCATION MAP
ARCADIS
FIGURE
2
Document Path: Z:\GIS\PROJECTS_ENVAEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd


D
E
A
A'
B
B'
C
C'
D'
E'
AD-29
AD-18
AD-3
AD-1
W1
W2
S9
S11
S6
S7
E1
AD-17
West Bottom Ash Pond
AD-31
East Bottom Ash Pond
S8
S10
S4
S5
AD-4
W3
W4
E2
AD-28
AD-30
AD-2
AD-32
E3
Clearwater Pond (Non-CCR)*
AD-20
AD-10
AD-19
Auxiliary Surge Pond (non-CCR)*
AD-12
S1
S2
AD-5
Surge Pond (Non-CCR)*
LR1
LR2
S13
AD-15
AD-11
AD-21
S12
AD-14
AD-13
AD-6
AD-7
S14
AD-22
AD-16
Stack Out Area
M3
AD-27
M1
AD-33
AD-9
AD-26
AD-8
R1
M2A
R2
R3
AD-25
Landfill
AD-34
M2
AD-35
Brandy Branch Reservoir
Landfill Runoff Pond*
AD-23
L1
AD-24
L2
0
750
1,500
SCALE IN FEET
Legend
CCR Boundary
Monitoring Well/Piezometer
Plugged Monitoring Well/Piezometer
Soil Boring
Line of Geologic Cross Section
* Non-CCR Unit
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS
SITE LAYOUT AND WELL LOCATIONS
ARCADIS
FIGURE
3
Document Path: Z:\GIS\PROJECTS\L_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd



LEGEND

- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

NOTES:

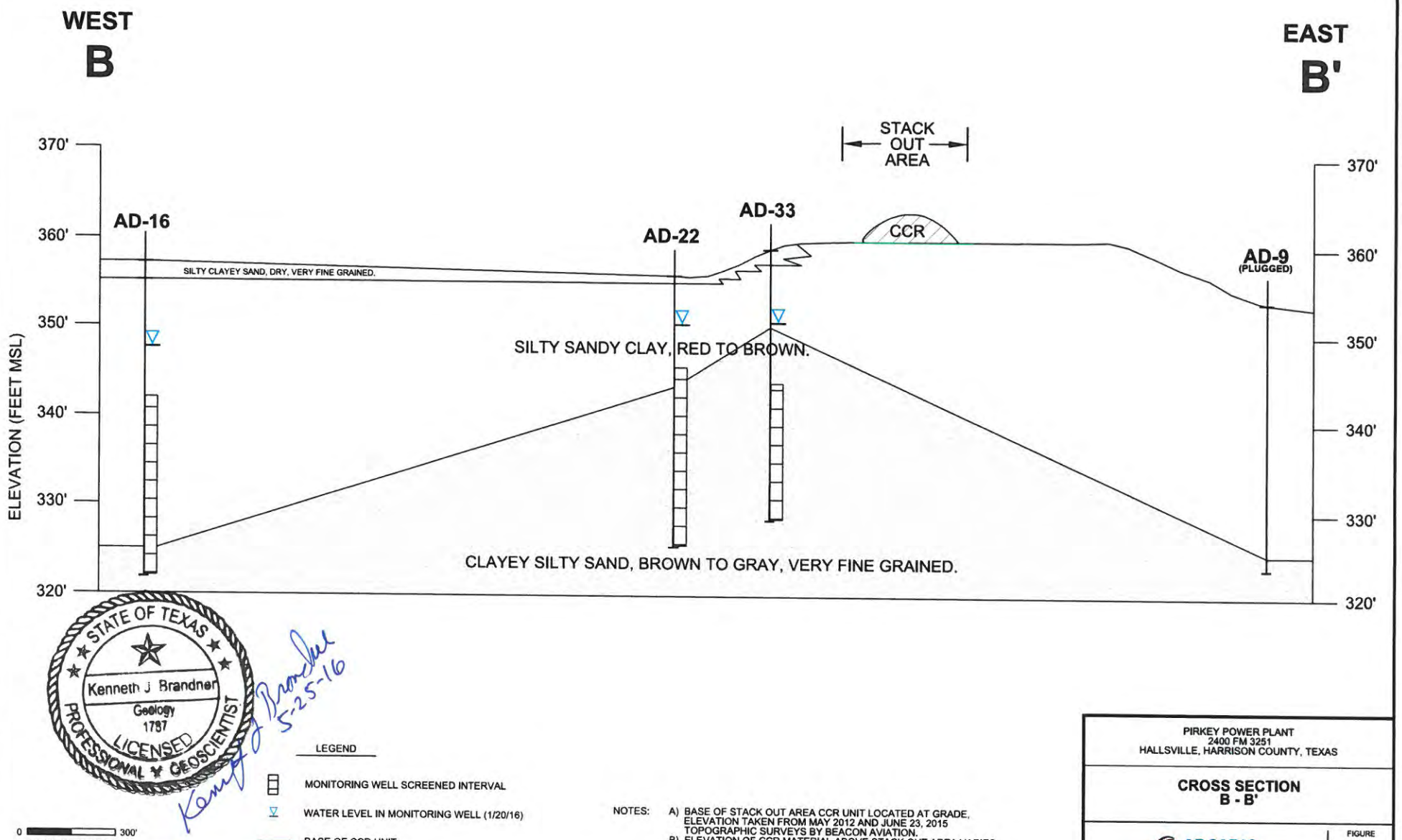
A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).
C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION A - A'

ARCADIS

FIGURE 4



STATE OF TEXAS
Kenneth J Brandner
Geology
1797
LICENSED PROFESSIONAL GEOSCIENTIST

Kenneth J Brandner 5-25-16

LEGEND

- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

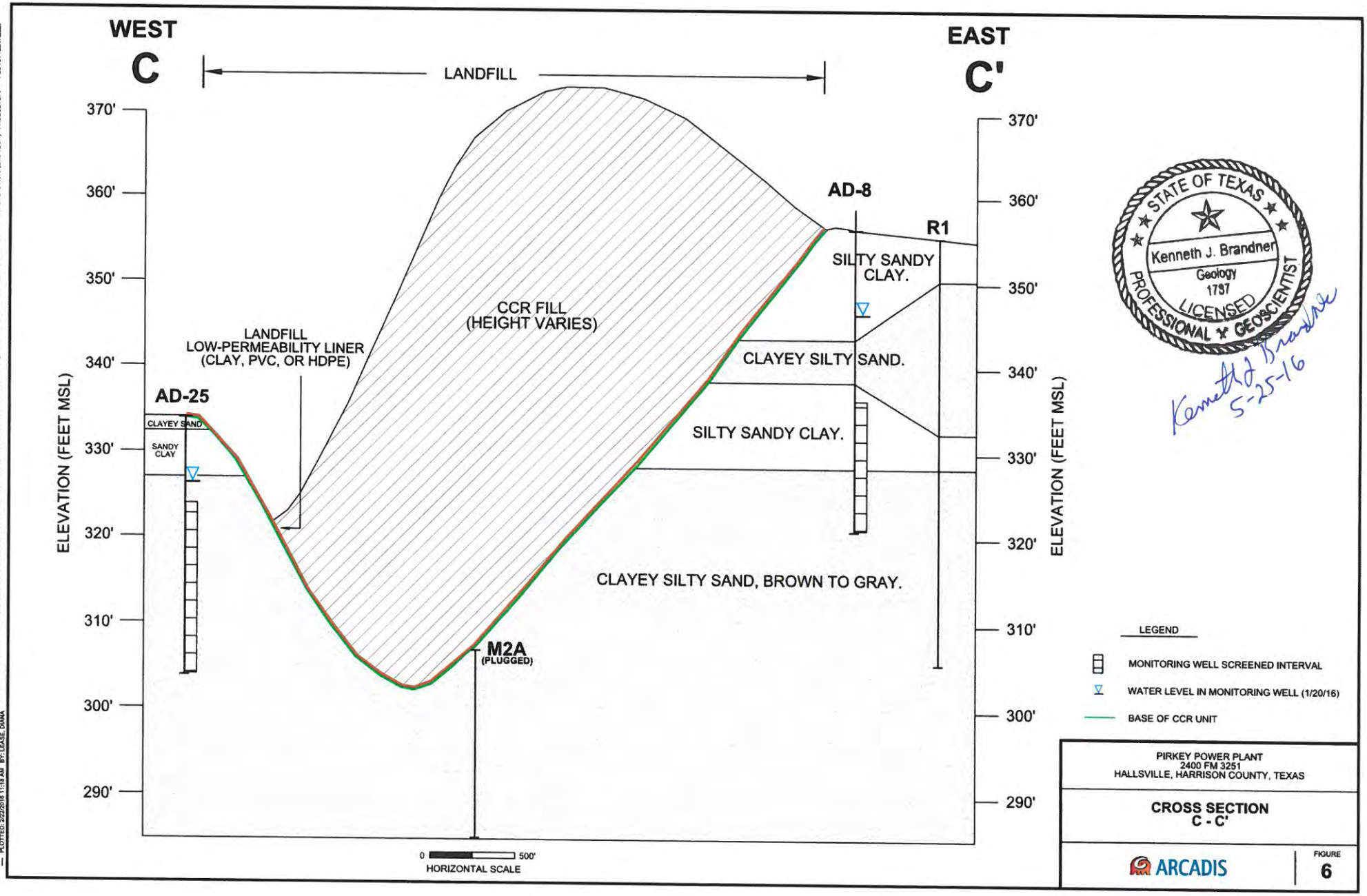
NOTES:
A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE, ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5



STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL GEOSCIENTIST

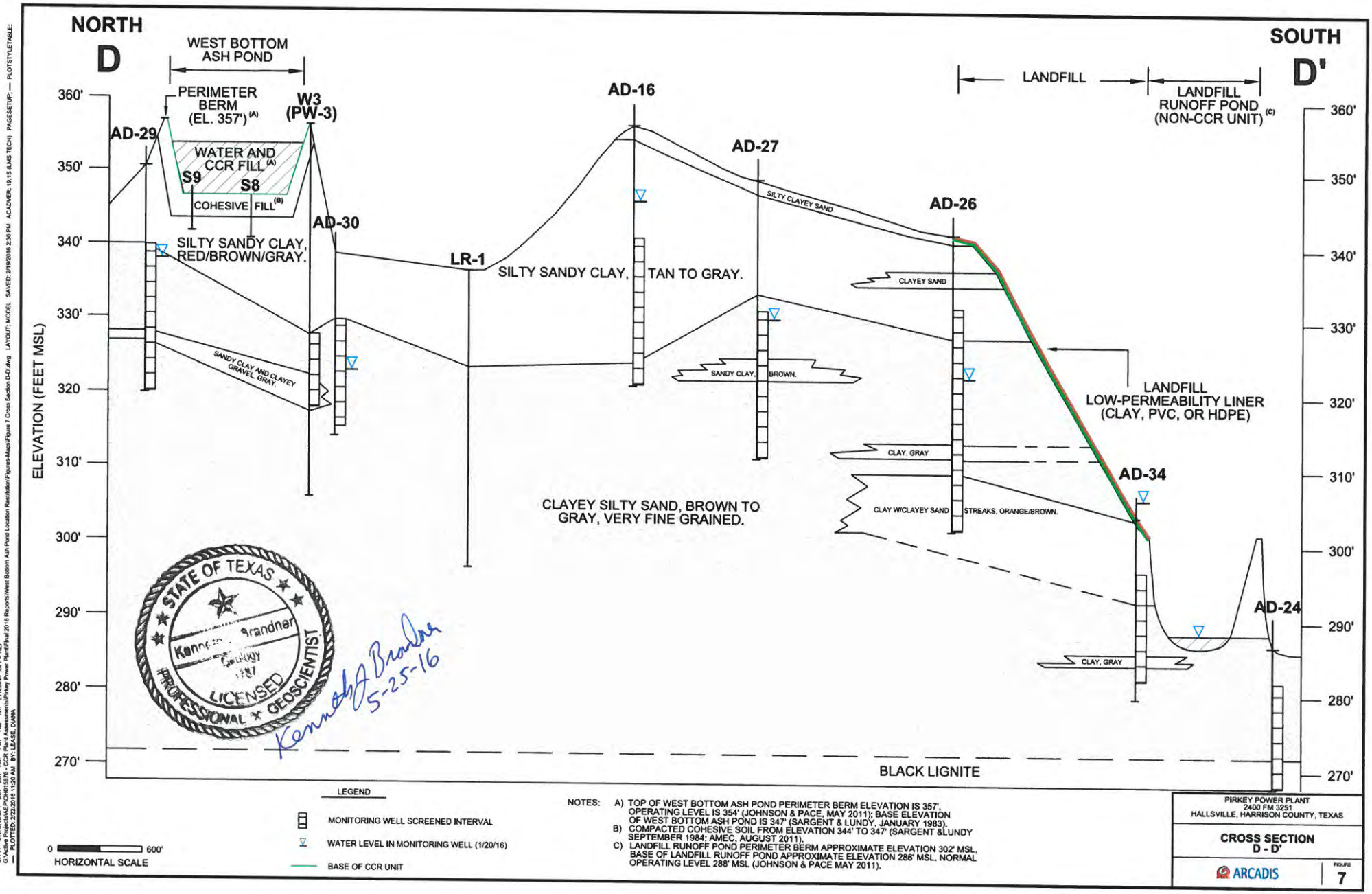
Kenneth J Brandner
5-25-16

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6



NOTES:

A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).

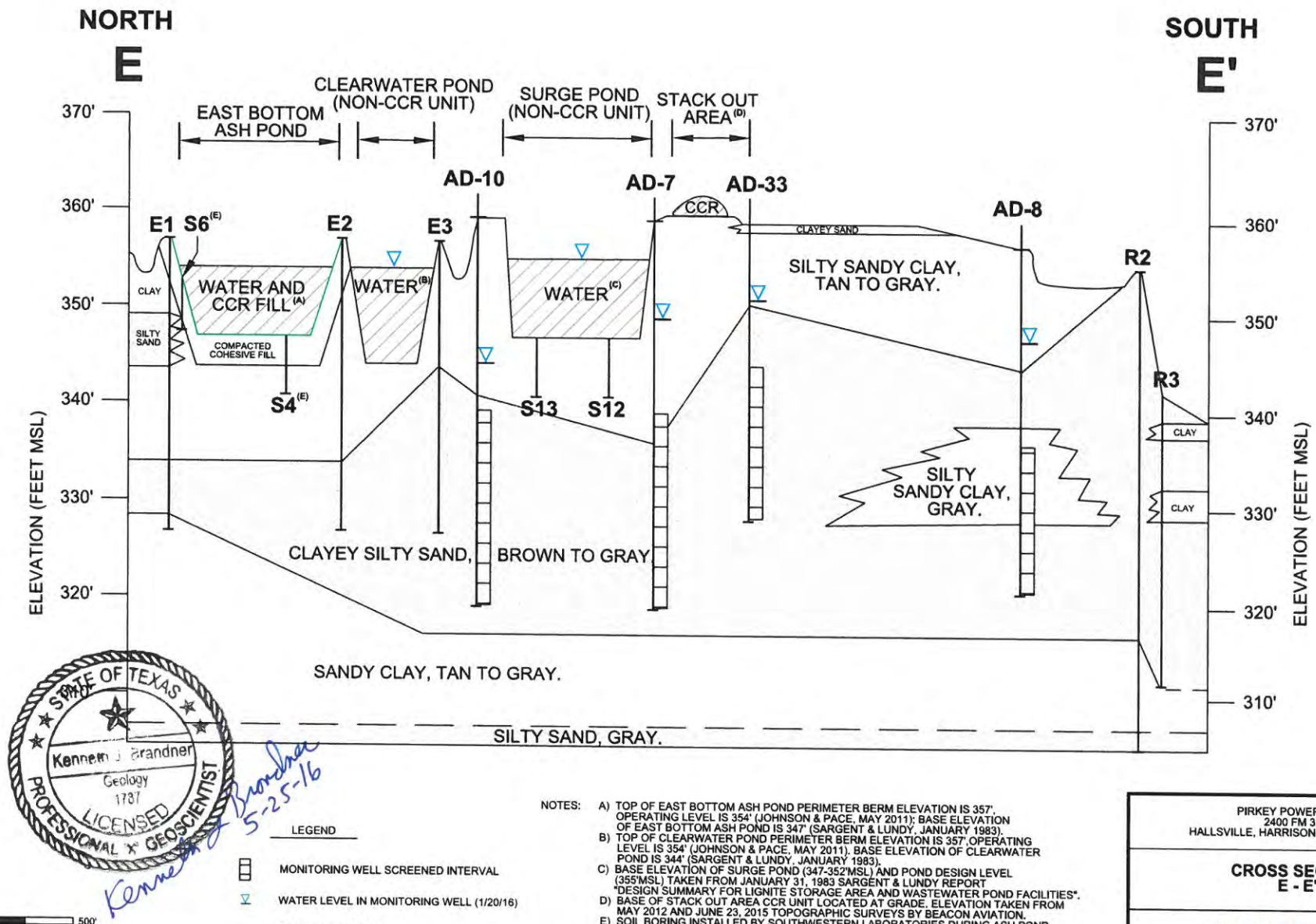
C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL, NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION D - D'

ARCADIS

FIGURE 7



NOTES:

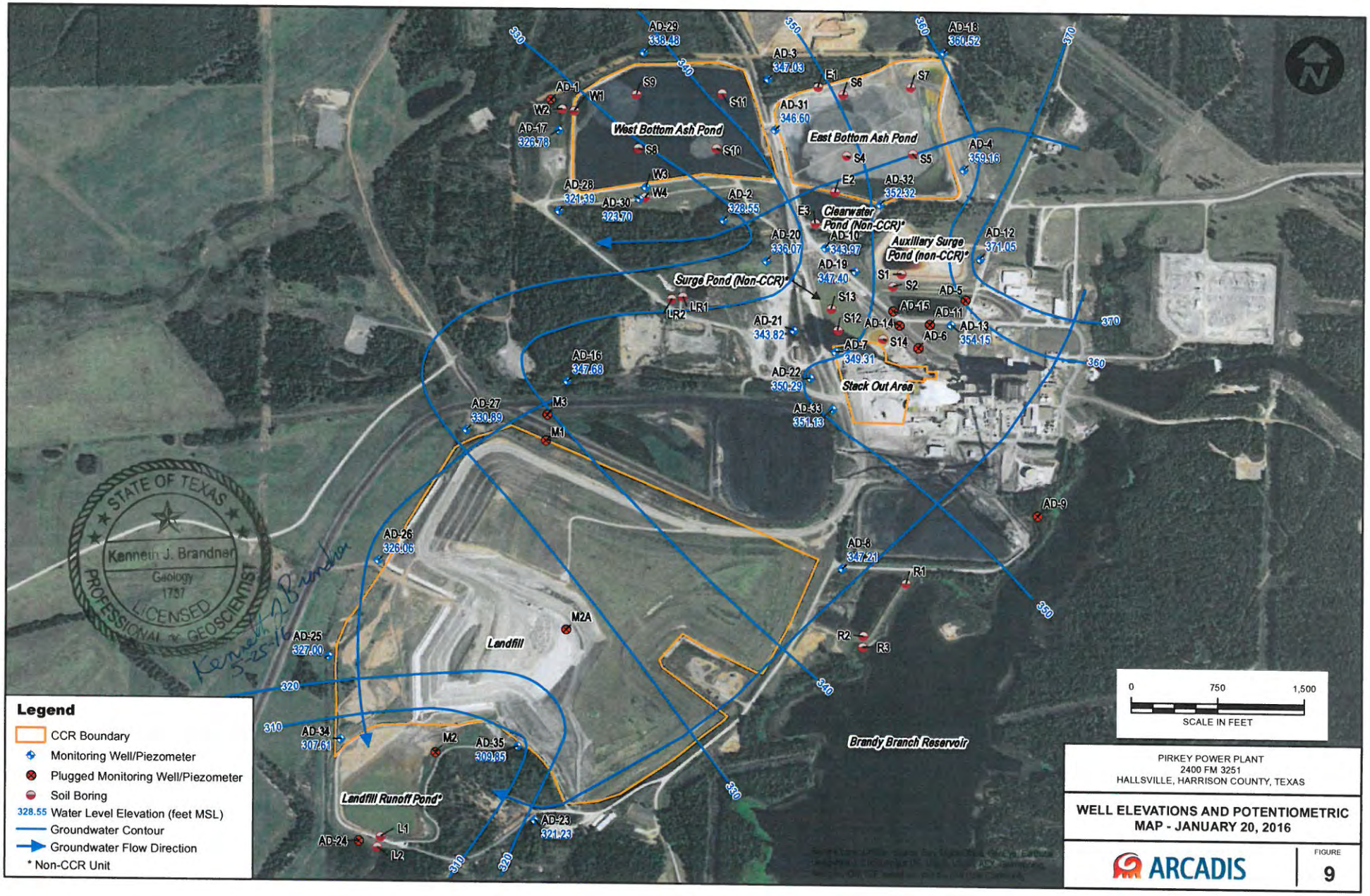
A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).
C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".
D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
8



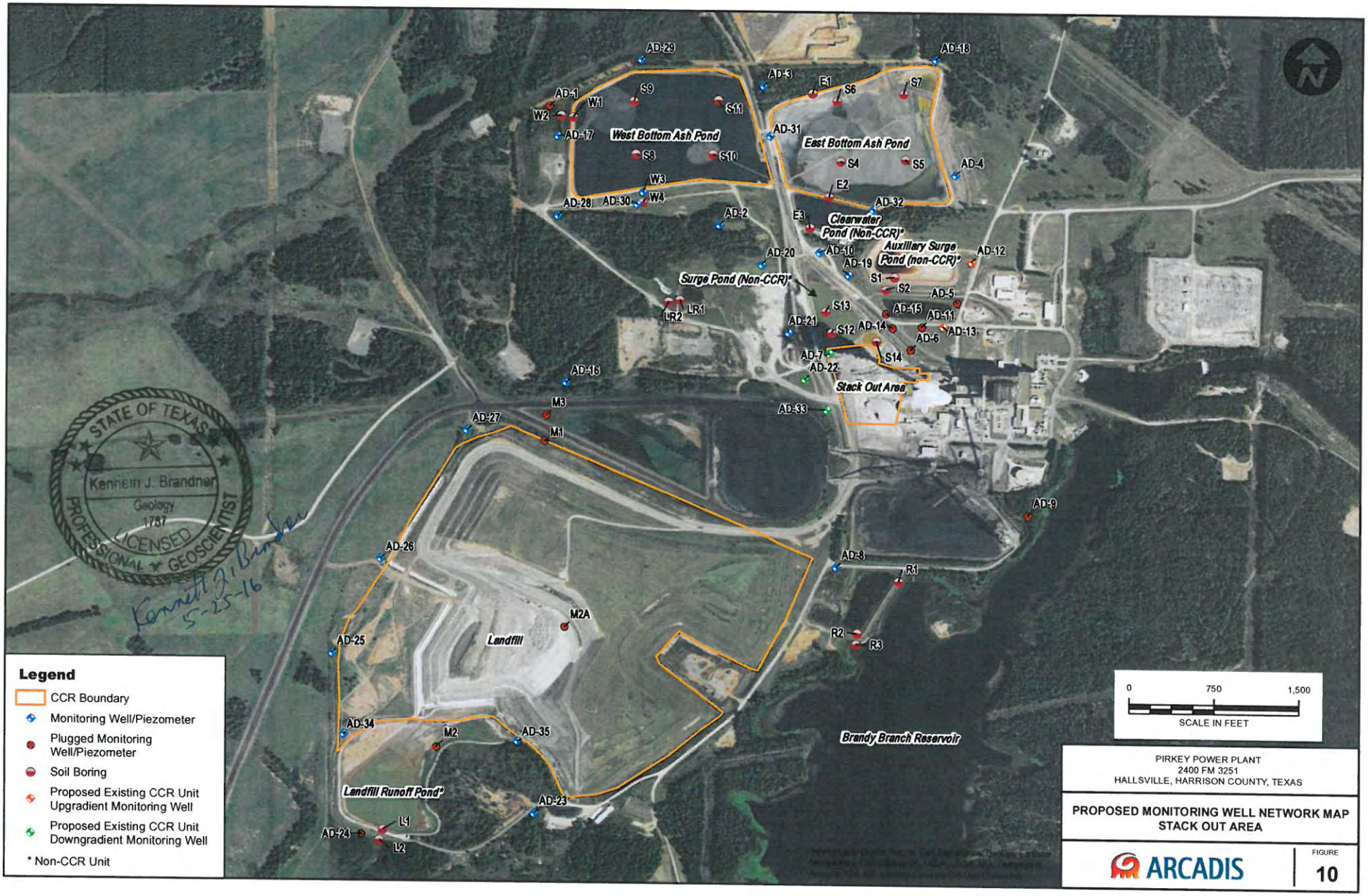
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

ARCADIS

FIGURE 9

Document Path: Z:\GIS\PROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



Legend

- CCR Boundary
- Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- Proposed Existing CCR Unit Upgradient Monitoring Well
- Proposed Existing CCR Unit Downgradient Monitoring Well

* Non-CCR Unit

STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL GEOSCIENTIST
Kenneth J. Brandner
5-25-16

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP
STACK OUT AREA

ARCADIS

FIGURE
10

Document Path: Z:\GISPROJECTS_ENVVAEP\Pirkey Plant\MXD\Figure 10 - Proposed Well Network - Stack Out Area.mxd

ARCADIS

Appendix A

Boring/Well Construction Logs

832964

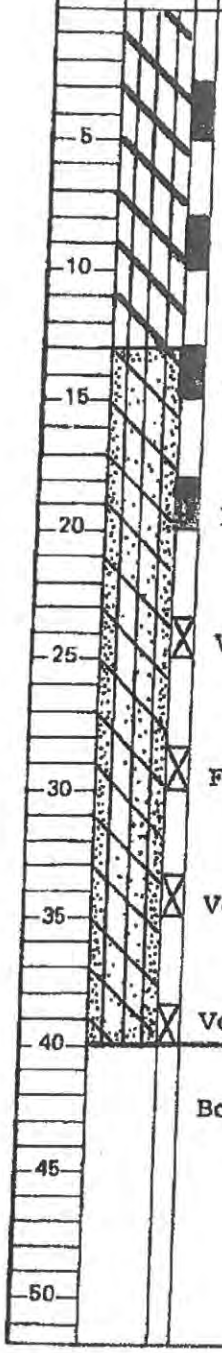
LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-6
LOCATION: Hallsville

Date: 10-3-83 Type: Auger Ground Elevation:

Legend: ▩ Sample X Penetration ▼ Water



Description of Stratum
Stiff tan and grey clay w/silt lenses and iron ore
Very stiff tan and grey clay w/silt lenses and iron ore
Firm tan and grey clayey silty sand
Loose brown and grey clayey silty sand
Very dense grey clayey silty sand 25-25=11½" 50 B/11½"
Firm grey clayey silty sand 7-7-17 24 B/F
Very dense grey clayey silty sand 25-25=9" 50 B/9"
Very dense grey clayey silty sand 18-32=10½" 50 B/10½"
Bottom of boring at 40 feet.

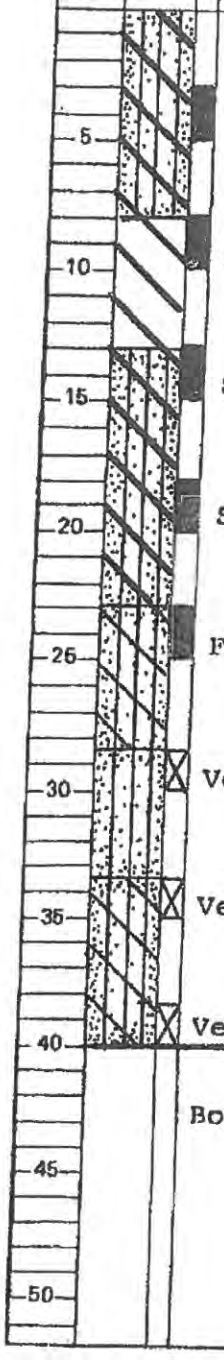
832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-7
LOCATION: Hallsville

Date: 10-3-83 Type: Auger Ground Elevation:



Legend: ■ Sample X Penetration ▼ Water

Description of Stratum
Stiff red, tan and grey sandy silty clay w/iron ore
Stiff tan and grey clay w/iron ore
Stiff tan and grey silty sandy clay lenses w/iron ore
Stiff tan and grey very sandy silty clay
Firm tan and grey clayey silty sand
Very dense grey silty sand 23-27=12" 50 B/F
Very dense grey clayey silty sand 17-35=12" 50 B/F
Very dense grey clayey silty sand 25-25=10½" 50 B/10½"
Bottom of boring at 40 feet.

832964

LOG OF BORING

PROJECT: Monitor Wells at Metal Cleaning Waste Pond BORING NO.: MW-12
CLIENT: Southwestern Electric Power Company LOCATION: Hallsville, TX

Date: 1/30/86 Type: Rotary N 6+13.25; W-6+90.36 Ground Elevation: 378.41

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
5			Brown and tan sandy clay
10			Brown, tan and gray sandy clay
15			Tan and gray sandy clay
20			Brown and tan sandy clay
25			Gray and tan sandy clay
30			Brown and gray clay
35			Brown and gray clay
40			Gray silty sand
45			Gray silty sand
50			Gray silty sand

Water encountered at 27.5 feet.
Bottom of Boring at 51 feet.

SOUTHWESTERN LABORATORIES

Observation Well Installation Report

Location	Date	Station #	City
Pirkey Power Plant	2-23-88	Elev. 361.85 0+33.3N, 8+84.7 W	Hallsville, Texas

Project	Observation Well Number	Location
880284	MW-13	

Type of Rig	Installed By	Date	Time
CME 55	DS, DY, LM	2-23-88	

Method of Installation: Hollow-stem auger

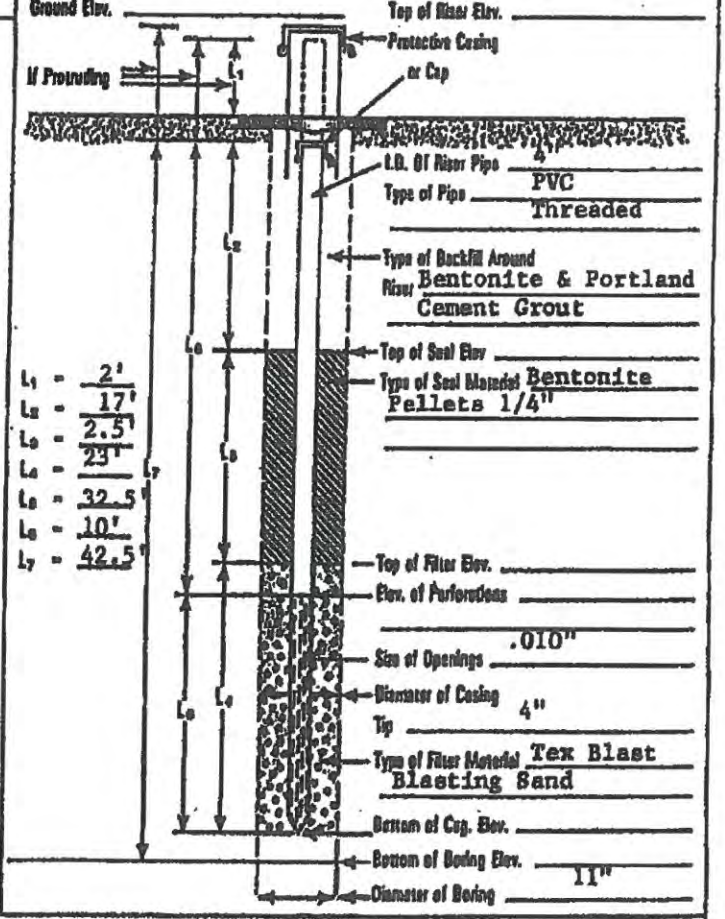
Log of Boring and Observation Well

Boring

Depth in ft.	Cored Interval	Description

Observation Well

Type of Observation Well: ☐ Flush ☒ Locking Cap ☒ Protruding ☐ Manhole



Remarks: L2, L5, L7 are measured from the top of the PVC pipe, which protrudes 2' above the ground surface.

Inspected By:

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ___ ■ MONITOR WELL MONITOR WELL NUMBER: AD-22

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/16/2010

PREPARED BY: David Bedford LOGGED BY: David Bedford

LATITUDE: N 32°27'03.3" Datum: WGS-84 WELL LOCATION: Triangle- South side Quansit Hut

LONGITUDE: W94°29'41.3"

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1				0-0.5 SC	Clayey sand, light brown, very fine grained	None	Moist
2-12				0.5-12 CL	Lean clay, light brown mottled with light gray Few iron ore (small) pebbles in clayey sandy streaks	None	Slightly Moist
13-20			▽	12-20 SC	Clayey sand, grayish brown with orangish brown streaks, very fine grained Slightly wet @ 12.5' from seepage Large amount of iron ore 15-17' Very firm 18-18.5'	None	Slightly Wet
21-25				20-25 SC	(Dense crystalline rock 21-21.1'), light brown clayey sand, greenish black, mica, black clay streaks, very fine grained, wet @ 20'	None	Wet
26-30				25-30 SM	Sand, greenish brown (1') grading to orangish brown, silty, very fine grained	None	Wet
31-40					Boring Terminated at 30'		

Cement Bentonite Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (bgs)-10'
Screen Interval: 10-30'
Water level: 12.5'
3'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-33**

PROJECT INFORMATION

PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-04-1821
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/11/2015
DEVELOPMENT:	12/16/2015
SITE LOCATION:	2400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

DRILLING INFORMATION

DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	60089
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	382.37 (Top of Casing)
HOLE DIAMETER:	8.25"
LATITUDE	32 27' 38.70" LONGITUDE 94 28' 15.82"

STATE OF TEXAS — JEFFREY D. SAMMONS — GEOLOGY #10070 — LICENSED PROFESSIONAL GEOSCIENTIST — 1.21.16

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	DEPTH	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, some silt, dark brownish black and brown, very moist	SC	0						
FAT CLAY: trace sand and silt, reddish brown and light gray - some iron ore gravel at 2.0' - some silt and ironstone in thin seams at 2.5', light gray, yellowish brown, and reddish brown,	CH	4	29	93	74	32	42	
CLAYEY SAND: interbedded clays and fine to very fine sand and silt, some iron ore gravel, light reddish brown and light gray - some clay and trace of iron ore gravel at 11', light gray and reddish brown, moist - trace clay at 13', thin saturated ironstone and gravel seams at 13' to 16', reddish brown, light reddish brown, and light gray - dark reddish brown at 15' - clay lense at 15.5' to 16.5', light reddish brown and light gray	SC	11	21	35	35	23	12	
SILTY CLAYEY SAND: very fine to fine sand, reddish brown, very moist to saturated - some clay lenses and iron ore gravel at 20' - clayey at 20.5' to 21' - trace clay at 21', light gray, saturated - some iron ore gravel at 28', reddish brown, very moist	SM-SC	21	23	19	27	18	9	
CLAYEY SAND: very fine to fine sand, dark gray and gray, moist	SC	29	23	30	25	18	7	

WELL CONSTRUCTION

- Locking Well Casing Cover
- Locking Well Cap
- Protective Well Casing
- Concrete Pad
- Ground Surface
- Cement
- Bentonite
- 2" Sch. 40 PVC Riser
- 20/40 Silica Sand
- 0.010" Slotted Sch. 40 PVC Well Screen
- PVC Bottom Cap

NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-12
LOCATION: Hallsville, TX

Date: 9-15-83 Type: Ground Elevation: 348.3

Legend:

■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
			Red and grey sandy silty clay
			Red and grey clay w/silt lenses
5			Red and grey clay
			Bottom of boring at 6 feet.
			No water encountered.
10			
15			
20			
25			
30			
35			
40			
45			
50			

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-14
LOCATION: Hallsville, TX

Date: 9-15-83 Type: Ground Elevation: 352.9

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
			Brown and red clay w/silt lenses
			Brown and red slightly silty clay
5			Brown and red sandy silty clay
			Bottom of boring at 6 feet.
			No water encountered.
10			
15			
20			
25			
30			
35			
40			
45			
50			

ARCADIS

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
1	8/19/2015

Direction Photo Taken:

East Southeast

Description:

P8190405
AD-21 Ground water monitoring well northeast of Stack Out Area.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
2	8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190438
Stack Out Area

ARCADIS Design & Consultancy for natural and built assets

American Electric Power Service Corporation

Landfill - CCR Groundwater Monitoring Well Network Evaluation (Updated October 2018)

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

October 25, 2018

ARCADIS Design & Consultancy for natural and built assets

Kenneth Brandner, P.E., P.G.
Senior Project Engineer

Matthew J. Lamb/KVB
Matthew J. Lamb
Project Manager

Landfill - CCR Groundwater Monitoring Well Network Evaluation (Updated October 2018)

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Prepared for:
AEP

Prepared by:
ARCADIS U.S., Inc.
100 E Campus View Blvd
Suite 200
Columbus
Ohio 43235-1447
Tel 614 985 9100
Fax 614 985 9170

Our Ref.:
TX015976.0003

Date:
October 25, 2018

Table of Contents

Table of Contents

Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
PTI	Permit to Install
TDS	total dissolved solids

1. Objective

This update report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to provide an updated assessment the adequacy of the groundwater monitoring well network included in the Coal Combustion Residual (CCR) requirements, as specified in Code of Federal Regulations (CFR) 40 CFR 257.91, for the Landfill CCR Unit at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The Landfill CCR Unit at the Plant is currently 130 acres in size. As shown on **Figure 2**, the Landfill will be expanded laterally to the south beginning in 2018 (2018 Lateral Expansion). The 2018 Lateral Expansion will be approximately 15 acres in size, and during Lateral Expansion construction activities one of the existing downgradient monitoring wells (monitoring well AD-35) will be plugged and replaced with new monitoring well AD-36.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report provides an updated evaluation of the groundwater monitoring well network in the uppermost aquifer at the Landfill, including the 2018 Lateral Expansion. The updated evaluation of the location restriction criteria for the Landfill 2018 Lateral Expansion is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the Landfill CCR unit, including the 2018 Lateral Expansion area, as well as publicly-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on all documents reviewed and will further describe the uppermost aquifer, include an evaluation of the adequacy of the existing monitoring well network, and provide recommendations for monitoring well augmentation, as necessary.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant Landfill.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The existing Landfill CCR unit is currently approximately 130 acres in size and is located in the southern portion of the Plant. The 2018 Landfill Lateral Expansion will cover approximately 15 acres directly south of the existing Landfill (**Figures 2** and **3**). Following completion of the 2018 Lateral Expansion, the Landfill will be approximately 145 acres in size.

2.2 Description of Landfill CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the Landfill.

2.2.1 Embankment Configuration

The Landfill was constructed in the southwestern portion of the Plant, and as shown on the U.S. Geological Survey 1983 topographic map (**Figure 1**), the southwestern portion of the Plant contained an unnamed intermittent tributary of Hatley Creek prior to Landfill construction in 1984. The Landfill was constructed within the unnamed tributary creek which had a bottom elevation ranging from approximately 290 feet amsl on the south side of the Landfill to 300 feet amsl on the north side of the Landfill. The native soil sidewalls of the tributary creek at the Landfill location have a maximum elevation of approximately 355 feet amsl. Therefore, as shown on Geologic Cross Section C-C' (**Figure 6**), the Landfill is partially incised within the tributary creek, and the tributary creek native soil sidewalls serve as a natural embankment for the lower portion of the Landfill.

The original Landfill design included emplacement of CCR materials in the Landfill with 3:1 slopes (3 feet horizontal, 1 foot vertical) with an approximate 10 foot wide bench for every 20 foot vertical rise of CCR material (VFL Technology Corporation, 1984). In addition to the Landfill CCR material embankments, earthen embankments are present around portions of the Landfill to control storm water flow.

The 2018 Landfill Lateral Expansion will cover approximately 15 acres directly south of the existing Landfill. In 2016, Auckland Consulting conducted a stability assessment of the 2018 Lateral Expansion area and concluded the embankments would be stable on slopes no steeper than 3:1 (Auckland, November 2016). The 2016 Auckland Consulting

report stated the northern and eastern extents of the 2018 Lateral Expansion will be constructed contiguous to the existing Landfill disposal area, and ash disposal will be completed in multiple lifts, each with an approximate height of 20 feet, integrated with safety benches, and maximum side slopes of 3:1 to a maximum waste height of 120 feet.

2.2.2 Area/Volume

The existing Landfill is approximately 130 acres in size and was designed to receive 12,207,000 cubic yards (7,566 acre feet) of CCR materials including fly ash, bottom ash, economizer ash, and stabilized FGD sludge (VFL Technology Corporation, 1984). The design capacity of the CCR materials to be placed within the 2018 Lateral Expansion is approximately 2,200,000 cubic yards.

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, stabilized FGD sludge) have been generated. The CCR materials that are not taken offsite for beneficial reuse are disposed of in the Landfill. The Landfill was constructed in several phases beginning with the northeast portion (Phase 1) in 1984. The Landfill was expanded (east-central portion) in 1985 and 1987. The Landfill was subsequently expanded to the west and south during the 1990's, including construction of the Landfill Stormwater Runoff Pond (non-CCR unit) directly south of the Landfill in 1993 and 1994.

In 2005, ETTL conducted a geotechnical evaluation of the Landfill and Landfill Stormwater Runoff Pond, including installation 30 soil borings, ten cone penetration test (CPT) borings, and geotechnical testing of soil samples. The Landfill was further expanded to the west between 2005 and 2015 to its current size of approximately 130 acres as shown on **Figure 3**.

The 2018 Landfill Lateral Expansion design includes emplacement of up to 120 feet of CCR materials with maximum side slopes of 3:1 above the Landfill liner system which will consist of a 60-mil HDPE top liner underlain by a 2-foot-thick compacted clay bottom liner. Prior to installation of the liner system, approximately 10 to 15 feet of cut into the existing soils will occur along the topographically higher southern portion of the Lateral Expansion, and emplacement of these soils (clayey sands, silty clayey sand and/or lean clays) as fill materials below the liner system in the topographically lower central and northern portions of the Lateral Expansion. As detailed below in Section 3.3.2, during Lateral Expansion construction activities, existing downgradient monitoring well AD-35, located within the Lateral Expansion construction zone, will be plugged and replaced with a new monitoring well (AD-36) located directly downgradient of the Lateral Expansion area.

2.2.4 Surface Water Control

Surface water in the area of the existing Landfill flows in a general southerly direction to the Landfill Stormwater Runoff Pond located directly southwest of the existing Landfill. Surface water in the area of the 2018 Landfill Lateral Expansion flows in a general westerly direction to the Landfill Stormwater Runoff Pond. The Landfill Stormwater Runoff Pond, which is approximately 16 acres in size, also receives (1) Landfill leachate that is gravity drained from the existing Landfill via underground lateral perforated pipes and permeable bottom ash materials that were installed above portions of the existing Landfill liner, (2) Landfill leachate that will gravity drain via underground lateral perforated pipes that will be installed above the 2018 Landfill Lateral Expansion liner system, and (3) shallow groundwater that will gravity drain via underground lateral perforated HDPE underdrain pipes that will be installed in permeable bottom ash materials approximately seven feet below the 60-mil HDPE liner of the 2018 Landfill Lateral Expansion.

2.3 Previous Investigations

The initial soils investigation and design of the Plant was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, including the Landfill Area.

A soils investigation of the Landfill was conducted by Southwestern Laboratories in 1984. The investigation included installation of 45 soil borings and geotechnical analyses of soil samples. The report recommended installation of three feet of compacted clay as the bottom liner for the Landfill (Southwestern Laboratories, July 1984).

An engineering design report for the Landfill was prepared by VFL Technology Corporation in 1984. The Landfill design included a bottom compacted clay liner three feet in thickness, and Landfill side slopes of 3:1 (VFL Technology Corporation, 1984).

In 1985, Southwestern Laboratories conducted a geotechnical evaluation of the clay liner that was installed at the base of the Landfill, including installation of four soil borings and permeability testing of soil samples. The report concluded the clay liner was three feet thick with a permeability less than 1×10^{-7} centimeters per second (cm/sec) (Southwestern Laboratories, 1985).

In 1993, Alliance Inc. conducted a geotechnical investigation of the clay liner installed at the base of the Landfill following a Landfill expansion phase in 1993. The report concluded the clay liner was three feet or more in thickness, and the clay liner met the permeability specifications of $<1 \times 10^{-7}$ cm/sec (Alliance Inc., 1993).

In 1995, Central and South West Services prepared design specifications for Landfill expansion to the west and south. The design specifications included a geosynthetic clay liner overlain by a 0.060-inch (60 mil) HDPE liner (Central and South West Services, 1995).

In 2005, ETTL conducted a geotechnical evaluation of the Landfill and Landfill Stormwater Runoff Pond, including installation 30 soil borings, ten CPT borings, and geotechnical testing of soil samples. The geotechnical data was obtained to design Landfill expansions in 2005 through 2007.

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, March 2011).

In 2012, Apex Geoscience conducted a geotechnical investigation for Landfill expansion activities planned at the western portion of the Landfill where surface lignite mining operations had previously been conducted to a depth of 50 to 100 feet using a dragline, and the spoils (reclaimed soil) were returned to the excavation. The report concluded the Landfill embankments would be stable with side slopes of 3:1 (Apex Geoscience, 2013).

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of six monitoring wells (AD-30 through AD-35) (Auckland Consulting, 2016).

In 2016, Auckland Consulting conducted a geotechnical evaluation of the 2018 Landfill Lateral Expansion area, including installation of eight soil borings (B1 through B8) with total depths ranging from 40 to 62 feet below ground surface (bgl). Soil boring locations are shown on **Figure 11**, and copies of the soil boring logs are provided in **Appendix C.** Based on the results of the 2016 geotechnical evaluation, including slope stability modeling and settlement analysis, Auckland Consulting concluded the 2018 Landfill Lateral Expansion will be structurally stable with maximum side slopes of 3:1 to a maximum disposal height of 120 feet (Auckland, November 2016).

In 2018, Auckland Consulting installed seven piezometers (PZ-1 through PZ-7) within the 2018 Landfill Lateral Expansion area to obtain detailed depth to groundwater and groundwater flow direction data prior to construction of the Lateral Expansion. The piezometers were completed in the uppermost water-bearing unit with total depths ranging from 14 to 20 feet bgl. Piezometer locations are shown on **Figure 11**, and piezometer completion data is provided in **Appendix C**

2.4 Hydrogeologic Setting

2.4.1 General

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Site in the area of the Landfill Stormwater Runoff Pond. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of up to approximately 100 feet in Harrison county, Texas (Broom, 1966). As shown on Geologic Cross Sections C-C' (**Figure 6**) and D-D' (**Figure 7**), a thick sand stratum is located below and adjacent to the Landfill between an elevation of approximately 270 feet and 330 feet amsl. This sand stratum likely corresponds to the Carrizo Sand based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

The Carrizo Sand is underlain by the Eocene-age Wilcox Formation, which outcrops in topographically low areas near the Sabine River to the south and southeast of the Plant (Flawn, 1965). The Wilcox Formation consists of interbedded sand and clay with seams of lignite, and attains a thickness of approximately 700 feet (Broom, 1966). As shown on Geologic Cross Section D-D' (**Figure 7**), a lignite seam was encountered below an elevation of approximately 270 feet amsl during drilling of monitoring well AD-24 at the south end of the Site. This lignite seam likely corresponds to the top of the Wilcox Formation based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

These features are further illustrated on five lines of cross section that were prepared through the existing Landfill Area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A') through **Figure 8** (E-E').

2.4.2 2018 Landfill Lateral Expansion Area

Based on the hydrogeologic data obtained from soil borings, monitoring wells, and piezometers installed in the 2018 Landfill Lateral Expansion area, three lines of cross section were prepared through the 2018 Landfill Lateral Expansion area. The cross section location map is included as **Figure 11** and the lines of cross section are included as **Figure 12** (F-F'), **Figure 13** (G-G'), and **Figure 14** (H-H').

As shown on **Figures 12** through **14**, a reddish-brown to gray clayey and silty sand stratum is located below the Lateral Expansion area between an elevation of

approximately 280 feet and 330 feet amsl. This sand stratum likely corresponds to the Carrizo Sand based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

As shown on **Figures 12** through **14**, a clay stratum with an average thickness of approximately 10 feet is located below the sand stratum, and a lignite seam is present below the clay stratum at an elevation of approximately 270 feet amsl. As discussed above in Section 2.4.1, this lignite seam likely corresponds to the top of the Wilcox Formation based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

2.4.3 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1˚ Fahrenheit (F) in January to 83.8˚F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.4 Regional and Local Geologic Setting

The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant where the existing Landfill, 2018 Landfill Lateral Expansion, and Landfill Stormwater Runoff Pond are located (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.5 Surface Water and Surface Water Groundwater Interactions

Figures 9 and **10** are potentiometric surface maps based on January 2016 and August 2017 water level data, respectively, for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figures 9** and **10**, shallow groundwater flow direction in the Landfill area is southwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The Landfill is located approximately 400 feet west of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy

Branch Reservoir is approximately 340 feet amsl. As shown on **Figures 9** and **10**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore, shallow groundwater in the Landfill area does not discharge into Brandy Branch Reservoir. Brandy Branch Reservoir likely recharges the uppermost water bearing unit in the southern portion of the Site, where the pool level in the Reservoir (340 feet amsl) is higher than water level elevations in monitoring wells located southwest (downslope) of the Reservoir.

Figure 15 is a current potentiometric surface map for the uppermost water-bearing unit in the 2018 Landfill Lateral Expansion area, and water level elevations for the 2018 Landfill Lateral Expansion area piezometers are summarized on **Table 2**. As shown on **Figure 15**, shallow groundwater flow direction in the 2018 Landfill Lateral Expansion area is westerly toward the Landfill Stormwater Runoff Pond at a hydraulic gradient of approximately 0.02 foot per foot. Water level elevations in the 2018 Landfill Lateral Expansion area piezometers are higher than the surface water elevation of the Landfill Stormwater Runoff Pond (approximately 298 feet amsl), which indicates shallow groundwater in the 2018 Landfill Lateral Expansion area discharges into the Landfill Stormwater Runoff Pond.

2.4.6 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled directly east of the Landfill in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 330 to 426 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled directly south of the Landfill by Amoco Production Company in 1991 for use as an oil field rig supply well. The water well was screened from 163 to 243 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The third closest water well was reportedly drilled approximately 200 feet southwest of the Landfill by Matador Operating in 2000 for use as an industrial well. The water well was screened from 340 to 420 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth and is located approximately ¼-mile east (upgradient) of the Pirkey Power Plant.

3. Groundwater Monitoring Well Network Evaluation

The existing monitoring well network present at the Site was evaluated to determine if any of the wells were viable for continued use as part of the groundwater monitoring well network or also retained as part of a larger groundwater hydraulic monitoring well network. The hydrogeologic conditions were also evaluated to determine if the uppermost aquifer unit has an effective well network. The evaluation was completed in accordance with 40 CFR 257.91 to have an established monitoring well network that effectively monitors the uppermost aquifer up gradient and down gradient of the Site. The up gradient wells represent background groundwater quality and the down gradient wells are to be placed down gradient of the CCR unit boundary to monitor water quality.

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost aquifer in the existing Landfill Area is a very fine to fine grained clayey and silty sand stratum located below and adjacent to the existing Landfill between an elevation of approximately 270 feet and 330 feet amsl (**Appendix A**). The location of the uppermost water bearing unit relative to the existing Landfill is shown on cross section C-C' (**Figure 6)** and cross section D-D' (**Figure 7)**.

The location of the uppermost water bearing unit relative to the 2018 Landfill Lateral Expansion is shown on cross section F-F' (**Figure 12**), cross section G-G' (**Figure 13**), and H-H' (**Figure 14**). As shown on these geologic cross sections, the uppermost aquifer in the Landfill Lateral Expansion area is a clayey and silty sand stratum located between an elevation of approximately 280 feet and 330 feet amsl. Clay interbeds are present within the sand stratum, but the clay interbeds are discontinuous, indicating the entire saturated thickness of the sand stratum between approximately 280 feet and 330 feet amsl in the Lateral Expansion area is in hydraulic communication and represents the uppermost aquifer.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness in the Landfill area (up to 60 feet), the yield of the uppermost aquifer is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Groundwater elevations from the plant monitoring wells are summarized on **Table 1**. The plant-wide comprehensive groundwater elevation data set from August 24, 2017 is depicted on **Figure 10**. The groundwater flow direction in the Landfill area is south to

southwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

Current groundwater elevations in the Landfill 2018 Lateral Expansion area are summarized on **Table 2**, and a June 22, 2018 piezometric surface map is depicted on **Figure 15**. As shown on **Figure 15**, shallow groundwater flow direction in the 2018 Landfill Lateral Expansion area is westerly toward the Landfill Stormwater Runoff Pond at a hydraulic gradient of approximately 0.02 foot per foot. Water level elevations in the 2018 Landfill Lateral Expansion area piezometers are higher than the surface water elevation of the Landfill Stormwater Runoff Pond (approximately 298 feet amsl), which indicates shallow groundwater in the 2018 Landfill Lateral Expansion area discharges into the Landfill Stormwater Runoff Pond.

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as 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 groundwater surface to which the aquifer rises during the wet season.

3.2.1.1 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the Landfill area is the clayey and silty sand stratum that is located between an elevation of approximately 270 and 330 feet amsl.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 19, 2015 to review existing well network conditions and locations. A well construction table that summarizes the location, ground surface elevation, borehole depth, installation date, and associated well construction details of the monitoring well network is included as

Table 3. Photo documentation of the located wells during the August 19, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-8, AD-12, AD-16, AD-23, AD-24, AD-25, AD-26, AD-27, AD-34, and AD-35 were previously installed at the Site to monitor the uppermost aquifer (clayey and silty sand stratum) associated with the Landfill. As discussed above in Section 3.1.1, the uppermost aquifer below and adjacent to the existing Landfill is up to 60 feet thick and is located between an elevation of approximately 270 and 330 feet amsl. The uppermost aquifer below the Landfill Lateral Expansion area is located between an elevation of approximately 280 and 330 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on **Figure 10**, shallow groundwater flow direction in the existing Landfill area is south to southwesterly. Four existing monitoring wells (AD-8, AD-12, AD-16, and AD-27) are located up gradient north and northeast of the Landfill and will be utilized as up gradient monitoring wells for the Landfill.

As shown on **Figure 10**, three existing monitoring wells (AD-23, AD-34, and AD-35) are located downgradient (south) of the Landfill and are currently utilized to monitor groundwater quality downgradient of the Landfill CCR unit. However, monitoring well MW-35 is located within the footprint of the proposed 2018 Landfill Lateral Expansion and will be plugged by a Texas Department of Licensing and Regulation (TDLR) licensed water well driller. This data gap will be addressed by installation of new downgradient monitoring well AD-36. As shown on **Figure 16**, monitoring well AD-36 will be located on the west (downgradient) side of the 2018 Landfill Lateral Expansion. With the addition of monitoring well AD-36 as a replacement for monitoring well AD-35, there will be no gaps in the groundwater monitoring network for the Landfill.

4. Recommended Monitoring Network and PE Certification

The recommended groundwater monitoring well network is intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the Landfill (up gradient or down gradient), well depth, and well construction. The recommended network would provide an improved understanding of groundwater quality, hydraulics, and groundwater flow at the Landfill.

4.1 Recommended Monitoring Well Network Distribution

Four up gradient well locations (existing monitoring wells AD-8, AD-12, AD-16, and AD-27) and three downgradient well locations (existing monitoring wells AD-23, AD-34, and AD-35) are currently utilized as the groundwater quality monitoring well network for the Landfill. During the 2018 Landfill Lateral Expansion construction activities, monitoring well AD-35 will be plugged and replaced with a new monitoring well (AD-36) to be installed directly west (downgradient) of the Lateral Expansion. In addition, existing side gradient monitoring wells AD-25 and AD-26 may be utilized as piezometers to obtain additional groundwater flow direction and gradient data for the Landfill.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the Landfill is summarized on **Table 4** and illustrated on **Figure 16.**

4.1.2 Depth

The screen depths for the monitoring wells recommended for inclusion in the monitoring network are within the shallow saturated sand stratum (uppermost aquifer) that occurs between an elevation of approximately 270 and 330 feet amsl in the existing Landfill area, and between an elevation of approximately 280 and 330 feet amsl in the Landfill Lateral Expansion area, as shown on Geologic Cross Sections C-C' (**Figure 6**), D-D' (**Figure 7**), F-F' (**Figure 12**), G-G' (**Figure 13**), and H-H' (**Figure 14**). The screen elevations are presented in **Table 4**.

4.1.3 Well Construction

As discussed above in Section 3.3.2, the gap in the monitoring well network for the uppermost aquifer at the Landfill following plugging of monitoring well AD-35 will be addressed by installation of new monitoring well AD-36. Monitoring wells AD-35 will be plugged and monitoring well AD-36 will be installed by a TDLR-licensed water well driller. Well construction data for the monitoring well network are summarized on **Tables 3** and **4**, and the monitoring well completion diagrams for the existing monitoring wells are provided in **Appendix A**.

4.2 Professional Engineer's Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, the proposed groundwater monitoring system for the Landfill CCR unit will be adequate to meet the requirements of 40 CFR Part 257.91.

Kenneth J. Brandner
Printed Name of Registered Professional Engineer

Kenneth J Brandner
Signature

69586	Texas	10-25-18
Registration No.	Registration State	Date

5. References

Alliance, Inc., "Henry W. Pirkey Power Plant Sludge Disposal Area Expansion, Phase I, Section IV", September 1993.

AMEC, "Report of Dam Safety Assessment of Coal Combustion Surface Impoundments, American Electric Power (AEP) and Southwest Electric Power Company (SWEPCO) H.W. Pirkey Power Plant, Hallsville, TX", August 2011.

Apex Geoscience Inc., "USWAG Monitoring Wells and Groundwater Evaluation, AEP Pirkey Power Station, Hallsville, Texas", March 2011.

Apex Geoscience Inc., "Geotechnical Investigation, Landfill Sedimentation Pond – Expansion, AEP/Pirkey Power Station, Hallsville, Texas", April 2011.

Apex Geoscience Inc., "Geotechnical Evaluation, Pirkey Power Station – Sludge Disposal Area, 2015 Expansion Phase – Addendum No. 2, Hallsville, Texas", November 27, 2012 (Revised January 17, 2013).

ARCADIS U.S., Inc., "Landfill – CCR Groundwater Monitoring Well Network Evaluation, H.W. Pirkey Power Plant, 2400 FM 3251, Harrison County, Hallsville, Texas", May 25, 2016.

Auckland Consulting LLC, "Monitoring Well Installation – 2015, Pirkey Generating Station, Hallsville, Texas", January 26, 2016.

Auckland Consulting LLC, "Stability Assessment – 2019 Landfill Expansion, Pirkey Power Plant, Hallsville, Texas", November 21, 2016.

Banks Information Solutions, "Water Well Report, Pirkey Power Plant, 2400 FM 3251, Hallsville, Texas, Harrison County", October 8, 2015.

Broom, M.E., and B. N. Myers, "Ground-Water Resources of Harrison County, Texas", Texas Water Development Board Report 27, August 1966.

Central and South West Services, Inc., "Coal Fly Ash/Flue Gas Desulfurization Material Landfill, Pirkey Power Station, Harrision County, Texas", June 8, 1995.

ETTL Engineers & Consultants Inc., "Geology and Geotechnical Report, Henry W. Pirkey Power Plant Sludge Disposal Area, 2005 and 2007 Expansion Phase, Harrison County, Texas", March 2005.

ETTL Engineers & Consultants Inc., "Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas", October 2010.

Fetter, C.W., "Applied Hydrogeology", University of Wisconsin – Oshkosh, 1980.

Flawn, Peter T., "Geologic Atlas of Texas, Tyler Sheet", The University of Texas at Austin Bureau of Economic Geology, March 1965.

George, Peter G., et. al., "Aquifers of Texas", Texas Water Development Board Report 380, July 2011.

Johnson & Pace Incorporated, "Lignite Pond and Landfill Runoff Pond Berm Plan & Profile", March 2010.

Johnson & Pace Incorporated, "Hydrology & Hydraulic Report, North Surge Pond, East & West Ash Ponds, Secondary Ash Pond, Landfill Pond, H.W. Pirkey Power Plant, Hallsville, Texas", May 2011.

Johnson & Pace Incorporated, "East Bottom Ash Pond June 2011 As-Built Plan & Profile, H.W. Pirkey Power Plant, Hallsville, Texas", June 2011.

Sargent & Lundy, "Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities", January 31, 1983.

Sargent & Lundy, "Henry W. Pirkey Power Plant Unit 1, Wastewater Ponds – Liner Verification & Monitoring Wells", September 14, 1984.

Southwestern Laboratories, "Subsurface Exploration for Section 1 Phase 1 of Sludge Disposal Area, Henry W. Pirkey Power Plant", July 1984.

Southwestern Laboratories, "Subsurface Exploration, Waste Water Ponds, Pirkey Power Plant, Hallsville, Texas", September 7, 1984.

Southwestern Laboratories, "Liner Verification, Sludge Disposal Area, Pirkey Power Plant", April 18, 1985.

Texas Commission on Environmental Quality, "Groundwater Classification, RG-366/TRRP-8", March 2010.

USGS, Aquifers and Groundwater. 2015. Available online at www.usgs.gov.

USGS, “Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin”, Open-File Report 88-450K, 1988.

USGS, “Texas Seismic Hazard Map”, 2014.

VFL Technology Corporation, “Engineering Design and Operations Report, Pirkey Station Solid Waste Disposal Site”, November 1, 1984.

Tables

ARCADIS

Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[a]	Top of Casing Elevation[a]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen[b]		Bottom of Screen[b]		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016	1/12/2017	3/1/2017	4/11/2017	8/24/2017
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																									
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55	327.65	327.96	329.09	327.63
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03	344.19	345.53	345.53	343.49
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16	353.27	355.38	356.62	353.58
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31	347.04	347.96	347.87	347.40
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21	345.74	346.00	345.81	346.31
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97	---	---	---	---
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05	365.11	368.79	372.97	367.68
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15	352.01	352.81	352.68	352.62
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68	343.09	344.54	344.69	342.71
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78	324.70	326.27	326.27	324.18
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52	357.06	359.21	358.63	358.23
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40	---	---	---	---
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07	---	---	---	---
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82	---	---	---	---
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29	347.20	348.52	348.45	347.37
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23	320.99	321.00	320.85	320.77
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---	---	---	---	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00	---	---	---	---
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06	---	---	---	---
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89	330.04	331.59	331.24	330.05
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39	320.27	320.51	320.69	320.07
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48	---	---	---	---
AD-30[d]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70	322.23	322.85	322.88	322.04
AD-31[d]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60	343.78	344.53	344.58	343.57
AD-32[d]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32	347.44	348.44	349.09	349.73
AD-33[d]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13	348.56	349.32	349.25	349.31
AD-34[d]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61	307.61	307.61	307.61	307.61
AD-35[d]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85	310.42	310.82	311.27	310.28
Piezometers[c]																									
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	---	---	---	---	---	---	---	---	---	---	---	---	---

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
--- Not Measured

Table 2
Piezometer Water Level Data - 2018 Landfill Lateral Expansion Area
AEP Pirkey Power Plant
Hallsville, Harrision County, Texas

Piezomenter Completion Information

Piezometer ID:	PZ1	PZ2	PZ3	PZ4	PZ5	PZ6	PZ7	AD-23	AD-35
Northing	6871372.73	6871442.96	6871218.9	6871018.52	6870962.73	6870939.86	6871250.41		
Easting	3203056.63	3203345.4	3203322.02	3203009.98	3203281.7	3203544.92	3202996.36		
Screen length	10	10	10	10	10	10	10	20	15
TD (from GS)	14	14	14	14	20	20	14	37.44	18
Sand pack, top (from GS)	3	3	3	3	8	8	3		
Elev, GS								346.72	334.15
Elev, TOC	308.85	312.74	307.35	311.53	328.3	328.78	303.73	350.1	318.95

Piezometer Depth to Water Measurements (feet) below TOC

Date	PZ1	PZ2	PZ3	PZ4	PZ5	PZ6	PZ7	AD-23	AD-35
6/20/2018	9.98	9.99	4.29	8.66	20.47	13.23	2.84		
6/21/2018	9.99	9.95	4.07	8.37	20.47	13.24	2.75	29.4	7.95
6/22/2018	9.99	9.91	3.98	8.31	20.47	13.25	2.76	29.42	7.92
6/29/2018	10.01	10.1	4.34	8.85	20.63	13.4	2.98	29.39	8.14
7/6/2018	10.02	10.23	4.45	8.92	20.75	13.52	3.21	29.43	8.23

Piezometer Potentiometric Surface (Water Table) Elevations (feet AMSL)

Date	PZ1	PZ2	PZ3	PZ4	PZ5	PZ6	PZ7	AD-23	AD-35
6/20/2018	298.87	302.75	303.06	302.87	307.83	315.55	300.89		
6/21/2018	298.86	302.79	303.28	303.16	307.83	315.54	300.98	320.70	311.00
6/22/2018	298.86	302.83	303.37	303.22	307.83	315.53	300.97	320.68	311.03
6/29/2018	298.84	302.64	303.01	302.68	307.67	315.38	300.75	320.71	310.81
7/6/2018	298.83	302.51	302.9	302.61	307.55	315.26	300.52	320.67	310.72

Legend

GS	Ground surface	TOC	Top of piezometer casing
TD	Total depth	AMSL	Above mean sea level

ARCADIS

Table 3
Well Construction Details
AEP Pirkey Power Plant - CCR Units
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[a]	Top of Casing Elevation[a]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen[b]		Bottom of Screen[b]	
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
Monitoring Wells																
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	18	323	40	301	20	321.25	40	301.25
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	35	338	57	316	37	335.76	57	315.76
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	24	340	46	318	26	337.69	46	317.69
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	18	342	40	320	20	339.61	40	319.61
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	18	339	35	322	20	336.92	35	321.92
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	18	341	40	319	20	339.48	40	319.48
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	29	350	51	328	31	347.84	51	327.84
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	17.5	344.5	40.5	321.5	30.5	331.48	40.5	321.48
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	13	344	35	322	15.0	341.81	35.0	321.81
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	8	335	30	313	10.0	332.65	30.0	312.65
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	13	347	25	335	15.0	345.48	25.0	335.48
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	8	352	30	330	10.0	349.50	30.0	329.50
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	13	339	35	317	15.0	337.30	35.0	317.30
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	8	339	30	317	10.0	337.23	30.0	317.23
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	8	348	30	326	10.0	345.57	30.0	325.57
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	13	334	35	312	15.0	331.72	35.0	311.72
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	3	285	20	268	5.0	282.68	20.0	267.68
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	8	326	30	304	10.0	324.15	30.0	304.15
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	8	334	40	302	10.0	332.41	40.0	302.41
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	15.5	334.3	37.5	312.3	17.5	332.33	37.5	312.33
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	13	323	35	301	15.0	320.92	35.0	300.92
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	8	342	30	320	10.0	340.21	30.0	320.21
AD-30[d]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	8	331	25	314	10.0	329.04	25.0	314.04
AD-31[d]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	18	340	35	323	20.0	337.75	35.0	322.75
AD-32[d]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	11	346	33	324	13.0	344.23	33.0	324.23
AD-33[d]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	12	347	30	329	15.0	344.30	30.0	329.30
AD-34[d]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	8	297	25	280	10.0	294.64	25.0	279.64
AD-35[d]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	2.5	313.5	20	296	3.0	313.01	18.0	298.01
Piezometers[c]																
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	26	330	38	318	28.0	328.30	38.0	318.30

General Note:
Elevations in feet above mean sea level.

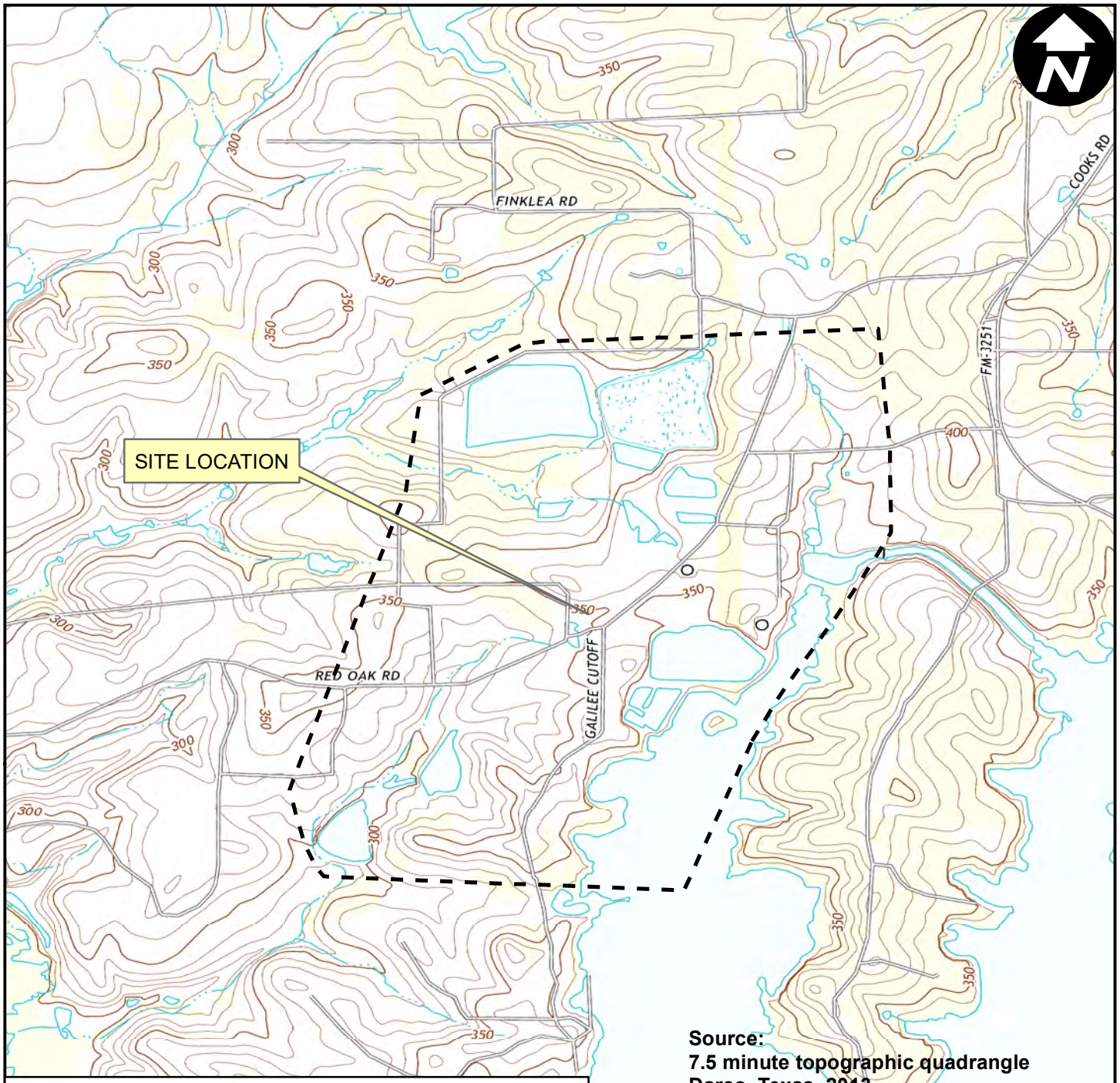
Footnotes:
(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011). Top of sand pack estimated 2 feet above top of screened interval.
(c) Souce: EETL (October 2010).
(d) Source: Aukland Consulting LLC (January 26, 2016).
Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

Table 4
Proposed Well Network
AEP Pirkey Power Plant - Landfill
Hallsville, Harrison County, Texas

Well ID	Exisiting/ Proposed	Hydrostratigraphic Unit Target	Location Description		Screen Top Target Elevation[(a)] (ft amsl)	Screen Bottom Target Elevation[(a)] (ft amsl)	Screen Length (ft)	Comments
Upgradient								
AD-8	Exisiting	Uppermost Water-Bearing Unit	Northeast of Landfill	Upgradient	336.9	321.9	15	Existing well installed in 1983; well will be utilitzed to establish backgroud water quality
AD-12	Exisiting	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilitzed to establish backgroud water quality
AD-16	Exisiting	Uppermost Water-Bearing Unit	North of Landfill	Upgradient	341.8	321.8	20	Existing well installed in 2010; well will be utilitzed to establish backgroud water quality
AD-27	Existing	Uppermost Water-Bearing Unit	Northwest of Landfill	Upgradient	332.3	312.3	20	Existing well installed in 2010; well will be utilitzed to establish backgroud water quality
Downgradient								
AD-23	Existing	Uppermost Water-Bearing Unit	South of Landfill	Down gradient	331.7	311.7	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to Landfill - downgradient
AD-34	Existing	Uppermost Water-Bearing Unit	Southwest of Landfill	Down gradient	294.6	279.6	15	Existing monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to Landfill - downgradient.
AD-35	Existing (to be plugged and replaced with AD-36 in 2018)	Uppermost Water-Bearing Unit	South of Landfill	Down gradient	313.0	298.0	15	Existing monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to Landfill - downgradient. Will be plugged during Landfill 2018 Lateral Expansion construction and replaced with AD-36.
AD-36	Proposed	Uppermost Water-Bearing Unit	South of Existing Landfill, West of 2018 Lateral Expansion	Down gradient	304 [(b)]	294.0	10	Proposed monitoring well tentatively scheduled to be installed during 4th quarter 2018 in uppermost shallow aquifer adjacent to Landfill - downgradient.
Piezometers								
AD-25	Existing	Uppermost Water-Bearing Unit	West of Landfill	Side gradient	324.2	304.2	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to Landfill - side gradient
AD-26	Existing	Uppermost Water-Bearing Unit	West of Landfill	Side gradient	332.4	302.4	30	Existing well installed in 2010; uppermost shallow aquifer adjacent to Landfill - side gradient

Footnotes:
a. Target elevations are an estimated range.
b. Ground surface elevation at proposed monitoring well location is approximately 308 feet amsl.
Acronyms and Abbreviations:
U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

Figures



Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

0 2,000 4,000

SCALE IN FEET

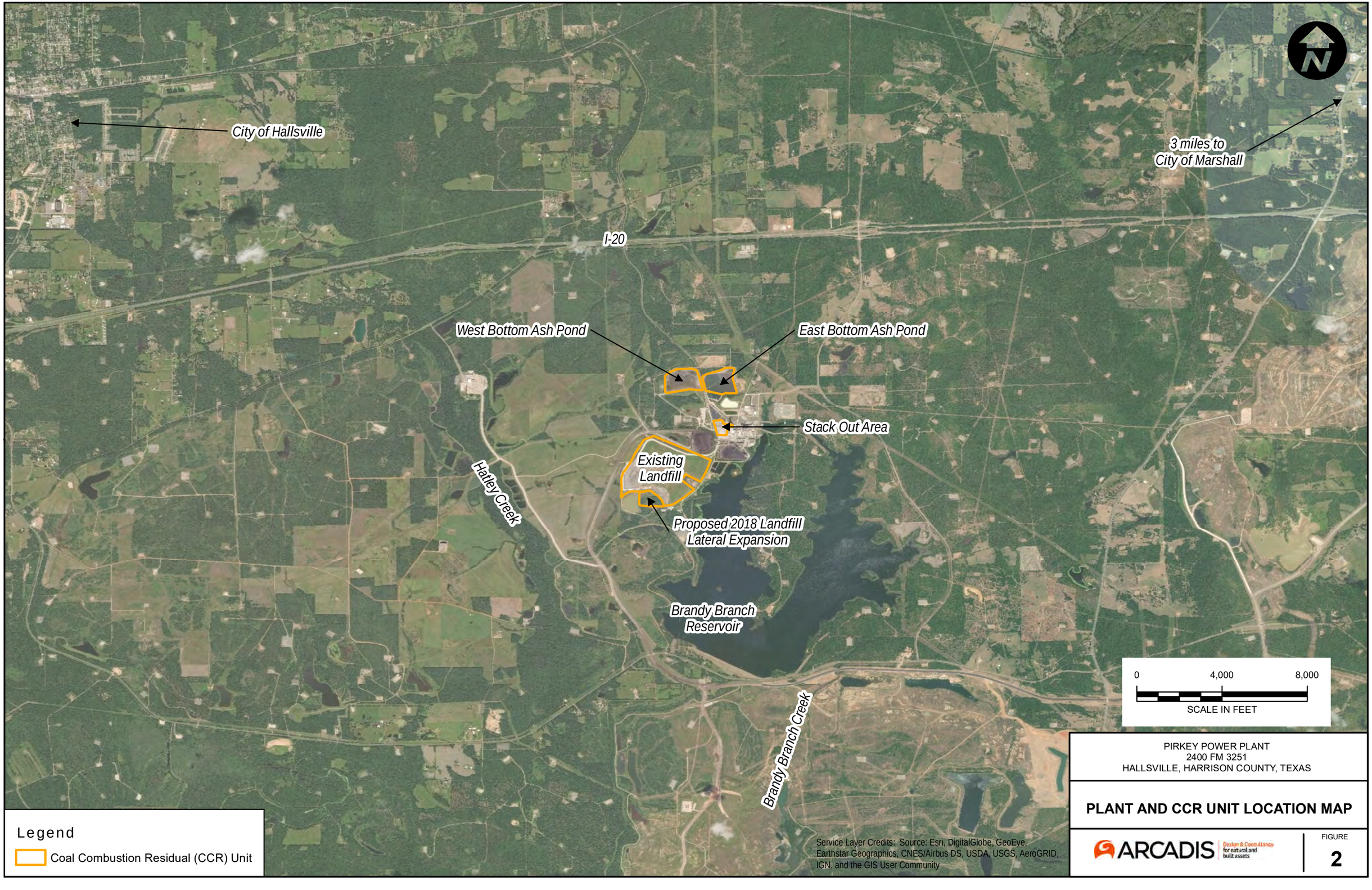
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd



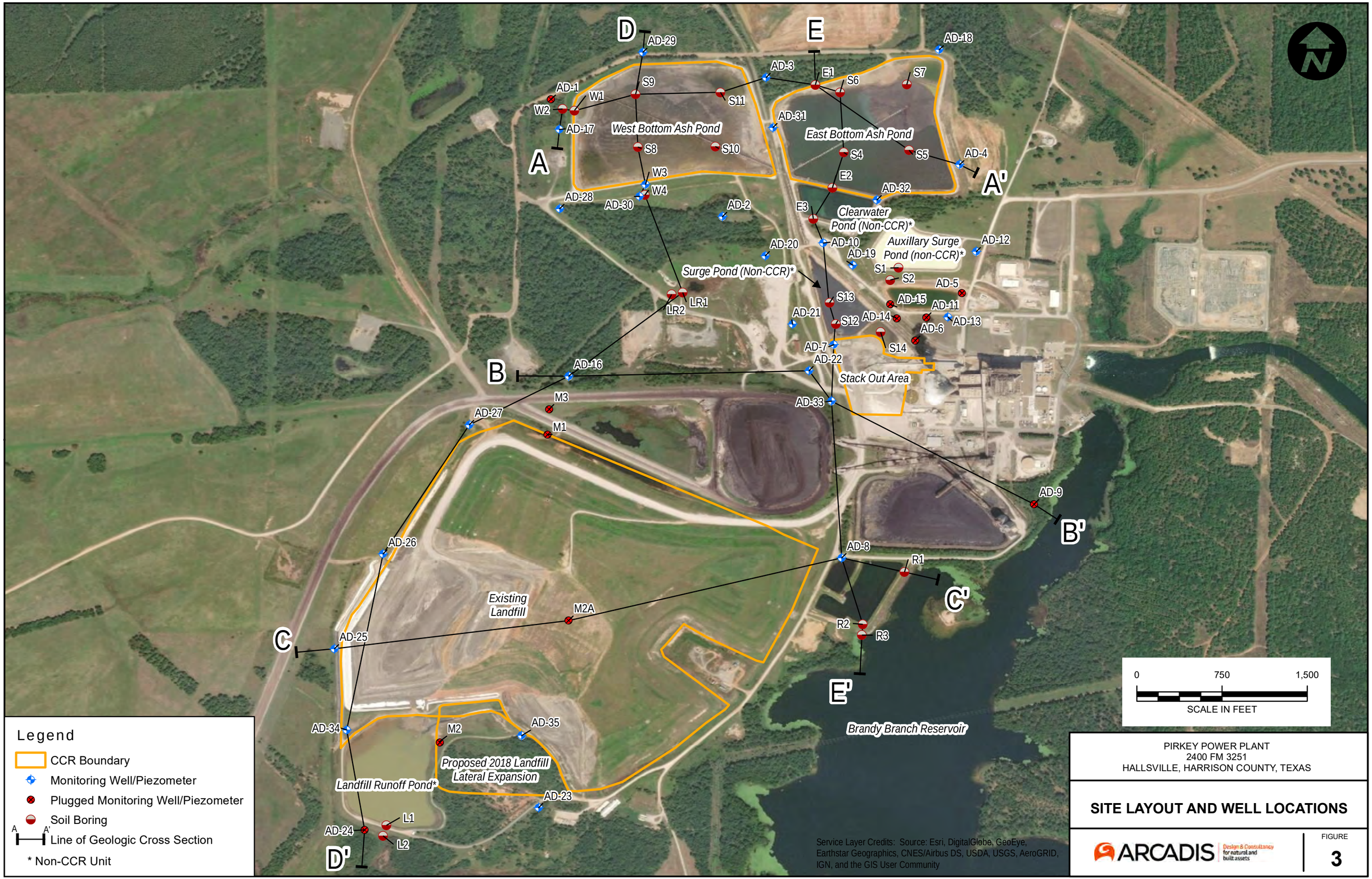
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd

WEST

A

A'

EAST

WEST BOTTOM ASH POND

EAST BOTTOM ASH POND

ELEVATION (FEET MSL)

380'
370'
360'
350'
340'
330'
320'
310'

AD-17

AD-3

AD-4

W1

W2

E1

PERIMETER BERM (EL. 357')

PERIMETER BERM (EL. 357')

WATER AND CCR FILL (A)

WATER AND CCR FILL (A)

S9 (C)

S11 (C)

S5 (C)

COMPACTED COHESIVE SOIL FILL (B)

COMPACTED COHESIVE SOIL FILL (B)

SILTY CLAY

SILTY SANDY CLAY, TAN TO GRAY.

SANDY CLAY, TAN TO GRAY.

CLAYEY SILTY SAND, TAN TO GRAY.

SILTY SANDY CLAY, RED/BROWN/GRAY.

CLAYEY SILTY SAND, TAN TO GRAY.

LEGEND

MONITORING WELL SCREENED INTERVAL

WATER LEVEL IN MONITORING WELL (1/20/16)

BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).
C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

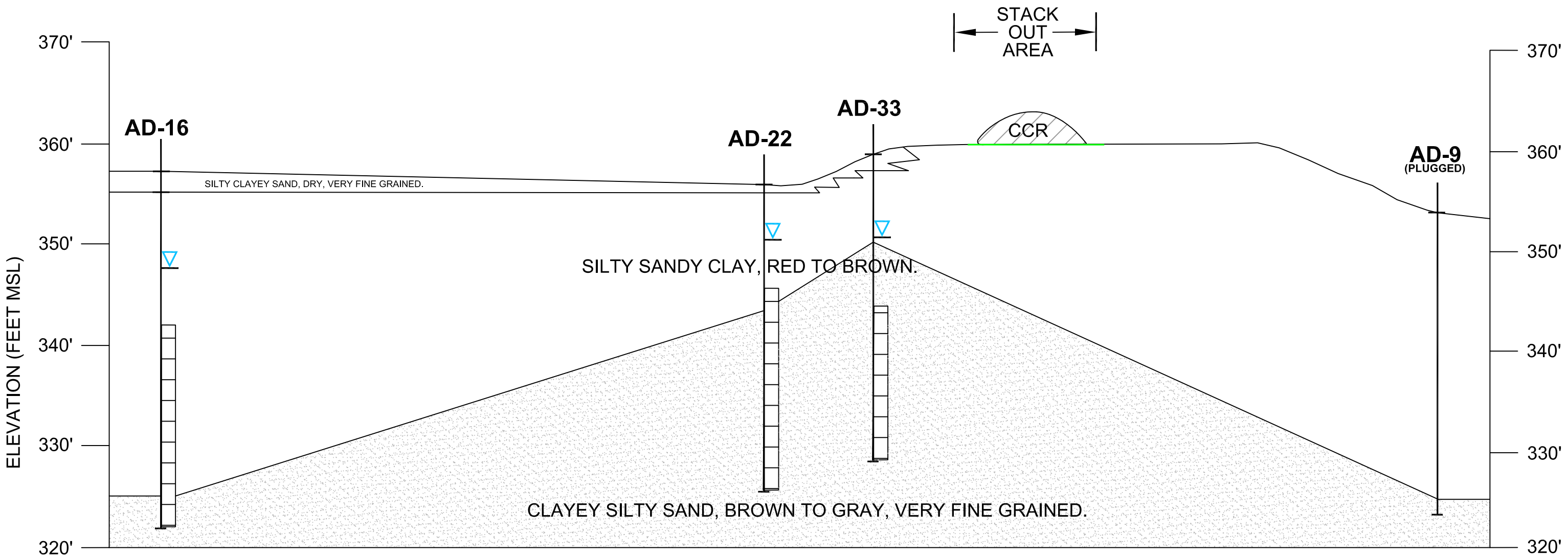
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION A - A'

ARCADIS

FIGURE 4

WEST B — EAST B'



LEGEND

- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

NOTES:
A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE, ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION B - B'

ARCADIS

FIGURE 5

WEST

C

LANDFILL

EAST

C'

370'
360'
350'
340'
330'
320'
310'
300'
290'

ELEVATION (FEET MSL)

AD-25

CLAYEY SAND

SANDY CLAY

LANDFILL
LOW-PERMEABILITY LINER
(CLAY, PVC, OR HDPE)

CCR FILL
(HEIGHT VARIES)

AD-8

R1

SILTY SANDY CLAY.

CLAYEY SILTY SAND.

SILTY SANDY CLAY.

CLAYEY SILTY SAND, BROWN TO GRAY.

M2A
(PLUGGED)

0 500'
HORIZONTAL SCALE

LEGEND

- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:25 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE:
PLOTTED: 2/22/2016 11:18 AM BY: LEASE, DIANA

NORTH

D

SOUTH

D'

WEST BOTTOM ASH POND

PERIMETER BERM (EL. 357') (A)

W3 (PW-3)

AD-29

WATER AND CCR FILL (A)

S9

S8

COHESIVE FILL (B)

AD-30

SILTY SANDY CLAY, RED/BROWN/GRAY.

LR-1

AD-16

SILTY SANDY CLAY, TAN TO GRAY.

AD-27

SILTY CLAYEY SAND

LANDFILL

LANDFILL RUNOFF POND (NON-CCR UNIT) (C)

AD-26

CLAYEY SAND

SANDY CLAY, BROWN.

SANDY CLAY AND CLAYEY GRAVEL, GRAY.

LANDFILL LOW-PERMEABILITY LINER (CLAY, PVC, OR HDPE)

CLAY, GRAY

AD-34

CLAY W/CLAYEY SAND STREAKS, ORANGE/BROWN.

AD-24

CLAY, GRAY

CLAYEY SILTY SAND, BROWN TO GRAY, VERY FINE GRAINED.

BLACK LIGNITE

ELEVATION (FEET MSL)

360'
350'
340'
330'
320'
310'
300'
290'
280'
270'

0 600'

HORIZONTAL SCALE

LEGEND

MONITORING WELL SCREENED INTERVAL

WATER LEVEL IN MONITORING WELL (1/20/16)

BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).

C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

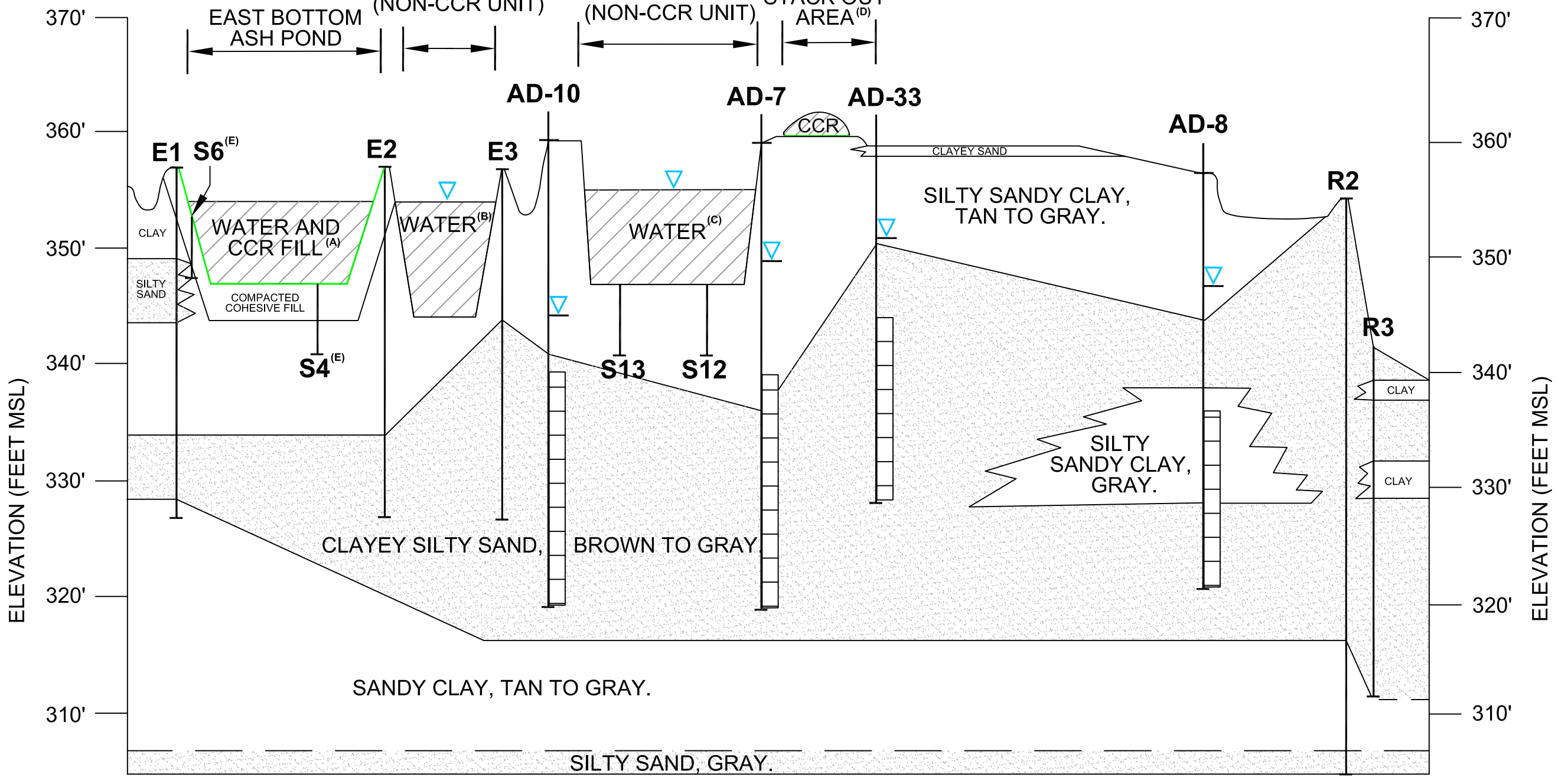
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION D - D'

ARCADIS

FIGURE 7

NORTH E — SOUTH E'



LEGEND

- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

0 500'
HORIZONTAL SCALE

NOTES:

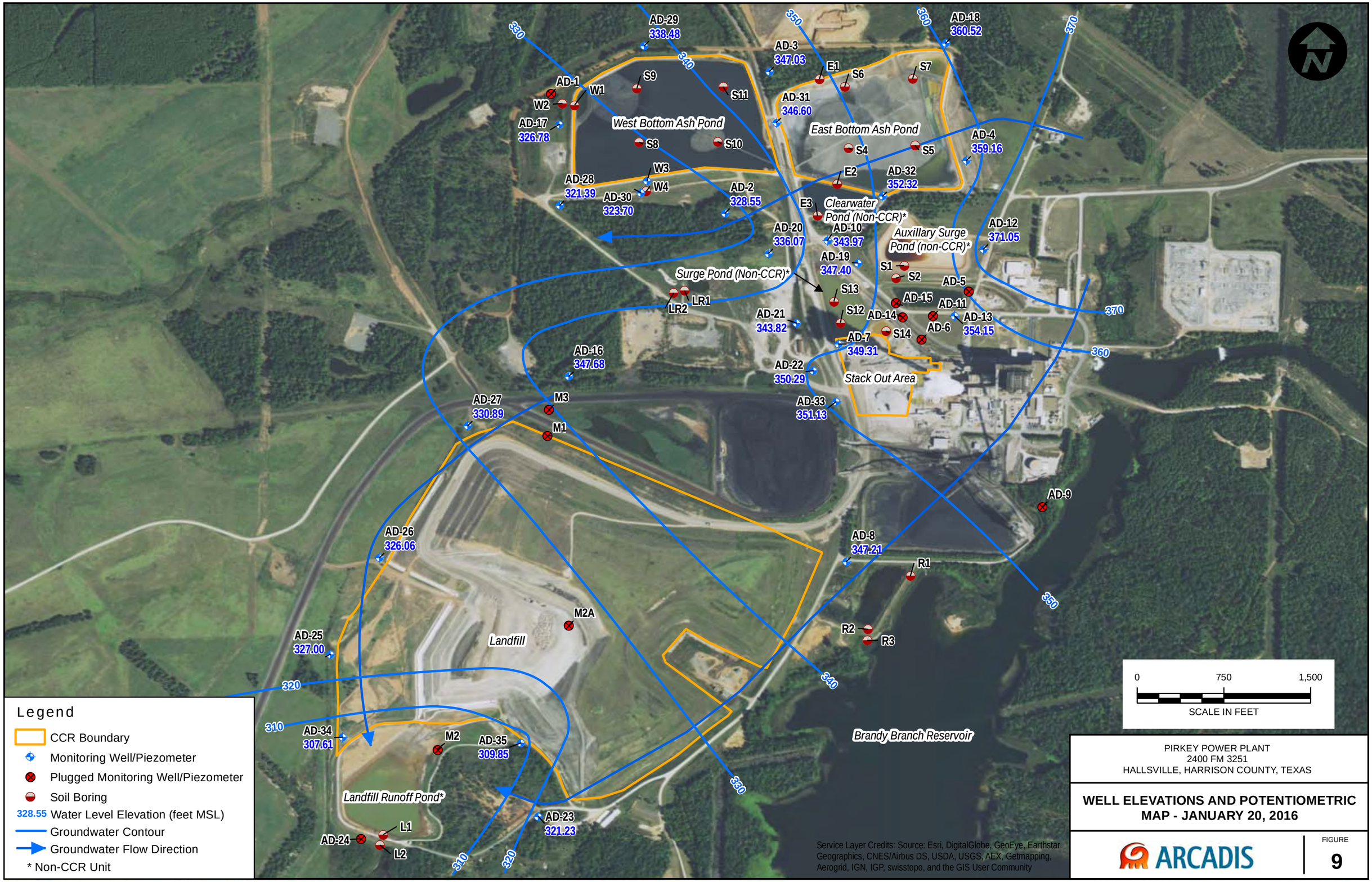
A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).
C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".
D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION E - E'

ARCADIS

FIGURE **8**



Legend

- CCR Boundary
- Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- 328.55 Water Level Elevation (feet MSL)
- Groundwater Contour
- Groundwater Flow Direction
- * Non-CCR Unit

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

ARCADIS

FIGURE
9

Document Path: Z:\GIS\PROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd

AD-29
NM
AD-18
358.23
AD-3
343.49
E1
S6
S7
S9
AD-1
W1
W2
S11
AD-31
343.57
AD-17
324.18
West Bottom Ash Pond
East Bottom Ash Pond
AD-4
353.58
S8
S10
S4
S5
W3
E2
AD-32
349.73
AD-28
320.07
W4
AD-30
322.04
AD-2
327.63
E3
Clearwater
Pond (Non-CCR)*
AD-20
NM
AD-10
NM
AD-12
367.68
Auxillary Surge
Pond (non-CCR)*
AD-19
NM
S1
S2
Surge Pond (Non-CCR)*
S13
AD-5
LR1
LR2
AD-15
AD-11
AD-21
NM
S12
AD-14
AD-13
352.62
AD-6
AD-7
347.40
S14
AD-16
342.71
AD-22
347.37
Stack Out Area
AD-27
330.05
M3
AD-33
349.31
M1
AD-9
AD-26
NM
AD-8
346.31
R1
M2A
Landfill
AD-25
NM
R2
R3
Brandy Branch Reservoir
AD-34
307.61
M2
AD-35
310.28
Landfill Runoff Pond*
AD-23
320.77
AD-24
L1
L2
330
340
350
360
370
320
310

Legend

- CCR Boundary
- Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- 328.55 Water Level Elevation (feet MSL)
- Groundwater Contour
- Groundwater Flow Direction

* Non-CCR Unit
NM - Not Measured

0 750 1,500
SCALE IN FEET

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

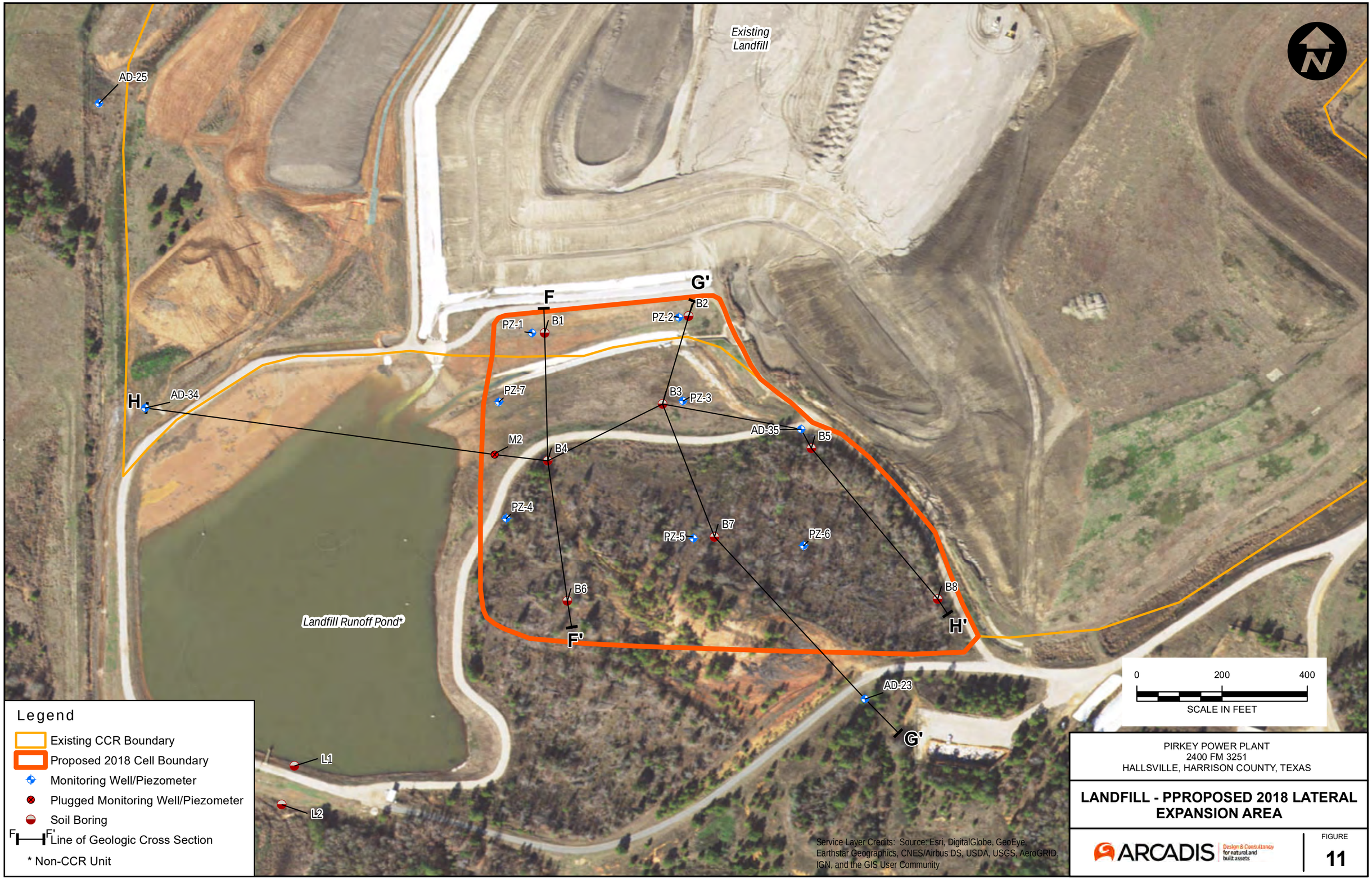
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - AUGUST 24, 2017

ARCADIS

FIGURE
10

Document Path: Z:\GISProjects_ENVVAEP\Pirkey Plant\MXD\Figure 10 - Well Elevations and Potentiometric Map - August 24, 2017.mxd



PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

LANDFILL - PPROPOSED 2018 LATERAL EXPANSION AREA

ARCADIS Design & Consultancy for natural and built assets

FIGURE
11

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 11 - Landfill - 2018 Cell Expansion.mxd

NORTH

F

PROPOSED 2018 LANDFILL LATERAL EXPANSION

SOUTH

F'

ELEVATION (FEET MSL)

330'
320'
310'
300'
290'
280'
270'
260'

PZ-1
B-1
B-4
B-6

RED-BROWN AND GRAY, SANDY CLAY (FILL)

GRAY BOTTOM ASH (FILL)

CLAY

REDDISH BROWN TO GRAY CLAYEY AND SILTY SAND

GRAY AND DARK GRAY CLAY

LIGNITE AND CLAY WITH LIGNITE SEAMS

GRAY AND DARK GRAY CLAY WITH LIGNITE MATERIAL

0 100'
HORIZONTAL SCALE

LEGEND

MONITORING WELL /PIEZOMETER SCREENED INTERVAL

WATER LEVEL IN PIEZOMETER/MONITORING WELL (6/22/18)

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
F - F'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
12

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR(N="OFF;*REF*
G:\Active Projects\AEP\TX0115976.0003 - Pirkey Landfill Expansion\Landfill Expansion Location Restriction Report\Figures-Maps\Figure 12 Cross-Sec F-F'.dwg LAYOUT: MODEL SAVED: 9/19/2018 3:27 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/19/2018 4:40 PM
BY: LEASE, DIANA

PROPOSED 2018 LANDFILL LATERAL EXPANSION

NORTH

G

SOUTH

G'

ELEVATION (FEET MSL)

350'
340'
330'
320'
310'
300'
290'
280'
270'
260'

PZ-2
B-2
B-3
PZ-5
(PROJECTED)
B-7
AD-23

RED-BROWN SANDY CLAY (FILL)

GRAY BOTTOM ASH (FILL)

LIGHT RED AND TAN, CLAY AND SANDY CLAY

REDDISH BROWN TO GRAY CLAYEY SAND SILTSTONE AND SANDY CLAY

ORANGE BROWN TO GRAY SANDY CLAY

BLACK LIGNITE

VERY STIFF TO HARD GRAY CLAY

0 100'
HORIZONTAL SCALE

LEGEND

MONITORING WELL/PIEZOMETER SCREENED INTERVAL

WATER LEVEL IN PIEZOMETER/MONITORING WELL (6/22/18)

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
G - G'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
13

WEST
H

EAST
H'

LANDFILL RUNOFF POND
(NON-CCR UNIT)

PROPOSED 2018 LANDFILL LATERAL EXPANSION

ELEVATION (FEET MSL)

340'
330'
320'
310'
300'
290'
280'
270'
260'

AD-34
B-4
M-2
PZ-3
B-3
AD-35
B-5
B-8

SAND
REDDISH BROWN TO GRAY CLAY
GRAY CLAY
REDDISH BROWN TO GRAY CLAYEY SAND AND SANDY CLAY
BROWN TO GRAY CLAY AND SANDY CLAY
RED-GRAY AND BROWN CLAY AND SANDY CLAY
LIGNITE AND CLAY WITH LIGNITE SEAMS
STIFF TO HARD GRAY CLAY
CLAYEY SAND

0 200'
HORIZONTAL SCALE

LEGEND

MONITORING WELL/PIEZOMETER SCREENED INTERVAL

WATER LEVEL IN PIEZOMETER/MONITORING WELL (6/22/18)

NOTE: LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL,
BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL.
NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
H - H'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
14

Existing Landfill

320
315
310
305
300

AD-25
AD-34
AD-35 311.03
AD-23 320.68

PZ-1 298.86
PZ-2 302.83
PZ-3 303.37
PZ-4 303.22
PZ-5 307.83
PZ-6 315.53
PZ-7 300.97

B1
B2
B3
B4
B5
B6
B7
B8
M2
L1
L2

Landfill Runoff Pond*

Legend

- Existing CCR Boundary
- Proposed 2018 Cell Boundary
- Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- 303.22 Water Level Elevation (feet MSL)
- Groundwater Contour
- Groundwater Flow Direction
- * Non-CCR Unit

0 200 400
SCALE IN FEET

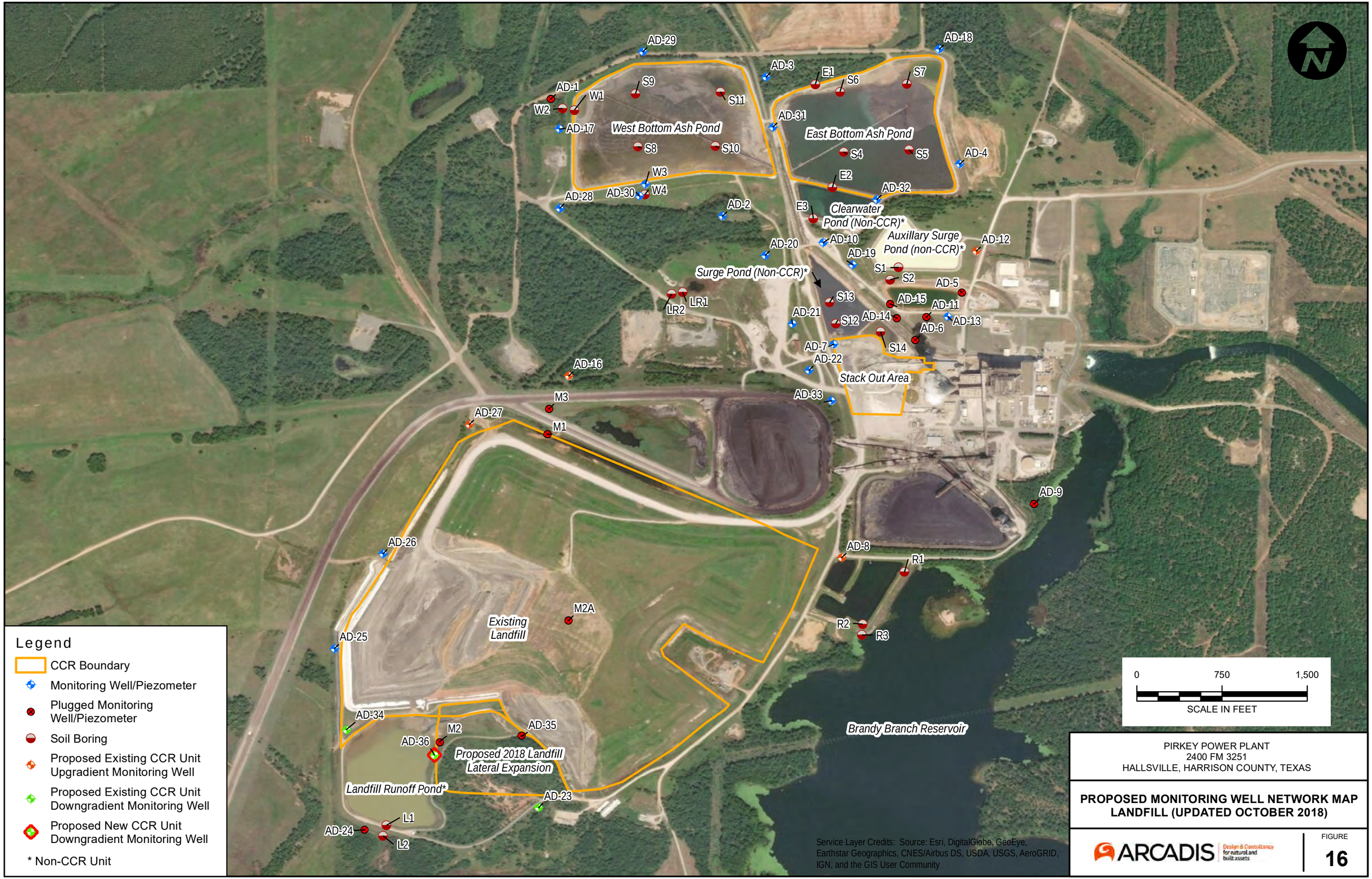
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

POTENTIOMETRIC SURFACE MAP
JUNE 22, 2018

ARCADIS Design & Consultancy for natural and built assets

FIGURE
15

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 15 - Potentiometric Surface Map June 22_2018.mxd



PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP
LANDFILL (UPDATED OCTOBER 2018)

ARCADIS Design & Consultancy for natural and built assets

FIGURE
16

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 16 - Proposed Well Network - Landfill.mxd

Appendix A

Boring/Well Construction Logs

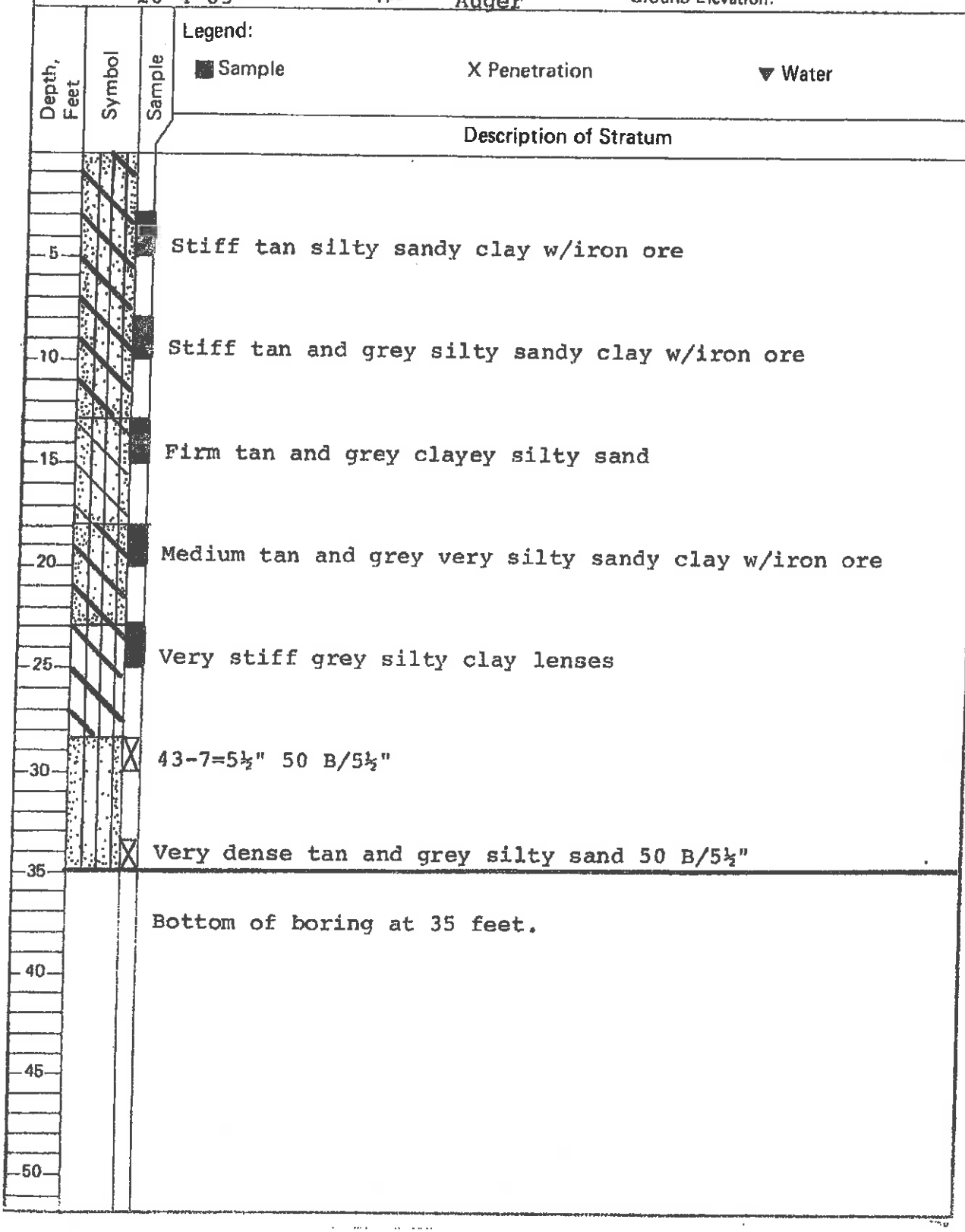
832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-8
LOCATION: Hallsville

Date: 10-4-83 Type: Auger Ground Elevation:



Description of Stratum
Stiff tan silty sandy clay w/iron ore
Stiff tan and grey silty sandy clay w/iron ore
Firm tan and grey clayey silty sand
Medium tan and grey very silty sandy clay w/iron ore
Very stiff grey silty clay lenses
43-7=5½" 50 B/5½"
Very dense tan and grey silty sand 50 B/5½"
Bottom of boring at 35 feet.

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ____ ■ MONITOR WELL MONITOR WELL NUMBER: AD-16

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/30/2010

PREPARED BY: Jeff Sammons LOGGED BY: Matt Lyon/Jeff Sammons

LATTITUDE: N 32°27.680' Datum: WGS-84 WELL LOCATION: North of Mine Haul Road
LONGITUDE: W94°29.642'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1 2			0-2	SM	Silty sand, very fine grained, light brown	None	Dry
3 4 5 6 7 8			2-8	CL	Sandy clay, yellowish brown, reddish brown -some iron oxide concretions at 2.5' -light gray at 5'	None	Dry
9 10			8-10	CL	Clay, red, light yellowish brown, gray, fat, hard, some very fine laminated sand seams	None	Dry
11			10-11	CL	Sandy clay, red, light gray, yellowish brown, stiff to hard	None	Dry
12 13 14			11-14.25	CL	Clay, yellowish brown, some sand, reddish brown, light gray, hard -clayey sand seam at 14-14.25', yellowish brown, light gray	None	Dry Moist
15 16 17 18			14.25-18	CL	Sandy clay, red, light gray, gray, very thin sand lenses interbedded in clay	None	Moist to V. Moist
19 20 21 22 23 24 25 26 27 28 29 30 31 32			18-29.5	CL	Clay, reddish gray, light gray, yellowish brown, hard, gray -2" reddish brown iron oxide cemented sand laminations at 19.75' -very moist, 1" gravelly sand lense, very fine gypsum crystals at 21' -sandy 22', 22.5', 24' -gray, yellowish brown at 24-24.5' - dark gray, very fine gypsum crystals, trace sand, hard, dry, at 25'	None	Moist V. Moist Dry
33 34 35			32-35	SC	Clayey sand, greenish gray, light gray, some very fine gypsum crystals, dense	None	Moist
36 37 38 39 40					Boring Terminated at 35'		

▽ Water Level

Cement | Bentonite | Filter Sand

Apex geoscience inc.

Total Depth: 35 feet
Filter Sand (Size/Interval): 13-35'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-15'
Screen Interval: 15-35'
Water level: 23.37'
3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ____ ■ MONITOR WELL MONITOR WELL NUMBER: AD-23

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/15/2010

PREPARED BY: David Bedford LOGGED BY: David Bedford

LATTITUDE: N 32°27'03.3" Datum: WGS-84 WELL LOCATION: ____
LONGITUDE: W94°29'41.3"

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1-9				SC	Clayey sand, brown, with yellowish brown and orangish brown laminations, very fine grained, very silty, few light gray clay streaks	None	Moist
10-14				ML	Siltstone with light gray clay streaks, light gray with orangish brown streaks, few small iron ore pebbles	None	Moist
15-20				SM	Sand, light gray with orangish brown streaks, very silty, very fine grained, few clay laminations	None	Slightly Moist
21-27				ML	Siltstone, light gray with orangish brown streaks	None None	Very Moist V. Moist
28-30				SM	Sand, light brown mottled with orangish brown, very fine grained, very silty	None	Wet
31-32			▽	SC	Slightly sandy clay, orangish brown mottle with orangish brown, silty, very fine grained (30-31.5')	None	Moist
33-35				CL	Lean clay, dense, small sandy streaks, dark gray, very fine grained (31.5-35')	None	Moist
36-40					Boring Terminated at 35'		

Cement Bentonite Filter Sand Water Level

Apex geoscience inc.

Total Depth: 35 feet Riser Interval: +3 (ags)-15'
Filter Sand (Size/Interval): 13-35' Screen Interval: 15-35'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13' Water level: 30.83
Surface Completion Flush ■ Above Ground 3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 | ☐ BORING BORING NUMBER: | ■ MONITOR WELL MONITOR WELL NUMBER: AD-24

FACILITY NAME: AEP- Pirkey Power Plant | FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

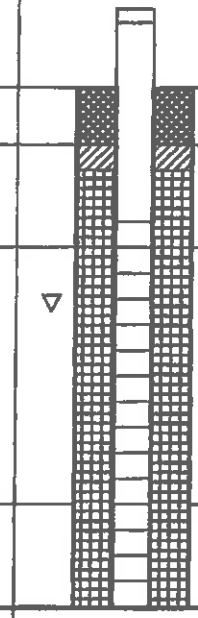
DRILLER: Ed Wilson, Apex Geoscience Inc. | COMPLETION DATE: 12/27/2010

PREPARED BY: Jeff Sammons | LOGGED BY: Jeff Sammons

LATTITUDE: N 32°27.024' Datum: WGS-84 | WELL LOCATION: South of LF pond dam

LONGITUDE: W94°29.940'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1-2			0-1.5	SM	Silty sand, very fine grained, some clay, brown and reddish brown, medium dense	None	Moist
3-6			1.5-6.5	SC	Clayey sand, silty, gray, yellowish brown, reddish brown, very fine grained, dense -some iron oxide concretions and gravel at 5-6', trace organic matter at 6', gray, dark gray, reddish brown, loose to med. dense	None	Dry Moist
7-16			6.5-16	SM	Silty sand, very fine grained, red, loose, trace clay -some gravel at 10' -hard cemented sandstone with iron oxide at 11' - some clay at 15-16', medium dense, gray, dark gray	None	Saturated Moist
17-20			16-20	Lignite	Lignite, black, loose, saturated at 16-17' - medium dense, moist at 17-20'	None	Saturated
21-30					Boring Terminated @ 20'		



Cement | Bentonite | Filter Sand | ▽ Water Level

Apex geoscience inc.

Total Depth: 20 feet | Riser Interval: +3 (ags)-5'

Filter Sand (Size/Interval): 3-20' | Screen Interval: 5-20'

Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-3' | Water level: 8.4

Surface Completion ☐ Flush ■ Above Ground | 3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ____ ■ MONITOR WELL MONITOR WELL NUMBER: AD-25

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/14/2010

PREPARED BY: David Bedford LOGGED BY: David Bedford

LATTITUDE: N 32°27'17.2" Datum: WGS-84 WELL LOCATION: S. of Diesel ASTs

LONGITUDE: W94°29'59.1"

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-1.5	SC	Clayey sand, brown, silty, very fine grained, moist	None	Moist
2			1.5-7	CH	Fat sandy clay, orangish brown, very fine grained, moist	None	Moist
3							
4							
5							
6							
7							
8			7-30	SC	Clayey sand, orangish brown mottled with dark gray, very fine grained, few light gray clay inclusions	None	Moist
9							
10							
11							
12							
13							
14		▽			Wet @ 14'		Wet
15							
16					15-20' - few pieces of dark gray cystalline rock		
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32					Boring Terminated at 30'		
33							
34							
35							

Cement Bentonite Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet Riser Interval: +3 (ags)-10'

Filter Sand (Size/Interval): 8-30' Screen Interval: 10-30'

Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8' Water level: 12.69'

Surface Completion ☐ Flush ■ Above Ground 3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ____ ■ MONITOR WELL MONITOR WELL NUMBER: AD-26

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/14/2010

PREPARED BY: David Bedford LOGGED BY: David Bedford

LATTITUDE: N 32°27'25.3" Datum: WGS-84 WELL LOCATION: By silt fence and plastic lined trench
LONGITUDE: W94°29'54.8"

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1				0-1 SC	Slightly clayey sand, light brown, very fine grained, silty	None	Moist
2				1-3 CL	Sandy clay, lean, very fine grained, reddish brown	None	Moist
3							
4				3-5 CL	Lean, slightly sandy clay with clayey sand streaks, orangish brown, small coal pieces, very fine grained	None	Moist
5							
6				5-7 SC	Clayey sand, orangish brown, very fine grained, brown clay inclusions	None	Moist
7							
8				7-14 CL	Lean clay, orangish brown mottled with brown/light gray clayey sand streaks, very fine grained, few coal pieces	None	Moist
9							
10							
11							
12							
13							
14							
15				14-28 SC	Clayey sand, dark brown with orangish brown streaks, very fine grained, coal pieces	None	Slightly Wet
16							
17							
18							
19							
20			▽				Wet
21					20-22' - Large clay inclusions, brown		
22							Very Moist
23							
24							
25							
26					Wet from 25-26'		
27							
28							
29				28-30 CL	Lean clay, light gray with orangish brown streaks, few small sandy streaks, very fine grained	None	V. Moist
30							
31				30-32 SC	Clayey sand, light black, very fine grained, small pieces mica Wet from 30-30.5'	None	Wet Moist
32							
33				32-40 CL	Lean clay, orangish brown, small clayey sand streaks, very fine grained, brown streaks	None	Moist
34							
35							Slightly Wet
36							
37							
38							
39							
40							
					Boring Terminated at 40'		

Cement Bentonite Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 40 feet Riser Interval: +3 (ags)-10'
Filter Sand (Size/Interval): 8-40' Screen Interval: 10-40'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8' Water level: 19.45'
Surface Completion ☐ Flush ■ Above Ground 3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ____ ■ MONITOR WELL MONITOR WELL NUMBER: AD-27

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/15/2010

PREPARED BY: David Bedford LOGGED BY: David Bedford

LATTITUDE: N 32°27'36.8" Datum: WGS-84 WELL LOCATION: By corner lined ditch
LONGITUDE: W94°29'47.3"

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1 2			0-2	SC	Clayey sand, orangish brown with dark gray laminations, very fine grained	None	Slightly Moist
3 4 5 6 7 8 9 10 11 12 13 14 15			2-15.5	CL	Lean clay, dense, few thin sandy streaks, reddish orange, very fine grained, mottled with light brownish gray Orange to brown with orangish brown streaks, at 10' becomes brittle	None	Slightly Moist
16 17 18 19 20 21 22 23			15.5-23	SC	Clayey sand, greenish brown with orangish brown streaks, few thin tan clay streaks, very fine grained	None	Moist
24			23-24	SM	Sand, orangish brown, silty, very fine grained	None	Wet
25 26 27 ▽			24-27	CH	Fat clay, brown with orangish brown streaks, many sandy streaks, very fine grained	None	Very Moist
28 29 30			27-30	SM	Sand, greenish gray with orangish brown streaks, very fine to fine grained, wet	None	Wet
31 32 33 34 35 36 37			30-37.5	SC	Clayey sand with clay streaks, light greenish black, very fine grained Wet red brittle shale from 35-35.2	None	Slightly Wet
38 39 40					Boring Terminated at 37.5'		

Cement Bentonite Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 40 feet Riser Interval: +3 (ags)-17.5'
Filter Sand (Size/Interval): 15.5-37.5' Screen Interval: 17.5-37.5'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-15.5' Water level: 26.73'
Surface Completion ☐ Flush ■ Above Ground 3'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: AD-34

PROJECT INFORMATION

PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-04-1021
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/11/2015
DEVELOPMENT:	12/16/2015
SITE LOCATION:	2400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

DRILLING INFORMATION

DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	60089
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	307.61 (Top of Casing)
HOLE DIAMETER:	8.25"
LATITUDE	32 27' 10.13" LONGITUDE 94 29' 57.93"

STATE OF TEXAS — JEFFREY D. SAMMONS — GEOLOGY #10070 — LICENSED PROFESSIONAL GEOSCIENTIST — JDS 1-21-16

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	DEPTH	SAMPLE	% MOISTURE	% FINES	LL	PL	PI	WELL CONSTRUCTION
		-4 to -1							Locking Well Casing Cover; Locking Well Cap; Protective Well Casing; Concrete Pad
CLAYEY SAND: very fine to fine sand, some silt, reddish brownish, light reddish brown, light gray, moist	SC	0 to 1							Ground Surface; Cement
FAT CLAY: trace sand and silt, some iron oxide concretions, dark reddish brown, reddish brown, and and light gray, moist	CH	2 to 3		31	89	63	23	40	Bentonite
- some silt and very fine to fine sand at 5', light gray, light reddish brown, and light yellowish brown, moist to very moist		4 to 5							2" Sch. 40 PVC Riser
SANDY LEAN CLAY: some very fine to fine sand, dark gray, moist	CL	6 to 9							
- reddish brown, dark reddish brown, dark gray, light gray at 10' to 12.5'		10 to 12		23	64	26	18	8	
SILTY SAND: very fine to fine sand, some clay, gray and dark gray, saturated	SM	13 to 15							
- increasing clay content with depth		16 to 18		22	29	25	NP	-	20/40 Silica Sand; 0.010" Slotted Sch. 40 PVC Well Screen
FAT CLAY: trace sand and silt, gray, moist	CH	19 to 20							
CLAYEY SAND: fine to very fine sand, dark gray, moist to very moist	SC	21 to 25		23	90	55	27	28	PVC Bottom Cap

NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: AD-35

PROJECT INFORMATION

PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-04-1021
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/11/2015
DEVELOPMENT:	12/16/2015
SITE LOCATION:	2400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

DRILLING INFORMATION

DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	50089
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	318.95 (Top of Casing)
HOLE DIAMETER:	8.25"
LATITUDE	32 27' 9.64" LONGITUDE 94 29' 42.74"

STATE OF TEXAS — JEFFREY D. SAMMONS — GEOLOGY #10070 — LICENSED PROFESSIONAL GEOSCIENTIST — JDS 1-21-16

▽ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	DEPTH	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, some iron ore gravel, reddish brownish, dark reddish brown, yellowish brown, gray, moist	SC	0–2		13	46	32	15	17
SILTY SAND: very fine to fine sand, trace clay, trace iron ore gravel, light reddish brown, moist, increasing moisture content with depth	SM	2–10		12	26	16	NP	
- saturated at 10' to 11'								
CLAYEY SAND: very fine to fine sand, trace iron ore gravel, light reddish brown, very moist - thin seams of saturated very fine sand with trace of clay at 12.25' to 12.5' - light reddish brown and light gray, moist to very moist at 12.5' to 15'	SC	11–15		19	33	31	18	13
LEAN CLAY: intebedded clays and silts with laminations of very fine sand, light gray, gray and light reddish brown, moist to very moist	CL	15–20		21	93	34	20	14
- thin lenses of very moist very fine sand and partially cemented very fine sand at 17.5' and 18', reddish brown								

WELL CONSTRUCTION

- Locking Well Casing Cover
- Locking Well Cap
- Protective Well Casing
- Concrete Pad
- Ground Surface
- Cement
- 2" Sch. 40 PVC Riser
- Bentonite
- 20/40 Silica Sand
- 0.010" Slotted Sch. 40 PVC Well Screen
- PVC Bottom Cap

NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

LOG OF BORING

852164
PROJECT: Monitoring Well Instllation
CLIENT: Southwestern Electric Power Company

BORING NO.: M-1
LOCATION: Hallsville, TX
S 12+32.79; W 35+34.55

Date: 1/29/86 Type: Rotary Ground Elevation: 337.67

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
5			Brown and tan sandy clay
10			Brown and tan sandy clay w/iron ore
15			Brown and tan sandy clay w/iron ore
20			Gray silty sand
25			Gray silty sand
30			Gray silty sand
35			Bottom of Boring at 30 feet. Water encountered at 10 feet.
40			
45			
50			

SOUTHWESTERN LABORATORIES

LOG OF BORING

852164

PROJECT: Monitoring Well Installation
CLIENT: Southwestern Electric Power Company
BORING NO.: M-2
LOCATION: Hallsville, TX
S 38+86.22; W 45+76.41

Date: 1/29/86 Type: Rotary Ground Elevation: 302.19

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
5			Brown silty sand w/iron ore
10			Brown silty sand w/iron ore
15			Brown and gray silty sand
20			Gray silty sand
25			Gray silty sand
30			Bottom of Boring at 27 feet. Water encountered at 11 feet.
35			
40			
45			
50			

SOUTHWESTERN LABORATORIES

LOG OF BORING

852164
PROJECT: Sludge Disposal Area
CLIENT: Southwestern Electric Power Company

BORING NO.: M. 2A
LOCATION: Hallsville, TX

Date: 6/20/85 Type: Auger Ground Elevation: 308.40

Legend: ■ Sample X Penetration

Plant Site Coordinates: South S 27+55.45 West W 36+47.44

▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
5			Red-brown clayey sand
10			Gravel
15		■	Gray clayey silty sand
20		■	Gray silty sand
25			Bottom of Boring at 22 feet. Water encountered at 12 feet. Bottom of Casing at 22 feet. Screen length 15 feet.
30			
35			
40			
45			
50			

SOUTHWESTERN LABORATORIES

Log of Boring

Number: M-3

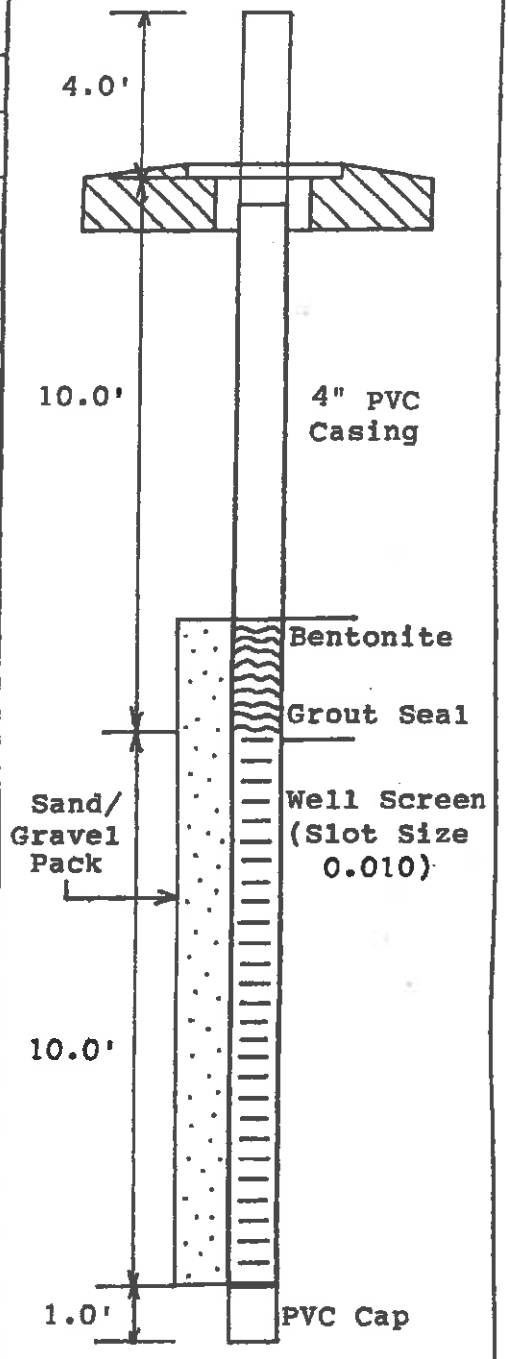
Location: Harrison Co., miles SW Marshall City Ha

Project: New Monitor Well Installation, H.W. Pirkey Power Plant

Type: Groundwater Monitor Well

Surface Elevation: 275.0'

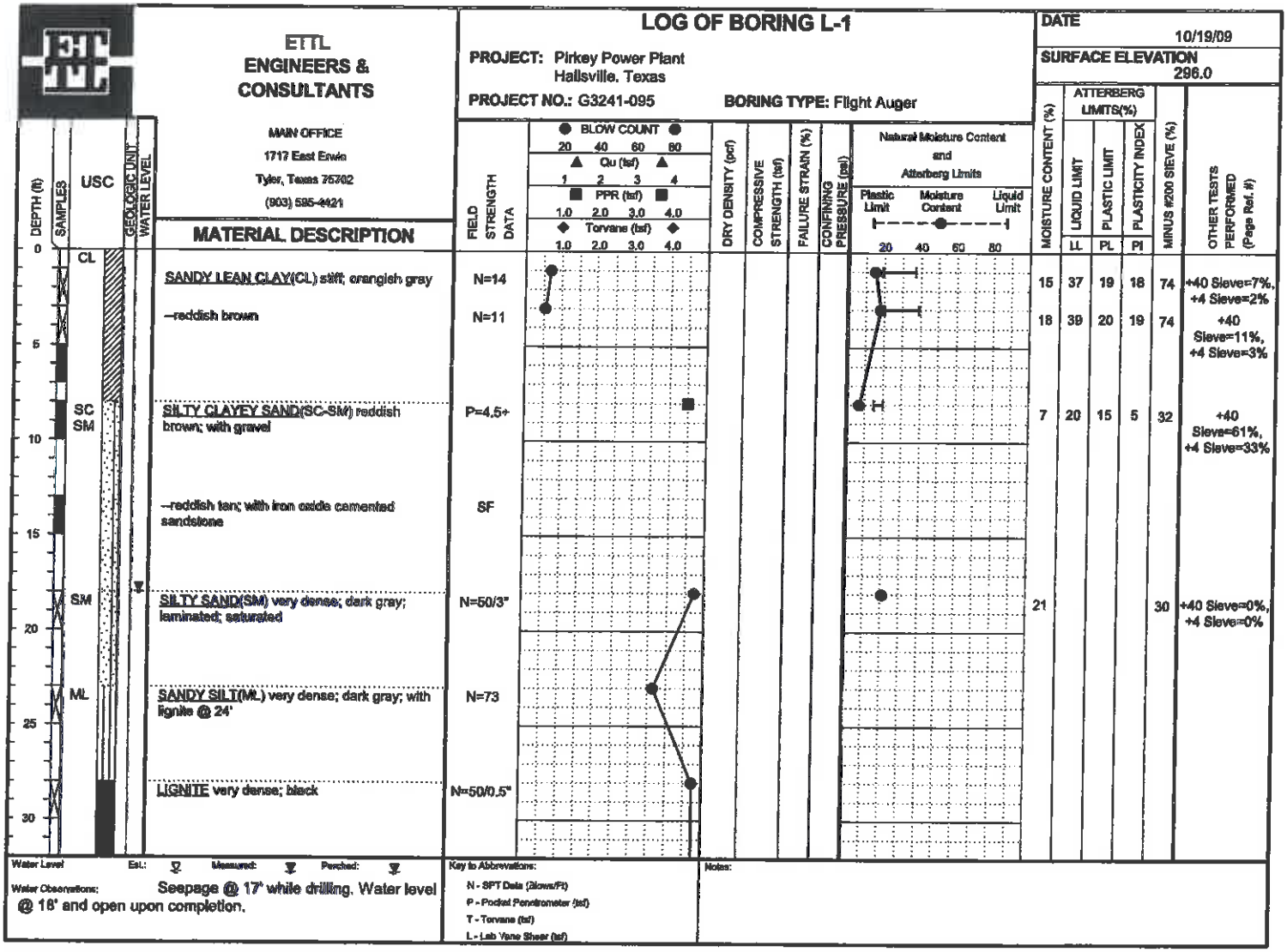
Feet Depth	Samples	Hand Penetrometer (Tons/Sq. Ft.)	Standard Penetration (Blows/Foot)	STRATUM DESCRIPTION
				Sod
				Brown Silty Clay
5				Brown Silty Sandy Clay
				Red & Gray Silty Clay
10				
15				Lignite
				Tan Silty Sandy Clay
20				
25				



Completion Depth: 20'

Date: 7-1-93

Water Observations: Water Encountered at 10.0'



ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING L-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 296.0

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT / WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		CL		SANDY LEAN CLAY(CL) stiff; orangish gray	N=14	15	37	19	18	74	+40 Sieve=7%, +4 Sieve=2%
5				--reddish brown	N=11	18	39	20	19	74	+40 Sieve=11%, +4 Sieve=3%
10		SC SM		SILTY CLAYEY SAND(SC-SM) reddish brown; with gravel	P=4.5+	7	20	15	5	32	+40 Sieve=61%, +4 Sieve=33%
15				--reddish tan; with iron oxide cemented sandstone	SF						
20		SM		SILTY SAND(SM) very dense; dark gray; laminated; saturated	N=50/3"	21				30	+40 Sieve=0%, +4 Sieve=0%
25		ML		SANDY SILT(ML) very dense; dark gray; with lignite @ 24'	N=73						
30				LIGNITE very dense; black	N=50/0.5"						

Field Strength Data: BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0)

DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

Natural Moisture Content and Atterberg Limits: Plastic Limit | Moisture Content | Liquid Limit (20, 40, 60, 80)

Water Level — Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 17' while drilling. Water level @ 16' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING L-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 296.0

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		CL			LEAN CLAY(CL) hard; light grey; with vertical black silty seam	N=50/3"	16	33	19	14	97	+40 Sieve=0%, +4 Sieve=0%
40		CL ML			SANDY SILT CLAY(CL-ML) hard; gray	P=2.25 P=4.5+	16	22	16	6	51	+40 Sieve=0%, +4 Sieve=0%
45		CL			LEAN CLAY(CL; hard; dark brown laminated	P=4.5+						
50					Bottom of Boring @ 50'	P=4.5+						

BLOW COUNT 20 40 60 80
Qu (tsf) 1 2 3 4
PPR (tsf) 1.0 2.0 3.0 4.0
Torvane (tsf) 1.0 2.0 3.0 4.0

DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

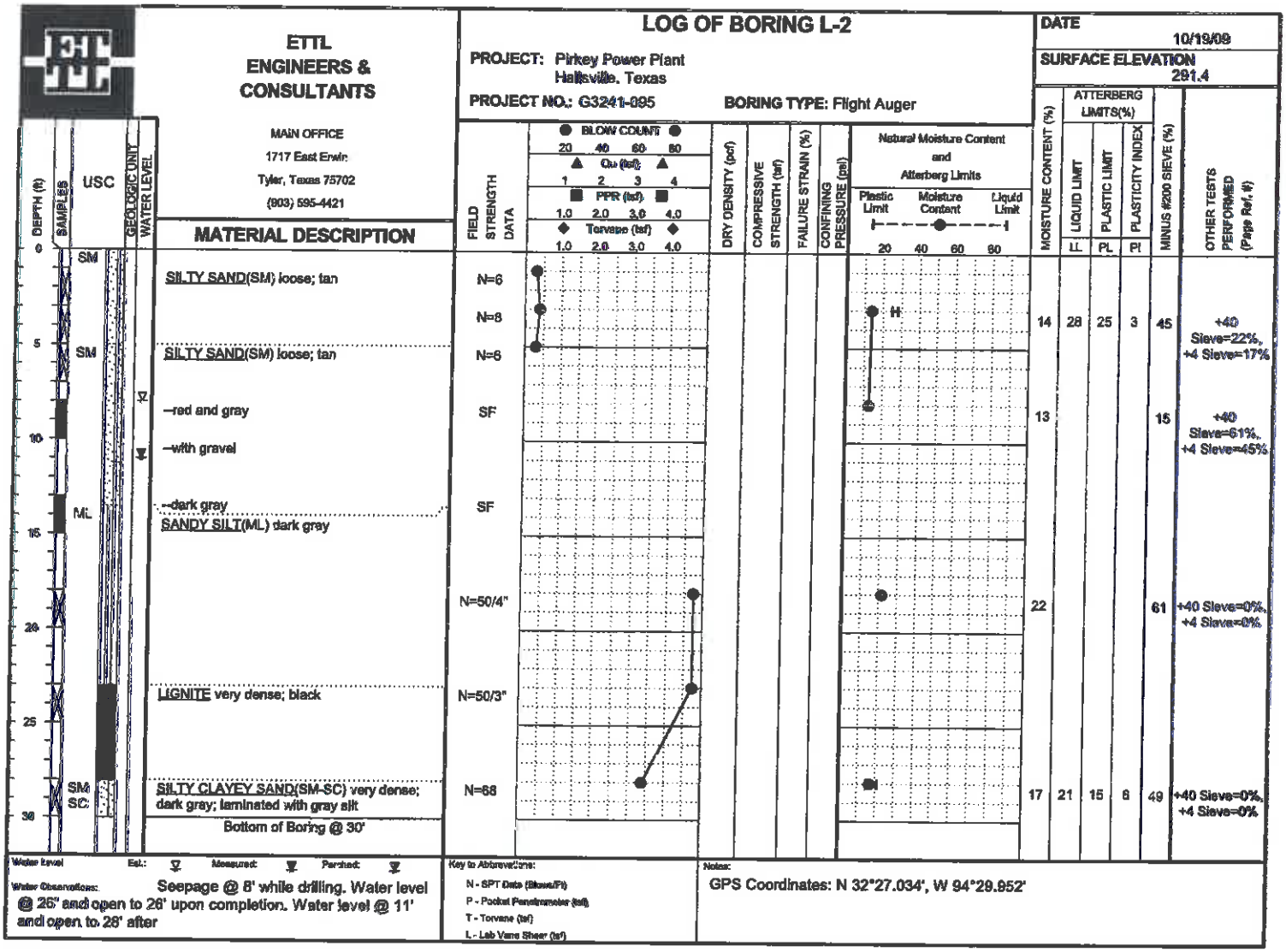
Natural Moisture Content and Atterberg Limits
Plastic Limit | Moisture Content | Liquid Limit
20 40 60 80

Water Level Est.: Measured: Perched:

Water Observations: Seepage @ 17' while drilling. Water level @ 18' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:



ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING L-2

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 291.4

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		SM			SILTY SAND(SM) loose; tan	N=6						
						N=8	14	28	25	3	45	+40 Sieve=22%, +4 Sieve=17%
5		SM			SILTY SAND(SM) loose; tan	N=6						
					–red and gray	SF	13				15	+40 Sieve=61%, +4 Sieve=45%
10					–with gravel							
		ML			–dark gray SANDY SILT(ML) dark gray	SF						
15												
20						N=50/4"	22				61	+40 Sieve=0%, +4 Sieve=0%
					LIGNITE very dense; black	N=50/3"						
25												
30		SM SC			SILTY CLAYEY SAND(SM-SC) very dense; dark gray; laminated with gray silt	N=68	17	21	15	6	49	+40 Sieve=0%, +4 Sieve=0%
					Bottom of Boring @ 30'							

FIELD STRENGTH DATA: BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0)

DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

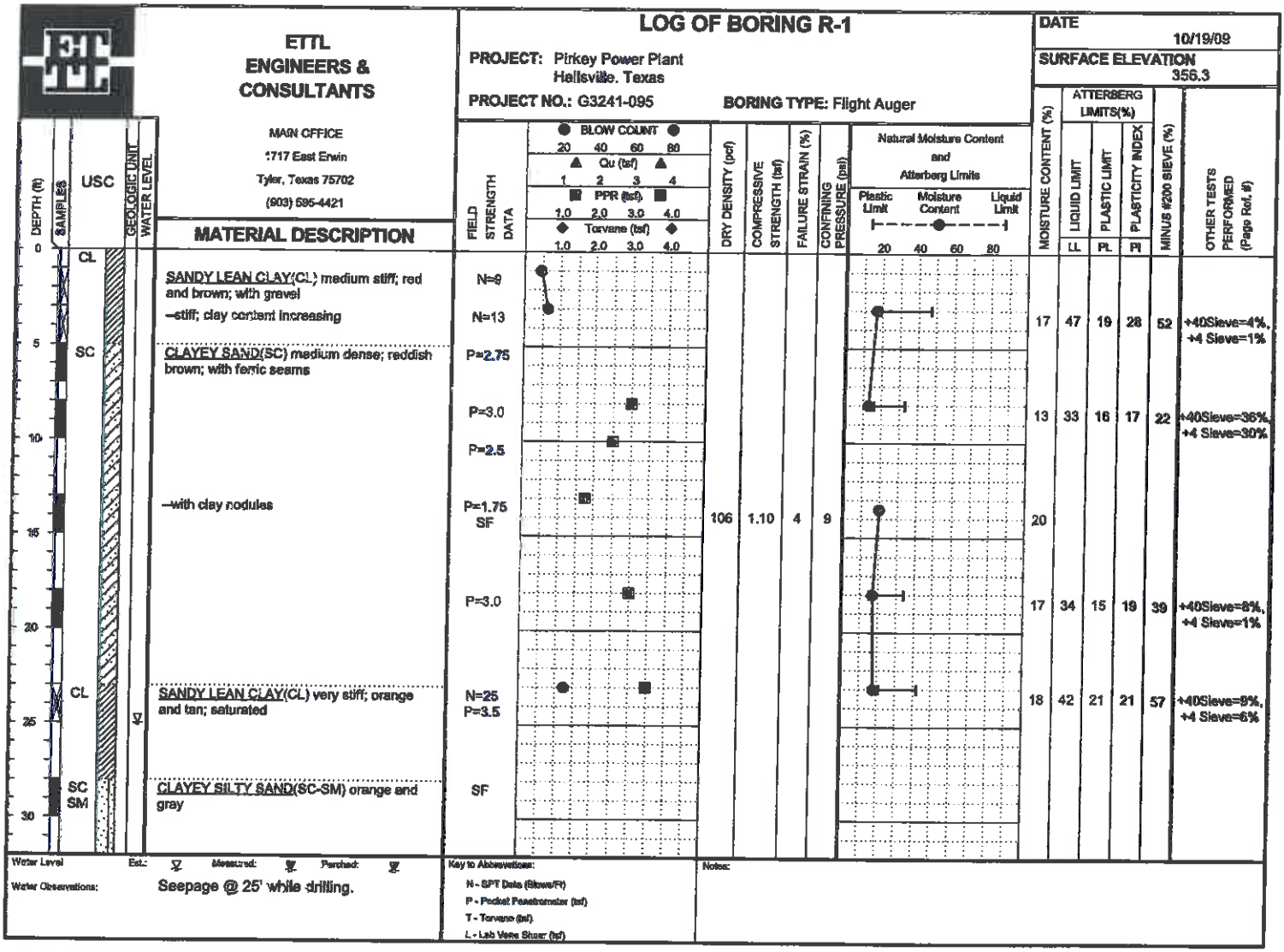
Natural Moisture Content and Atterberg Limits: Plastic Limit | Moisture Content | Liquid Limit (20, 40, 60, 80)

Water Level — Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 8' while drilling. Water level @ 26" and open to 26' upon completion. Water level @ 11' and open to 28' after

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.034', W 94°29.952'



ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING R-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/19/09

SURFACE ELEVATION: 356.3

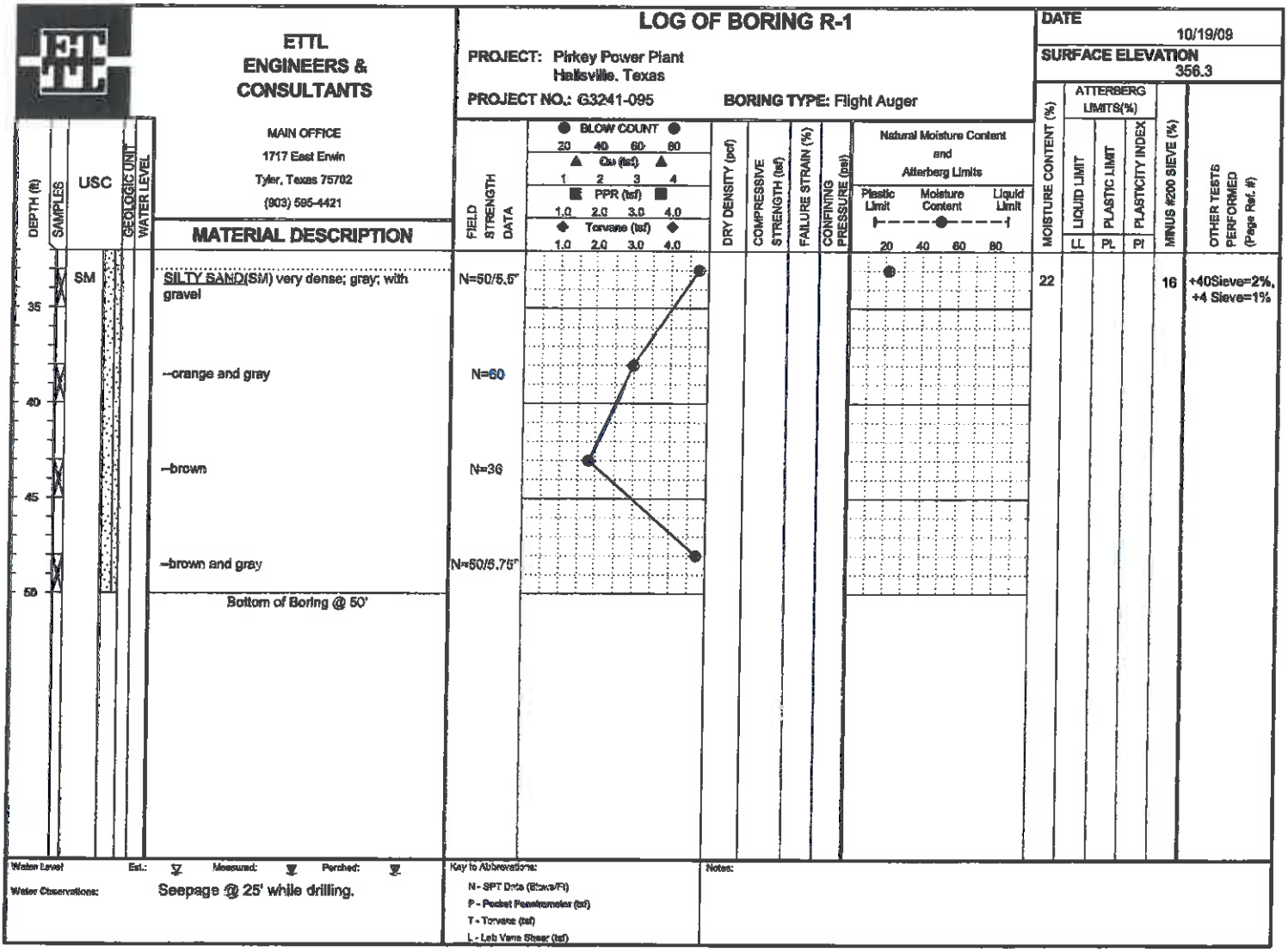
DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		CL			SANDY LEAN CLAY(CL) medium stiff; red and brown; with gravel	N=9										
					–stiff; clay content increasing	N=13					17	47	19	28	52	+40Sieve=4%, +4 Sieve=1%
5		SC			CLAYEY SAND(SC) medium dense; reddish brown; with ferric seams	P=2.75										
						P=3.0					13	33	16	17	22	+40Sieve=36%, +4 Sieve=30%
10						P=2.5										
					–with clay nodules	P=1.75	106	1.10	4	9						
15						SF					20					
						P=3.0					17	34	15	19	39	+40Sieve=8%, +4 Sieve=1%
20																
		CL			SANDY LEAN CLAY(CL) very stiff; orange and tan; saturated	N=25					18	42	21	21	57	+40Sieve=9%, +4 Sieve=6%
25				▽		P=3.5										
		SC SM			CLAYEY SILTY SAND(SC-SM) orange and gray	SF										
30																

Water Level — Est.: ▽ Measured: ▽ Perched: ▽

Water Observations: Seepage @ 25' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:



ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING R-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/19/09

SURFACE ELEVATION: 356.3

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		SM			SILTY SAND(SM) very dense; gray; with gravel	N=50/5.5"						22				16	+40Sieve=2%, +4 Sieve=1%
40					--orange and gray	N=60											
45					--brown	N=36											
50					--brown and gray	N=50/5.75"											
					Bottom of Boring @ 50'												

Field Strength Data: BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0)

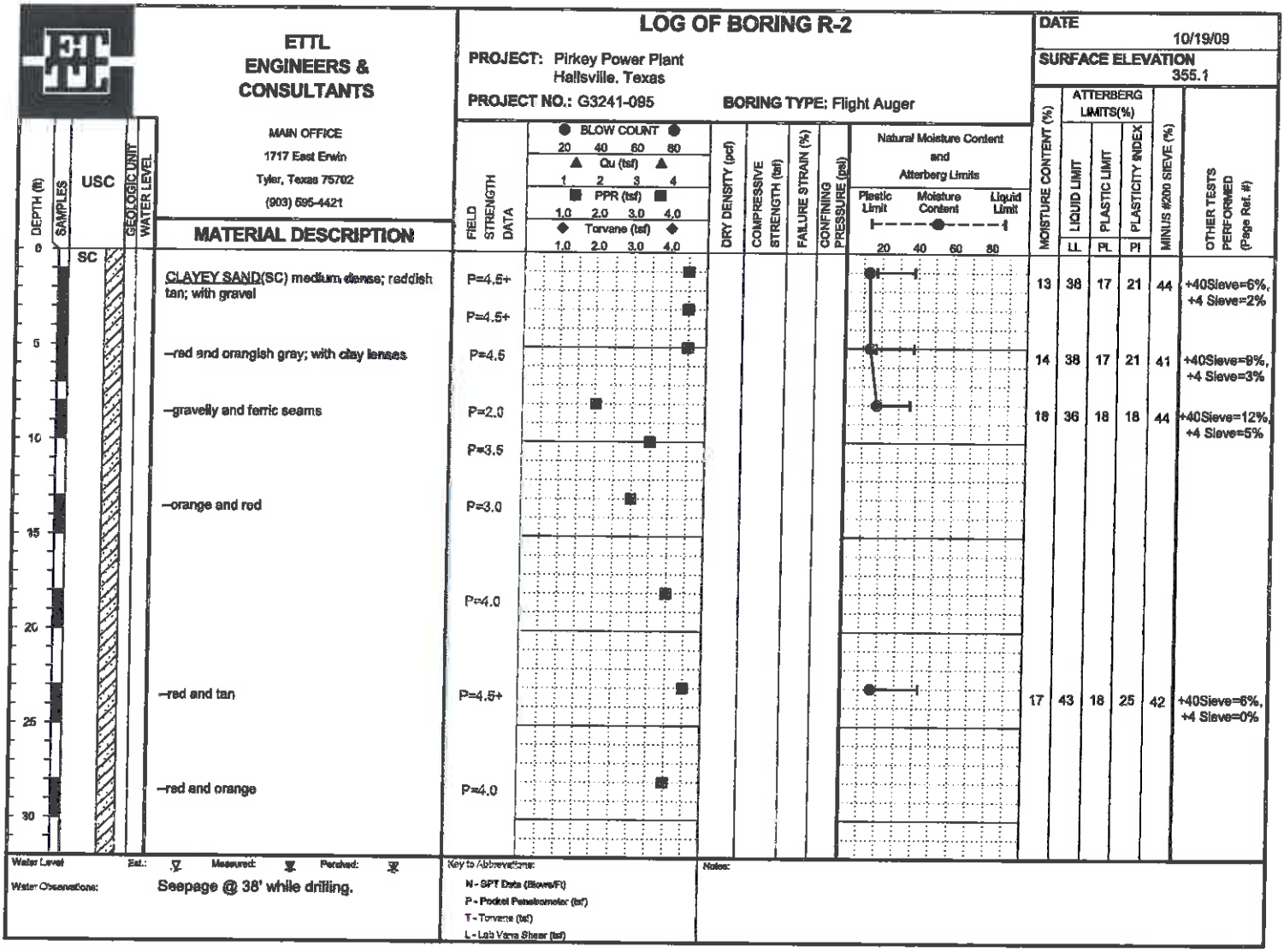
Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20, 40, 60, 80)

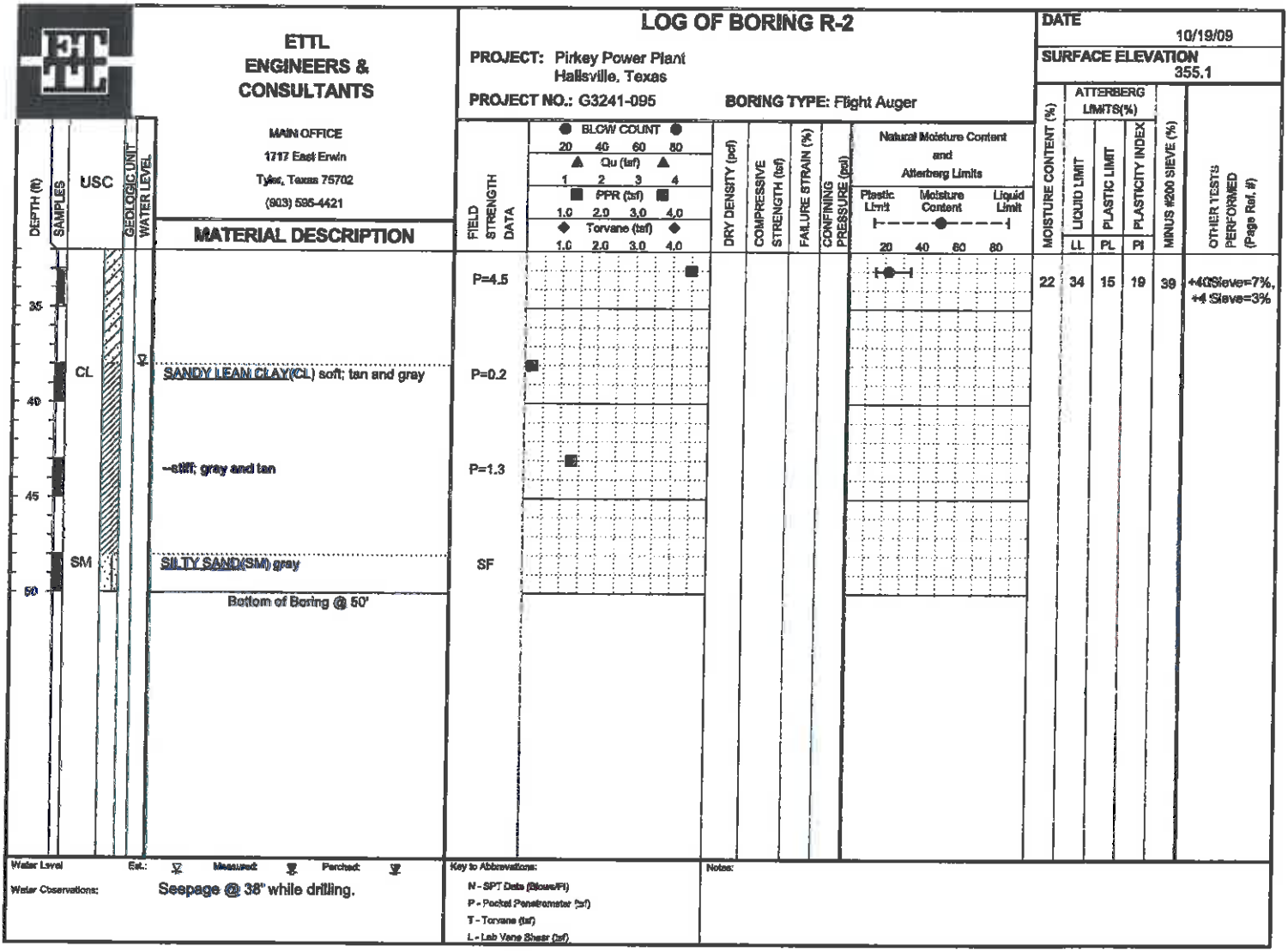
Water Level — Est.: ▽ Measured: ▼ Perched: ▽

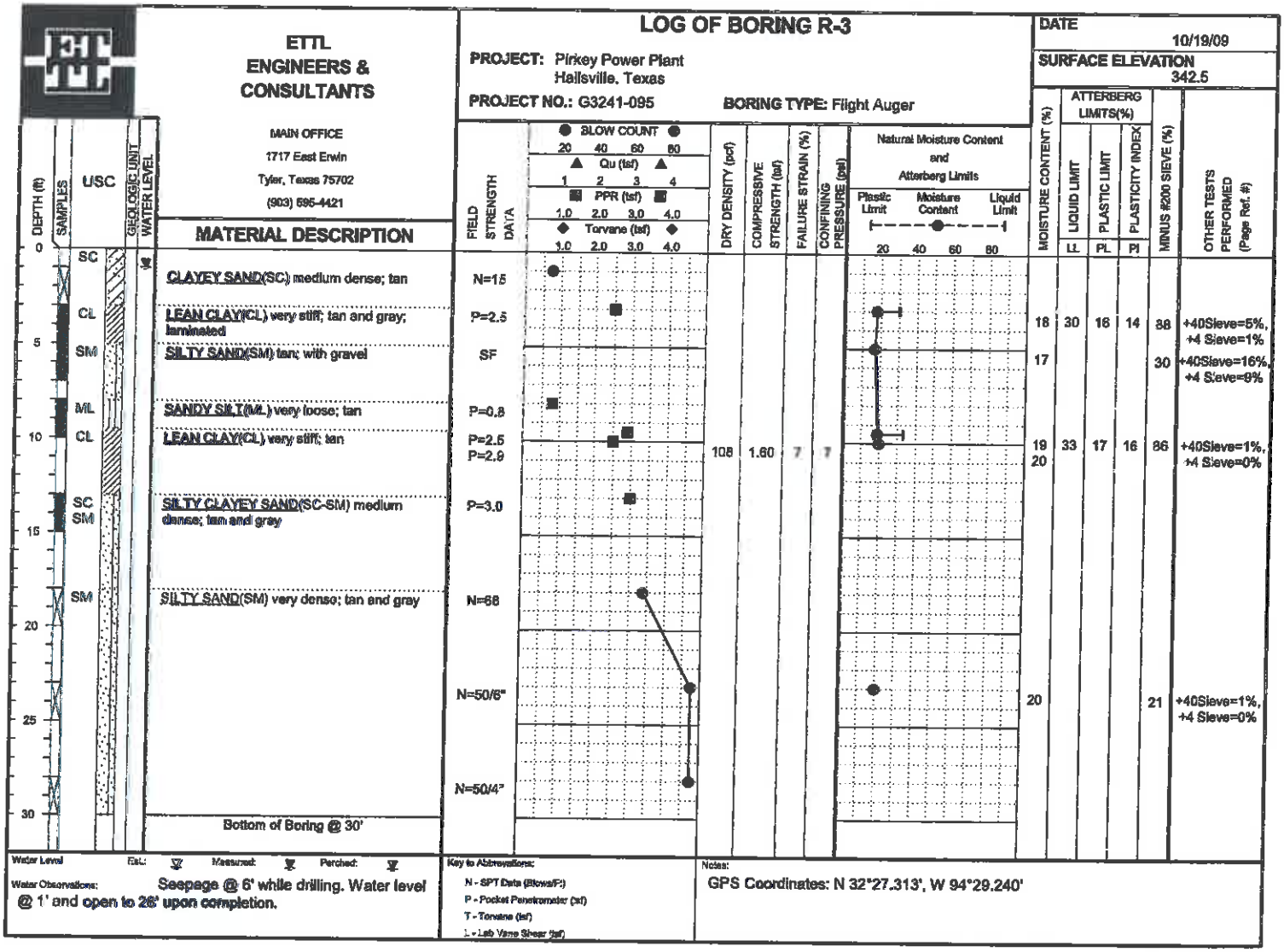
Water Observations: Seepage @ 25' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:


ETTL
ENGINEERS &
CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421
LOG OF BORING R-2
PROJECT: Pirkey Power Plant
Hallsville, Texas
PROJECT NO.: G3241-095
BORING TYPE: Flight Auger
DATE
10/19/09
SURFACE ELEVATION
355.1
MATERIAL DESCRIPTION
DEPTH (ft)
SAMPLES
USC
GEOLOGIC UNIT
WATER LEVEL
FIELD STRENGTH DATA
BLOW COUNT
Qu (tsf)
PPR (tsf)
Torvane (tsf)
DRY DENSITY (pcf)
COMPRESSIVE STRENGTH (tsf)
FAILURE STRAIN (%)
CONFINING PRESSURE (psi)
Natural Moisture Content and Atterberg Limits
Plastic Limit
Moisture Content
Liquid Limit
MOISTURE CONTENT (%)
ATTERBERG LIMITS(%)
LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
LL
PL
PI
MINUS #200 SIEVE (%)
OTHER TESTS PERFORMED (Page Ref. #)
SC
CLAYEY SAND(SC) medium dense; reddish tan; with gravel
P=4.5+
P=4.5+
–red and orangish gray; with clay lenses
P=4.5
–gravelly and ferric seams
P=2.0
P=3.5
–orange and red
P=3.0
P=4.0
–red and tan
P=4.5+
–red and orange
P=4.0
13 38 17 21 44 +40Sieve=6%, +4 Sieve=2%
14 38 17 21 41 +40Sieve=9%, +4 Sieve=3%
18 36 18 18 44 +40Sieve=12%, +4 Sieve=5%
17 43 18 25 42 +40Sieve=6%, +4 Sieve=0%
Water Level
Est.:
Measured:
Perched:
Water Observations:
Seepage @ 38' while drilling.
Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Notes:


ETTL
ENGINEERS &
CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421
LOG OF BORING R-2
PROJECT: Pirkey Power Plant
Hallsville, Texas
PROJECT NO.: G3241-095
BORING TYPE: Flight Auger
DATE
10/19/09
SURFACE ELEVATION
355.1
DEPTH (ft)
SAMPLES
USC
GEOLOGIC UNIT
WATER LEVEL
MATERIAL DESCRIPTION
FIELD STRENGTH DATA
BLOW COUNT
Qu (tsf)
PPR (tsf)
Torvane (tsf)
DRY DENSITY (pcf)
COMPRESSIVE STRENGTH (tsf)
FAILURE STRAIN (%)
CONFINING PRESSURE (psi)
Natural Moisture Content and Atterberg Limits
Plastic Limit
Moisture Content
Liquid Limit
MOISTURE CONTENT (%)
ATTERBERG LIMITS(%)
LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
MINUS #200 SIEVE (%)
OTHER TESTS PERFORMED (Page Ref. #)
35
40
45
50
CL
SM
SANDY LEAN CLAY(CL) soft; tan and gray
--stiff; gray and tan
SILTY SAND(SM) gray
Bottom of Boring @ 50'
P=4.5
P=0.2
P=1.3
SF
22
34
15
19
39
+40Sieve=7%,
+4 Sieve=3%
Water Level
Est.:
Measured:
Perched:
Water Observations:
Seepage @ 38' while drilling.
Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Notes:


ETTL
ENGINEERS &
CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421
LOG OF BORING R-3
PROJECT: Pirkey Power Plant
Hallsville, Texas
PROJECT NO.: G3241-095
BORING TYPE: Flight Auger
DATE
10/19/09
SURFACE ELEVATION
342.5
MATERIAL DESCRIPTION
DEPTH (ft)
SAMPLES
USC
GEOLOGIC UNIT
WATER LEVEL
FIELD STRENGTH DATA
BLOW COUNT
Qu (tsf)
PPR (tsf)
Torvane (tsf)
DRY DENSITY (pcf)
COMPRESSIVE STRENGTH (tsf)
FAILURE STRAIN (%)
CONFINING PRESSURE (psi)
Natural Moisture Content and Atterberg Limits
Plastic Limit
Moisture Content
Liquid Limit
MOISTURE CONTENT (%)
ATTERBERG LIMITS(%)
LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX
LL
PL
PI
MINUS #200 SIEVE (%)
OTHER TESTS PERFORMED (Page Ref. #)
SC
CLAYEY SAND(SC) medium dense; tan
N=15
18
30
16
14
38
+40Sieve=5%, +4 Sieve=1%
CL
LEAN CLAY(CL) very stiff; tan and gray; laminated
P=2.5
SM
SILTY SAND(SM) tan; with gravel
SF
17
30
+40Sieve=16%, +4 Sieve=9%
ML
SANDY SILT(ML) very loose; tan
P=0.8
CL
LEAN CLAY(CL) very stiff; tan
P=2.5
P=2.9
108
1.60
7
7
19
20
33
17
16
86
+40Sieve=1%, +4 Sieve=0%
SC
SM
SILTY CLAYEY SAND(SC-SM) medium dense; tan and gray
P=3.0
SM
SILTY SAND(SM) very dense; tan and gray
N=68
N=50/6"
20
21
+40Sieve=1%, +4 Sieve=0%
N=50/4"
Bottom of Boring @ 30'
Water Level
Est.:
Measured:
Perched:
Water Observations:
Seepage @ 6' while drilling. Water level @ 1' and open to 26' upon completion.
Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Notes:
GPS Coordinates: N 32°27.313', W 94°29.240'

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
1	8/19/2015

Direction Photo Taken:

South

Description:

P8190454
Upland drainage area along southeastern side of Landfill.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
2	8/19/2015

Direction Photo Taken:

South

Description:

P8190467
Lining for new landfill expansion cell

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
3	8/19/2015

Direction Photo Taken:

East Northeast

Description:

P8190470
Lining for new landfill expansion cell

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
4	8/19/2015

Direction Photo Taken:

East Northeast

Description:

P8190475
Upland ditch on east side of landfill.

Appendix C

Soil Boring Logs and Piezometers -
2018 Landfill Lateral Expansion Area

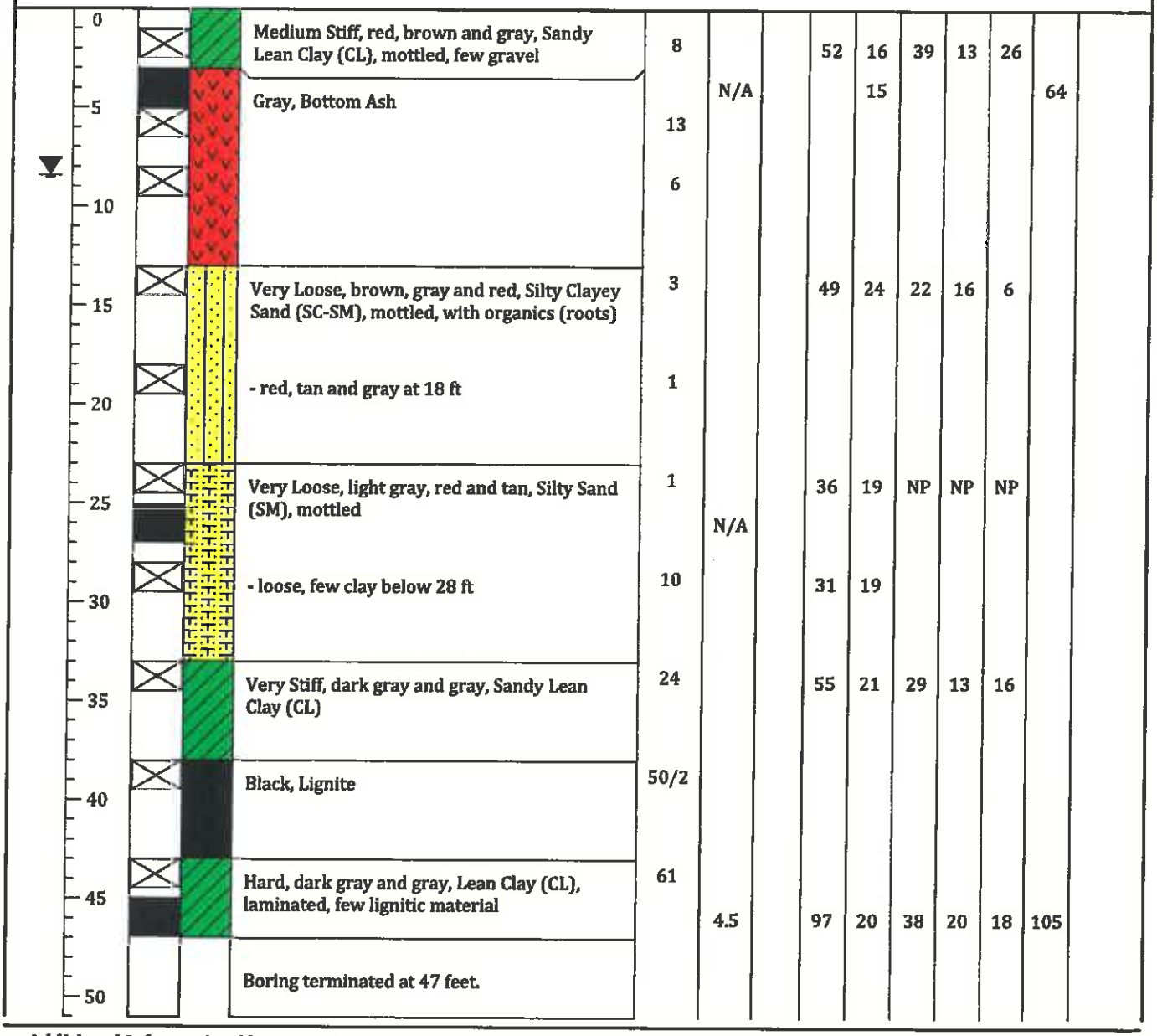
Auckland Consulting LLC

LOG OF BORING B1

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-011
Drill Date(s): 09/07/2016

GPS Coordinates: N32° 27' 12.0" W94° 29' 48.6"
Surface Elevation: N/A
Drilling Method: HSA



Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0			Medium Stiff, red, brown and gray, Sandy Lean Clay (CL), mottled, few gravel	8			52	16	39	13	26	
	5			Gray, Bottom Ash	13	N/A			15				64
▼	10				6								
	15			Very Loose, brown, gray and red, Silty Clayey Sand (SC-SM), mottled, with organics (roots)	3			49	24	22	16	6	
	20			- red, tan and gray at 18 ft	1								
	25			Very Loose, light gray, red and tan, Silty Sand (SM), mottled	1	N/A		36	19	NP	NP	NP	
	30			- loose, few clay below 28 ft	10			31	19				
	35			Very Stiff, dark gray and gray, Sandy Lean Clay (CL)	24			55	21	29	13	16	
	40			Black, Lignite	50/2								
	45			Hard, dark gray and gray, Lean Clay (CL), laminated, few lignitic material	61	4.5		97	20	38	20	18	105
	50			Boring terminated at 47 feet.									

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 8 ft during drilling. Water level at 8 feet upon completion.

N/A: Not Attempted

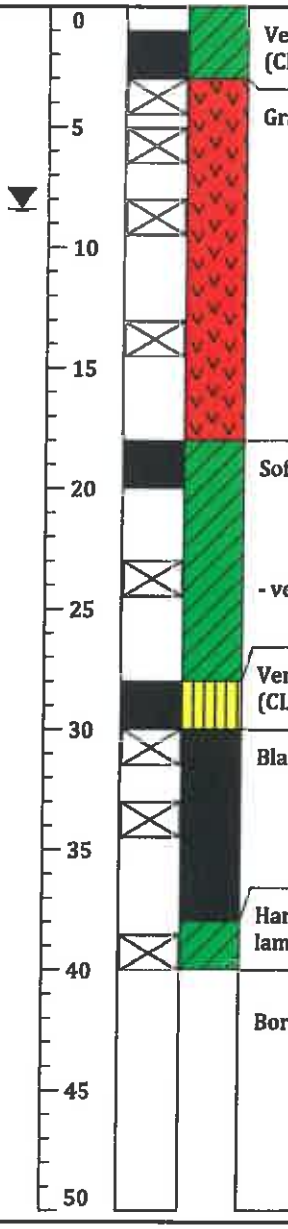
Auckland Consulting LLC

LOG OF BORING B2

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-011
Drill Date(s): 09/06/2016

GPS Coordinates: N32° 27' 12.3" W94° 29' 45.3"
Surface Elevation: N/A
Drilling Method: HSA



Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0			Very Stiff, red and brown, Sandy Lean Clay (CL), mottled, few gravel		2.5		57	18	30	12	18	
	5			Gray, Bottom Ash	4								
▼					3								
	10				1								
	15				2								
	20			Soft, dark gray, Sandy Lean Clay (CL)		0.5		62	20	34	13	21	91
	25			- very soft below 23 ft	1								
	30			Very Stiff, dark gray and gray, Sandy Silty Clay (CL-ML), with lignitic material		3.0		50	15	20	16	4	117
				Black, Lignite	50/3								
	35				50/3								
	40			Hard, gray and dark gray, Lean Clay (CL), laminated, trace gypsum	44			95	22	38	17	21	
				Boring terminated at 40 feet.									
	45												
	50												

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 8 ft during drilling. Water level at 8 feet upon completion.

N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B3

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-011
Drill Date(s): 09/08/2016

GPS Coordinates: N32° 27' 10.3" W94° 29' 45.9"
Surface Elevation: N/A
Drilling Method: HSA

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
▼	0			Soft, brown, tan and red, Sandy Silty Clay (CL-ML), mottled, with few organics	4	N/A		53	19	20	15	5	
	5					N/A							
	10			Very Stiff, brown and gray, Lean Clay with Sand (CL), mottled, laminated	24			77	19	29	17	12	
	15			- stiff below 13 ft		1.5		75	22	31	17	14	103
	20			Black, Lignite	50/3.75								
	25			Hard, gray, Lean Clay (CL), mottled, laminated, few lignitic material	55								
	30			- very stiff between 28 ft and 30 ft		2.5		99	17	38	18	20	117
				- hard below 30 ft	33								
	35			- attempted, no recovery		N/A							
				Very Stiff, gray, Fat Clay (CH), mottled, laminated, trace gypsum	27			97	23	51	17	34	
	40				26								
				Boring terminated at 40 feet.									
	45												
	50												

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 5 ft during drilling. Water level at 5 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B4

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-011
Drill Date(s): 09/12/2016

GPS Coordinates: N32° 27' 9.0" W94° 29' 48.6"
Surface Elevation: N/A
Drilling Method: HSA

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0			Very Loose, reddish brown, Clayey Sand (SC), mottled	2								
	5			- medium dense between 3 ft and 10 ft		3.5		27	14	23	14	9	
				- few gravel below 5 ft	15								
▼	10			- loose between 10 ft and 15 ft	5	2.5		49	18	28	13	15	115
	15			- medium dense between 15 ft and 18 ft	27	0.5		49	20	29	15	14	
	20			- very dense below 18 ft	60								
	25			Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	32								
	30			- very stiff at 28 ft	17			88	22	45	16	29	
	35			- attempted, no recovery		N/A							
				Very Dense, gray and tan, Silty Sand (SM), with lignitic material	50/2								
	40			Hard, gray, dark gray and black, Lean Clay (CL), mottled, with lignitic material	95/11								
				Boring terminated at 40 feet.									
	45												
	50												

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 10 ft during drilling. Water level at 10 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B5

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-011
Drill Date(s): 09/09/2016

GPS Coordinates: N32° 27' 9.2" W94° 29' 42.4"
Surface Elevation: N/A
Drilling Method: HSA

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0			Loose, reddish brown, Clayey Sand (SC), mottled	8								
	5			Very Stiff, red and brown, Sandy Lean Clay (CL), mottled, few gravel	19	4.0	6.6	51	16	34	14	20	116
	10			Dense, red, tan and brown, Clayey Sand (SC), mottled	34	4.0		40	20				
▼	15			Very Stiff, gray and tan, Lean Clay (CL), mottled, laminated	17			96	21	41	16	25	
	20			Very Stiff, gray and dark gray, Lean Clay with Sand (CL), mottled	38	3.0		55	18	29	17	12	
	25			Black, Lignite	50/6								
	30			Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	39	4.0		99	21				
	35			- very stiff at 33 ft	24								
	40			Medium Dense, gray and dark gray, Clayey Sand (SC)	27	2.5		45	27	36	16	20	
	45			Boring terminated at 42 feet.									
	50												

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 13 ft during drilling. Water level at 13 feet upon completion.

N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B6

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Project No.: 2016-011
Drilling Contractor: C&S Lease
Drill Date(s): 09/16/2016

GPS Coordinates: N32° 27' 5.7" W94° 29' 48.0"
Surface Elevation: N/A
Drilling Method: HSA

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0			Very Stiff, red and brown, Sandy Fat Clay (CH), mottled	17	4.5		55	19	61	25	36	
	5			Medium Dense, light red, tan and brown, Silty Clayey Sand (SC-SM), mottled	28			48	11				
	10			- tan, light red and gray below 8 ft, with few gravel between 8 ft and 10 ft	19	3.5							
	15			Very Dense, tan, light red and gray, Silty Sand (SM), mottled	88/10	2.5		33	12	19	15	4	
	20			- dense between 18 ft and 23 ft	42								
	25			- medium dense between 23 ft and 28 ft	28								
▼	30			- very dense below 28 ft	85/11			17	22	NP	NP	NP	
	35			Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	72								
	40			- little recovery, few sand between 38 ft and 40 ft	48	N/A		97	22	42	17	25	
	45			- gray, dark gray and black, with lignitic material, laminated between 43 ft and 45 ft	50/3								
	50				40								
	55				60								
	60				40			98	19	42	17	25	
	65			Boring terminated at 60 feet.									

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 28 ft during drilling. Water level at 28 feet upon completion.

N/A: Not Attempted

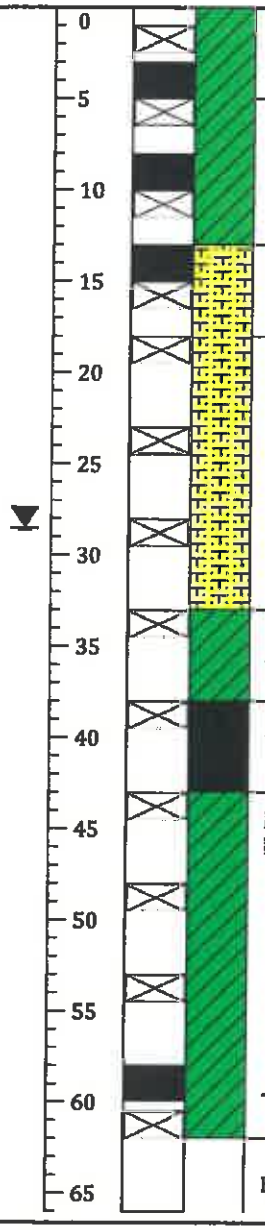
Auckland Consulting LLC

LOG OF BORING B7

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-011
Drill Date(s): 09/14/2016

GPS Coordinates: N32° 27' 7.1" W94° 29' 44.6"
Surface Elevation: N/A
Drilling Method: HSA



Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0			Stiff, light red and tan, Sandy Lean Clay (CL), mottled	13	N/A		51	19				
	5			Very Stiff, light tan, red and brown, Lean Clay (CL), mottled	20	N/A		85	17	29	14	15	
	10				21	N/A							
	15			Very Dense, light gray, Silty Sand (SM)	87/10			45	10	NP	NP	NP	
	20			Very Dense, red, brown and gray, Silty Sand (SM)	60								
	25				84/11			18	21				
▼	30				50/2								
	35			Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	40								
	40			Black, Lignite	50/5								
	45			Hard, dark gray, Lean Clay (CL), mottled, laminated, trace gypsum	81								
	50				64								
	55				35			95	18	43	17	26	
	60			- attempted, no recovery	77	N/A							
	65			Boring terminated at 62 feet.									

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 28 ft during drilling. Water level at 28 feet upon completion.

N/A: Not Attempted

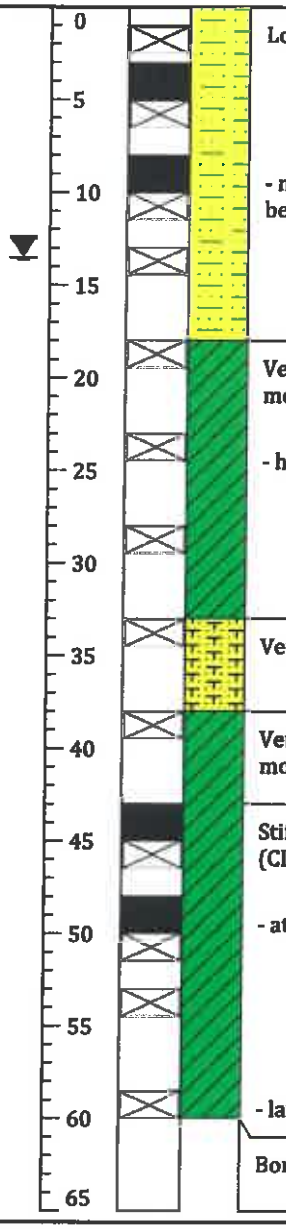
Auckland Consulting LLC

LOG OF BORING B8

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-011
Drill Date(s): 09/13/2016

GPS Coordinates: N32° 27' 5.7" W94° 29' 39.6"
Surface Elevation: N/A
Drilling Method: HSA

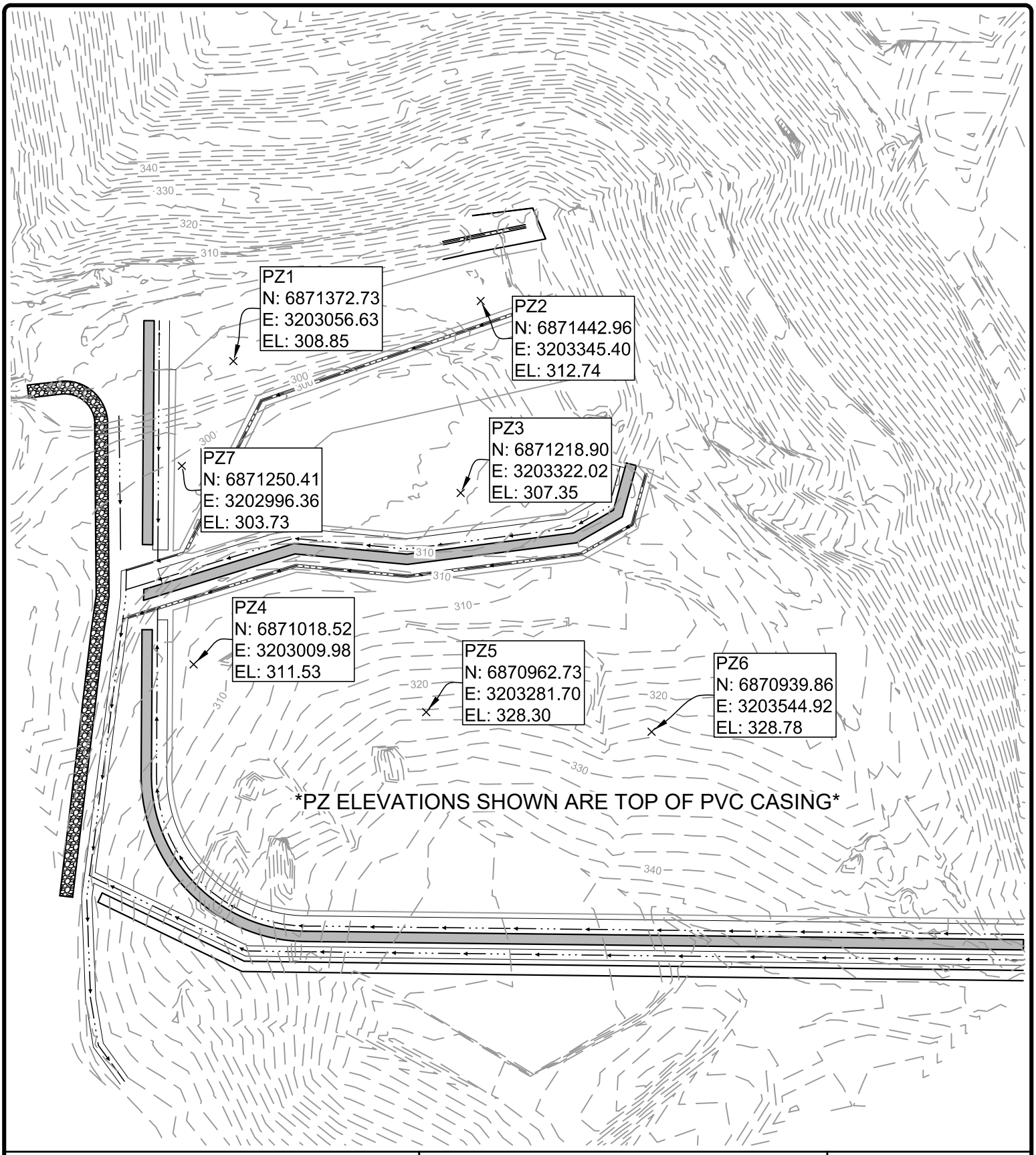


Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0			Loose, red, tan, and brown, Clayey Sand (SC)	6	2.0		39	13	19	12	7	
	5				7								
	10			- medium dense, light gray, red and tan below 8 ft	18	N/A		37	23				
▼	15				15								
	20			Very Stiff, gray and brown, Lean Clay (CL), mottled, laminated	22			91	25	42	16	26	
	25			- hard below 23 ft	79								
	30				79/11								
	35			Very Dense, dark gray, Silty Sand (SM)	76/11			43	30	NP	NP	NP	
	40			Very Stiff, gray and dark gray, Lean Clay (CL), mottled, laminated	21			97	23				
	45			Stiff, gray and dark gray, Sandy Lean Clay (CL), mottled, with occasional lignitic seams	22	1.5		59	25	33	18	15	93
	50			- attempted, no recovery	16	N/A		48	30				
	55				22								
	60			- laminated at 58 ft	29			62	25	44	21	23	
	65			Boring terminated at 60 feet.									

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 13 ft during drilling. Water level at 13 feet upon completion.
N/A: Not Attempted



AKRON CONSULTING, LLC.
431 N. CENTER ST.
LONGVIEW, TX 75601
TBPE Firm Reg. # 14014
(O) 903-236-9744
(F) 903-236-9745
www.akron-consulting.com

PZ WELL
AS-BUILT
LOCATIONS

STATE OF TEXAS WELL REPORT for Tracking #482280

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-1**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Latitude:	**32° 27' 11.79" N**
		Longitude:	**094° 29' 48.1" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Piezometer**

Drilling Start Date: **6/14/2018** Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482283

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-2**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
		Latitude:	**32° 27' 12.36" N**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Longitude:	**094° 29' 44.64" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Piezometer**

Drilling Start Date: **6/14/2018** Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482286

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-3**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
		Latitude:	**32° 27' 10.18" N**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Longitude:	**094° 29' 45.15" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Piezometer**

Drilling Start Date: **6/14/2018** Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482290

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-4**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
		Latitude:	**32° 27' 08.3" N**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Longitude:	**094° 29' 48.73" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Piezometer**

Drilling Start Date: **6/15/2018** Drilling End Date: **6/15/2018**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
Filter Pack Intervals:	**3**	**14**	**Sand**	**20/40**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**0**	**1**	**Cement 1 Bags/Sacks**
	1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482295

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-5**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Latitude:	**32° 27' 07.7" N**
		Longitude:	**094° 29' 45.72" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Piezometer**

Drilling Start Date: **6/15/2018** Drilling End Date: **6/15/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**20**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**20**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**8**	**Bentonite 4 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Sandy Clay**
5	**10**	**Very Soft Red/Brown Clay**
10	**15**	**Very Soft Red/Tan Sandy Clay**
15	**20**	**Tan/Red Silty Sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**10**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**10**	**20**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482297

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-6**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Latitude:	**32° 27' 07.69" N**
		Longitude:	**094° 29' 42.56" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Piezometer**

Drilling Start Date: **6/15/2018** Drilling End Date: **6/15/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**20**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**20**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**8**	**Bentonite 4 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Sandy Clay**
5	**10**	**Very Soft Red/Brown Clay**
10	**15**	**Very Soft Red/Tan Sandy Clay**
15	**20**	**Tan/Red Silty Sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**10**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**10**	**20**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482288

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-7**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
		Latitude:	**32° 27' 10.81" N**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Longitude:	**094° 29' 48.7" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Piezometer**

Drilling Start Date: **6/14/2018** Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Appendix D

Structural stability assessment required at § 257.73(d)

STRUCTURAL STABILITY ASSESSMENT

CFR 257.73(d)

East and West Bottom Ash Pond

Pirkey Plant
Hallsville, Texas

October, 2016

Prepared for: Southwest Electric Power Company (SWEPCO) - Pirkey Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

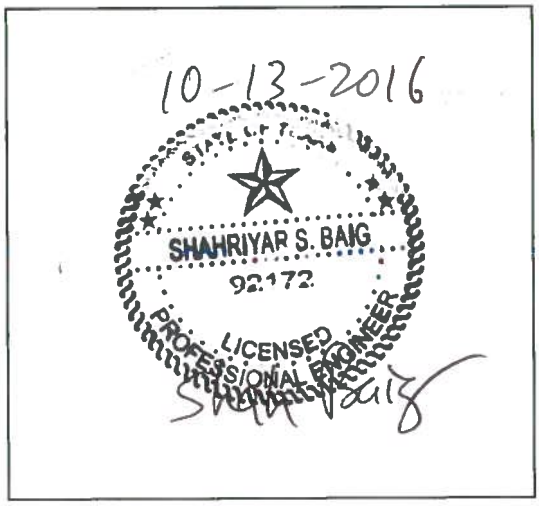
Document No. GERS-16-131

Structural Stability Assessment
CFR 257.73(d)
Pirkey Plant
East and West Bottom Ash Pond

PREPARED BY Brett A. Dreger DATE 10/12/2016
Brett A. Dreger, P.E.

REVIEWED BY DATE 10-13-16
Shah S. Baig, P.E.

APPROVED BY Gary F. Zych DATE 10/13/2016
Gary Zych, P.E.
Manager – AEP Geotechnical Engineering



I certify to the best of my knowledge, information and belief that the information contained in this structural stability assessment meets the requirements of 40 CFR 257.73(d)

Table of CONTENTS

1.0 OBJECTIVE 257.73(d)

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of CFR 257.73(d) and document whether the design, construction, operations, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices. This is the initial assessment as per the Rule.

2.0 NAME AND DESCRIPTION OF CCR SURFACE IMPOUNDMENT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas. It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for storing CCR materials called the East Bottom Ash Pond (East BAP) and the West Bottom Ash Pond (West BAP).

The East BAP is located directly adjacent to and east of the West BAP. The East BAP receives sluiced bottom ash and has a surface area of 30.9 acres and a storage capacity of 188 acre-feet. The pond is almost entirely incised, with a reported maximum embankment height of 4 feet.

The West BAP, which also receives sluiced bottom ash, is located northwest of the main plant buildings and shares its eastern border with the western border of the East BAP. The West BAP receives sluiced bottom ash and has a surface area of 30 acres and a storage capacity of 188 acre-feet. The maximum embankment height is 25 feet. Design documents indicate that the main upstream embankment slopes are 3 feet horizontal to 1 foot vertical (3:1 H:V); while the main downstream slopes area 2.5:1 H:V.

3.0 STABLE FOUNDATION AND ABUTMENTS 257.73(d)(1)(i)

[Was the facility designed for and constructed on stable foundations and abutments? Describe any foundation improvements required as part of construction.]

The foundaion materials for the East BAP are native soils which consist of stiff to very stiff sandy lean clay (CL) and sandy fat clay (CH) with intermittent layers of medium dense to dense silty

sand (SM) and clayey sand (SC). Atterberg Plasticity Indices of tested soils ranged between a low of 16 to a high of 39. Based on the subsurface investigation and engineering properties of the subsurface soils, it is concluded that the East Bottom Ash Pond dikes are supported on a stable foundation base.

The foundation materials for the West BAP are native soils which consist primarily of medium dense to very dense clayey sand (SC) with layers of of dense clayey gravel (GC) and very dense silty clayey sand (SC-SM). Atterberg Plasticity Indices of tested soils ranged between a low of 9 to a high of 46. Based on the subsurface investigation and engineering properties of the subsurface soils, it is concluded that the West Bottom Ash Pond dikes are supported on a stable foundation base.

Operation of the impoundment is performed so as to not adversely affect the foundation and abutments. As required by the CCR rules the Bottom Ash Pond Complex is inspected at least every 7 days by a qualified person. Also as a requirement of the CCR rules, the impoundment is also inspected annually by a professional engineer. Maintenance items are addressed as they are discovered as a part of those inspections.

4.0 SLOPE PROTECTION 257.73(D)(1)(II)

[DESCRIBE THE SLOPE PROTECTION MEASURES ON THE UPSTREAM AND DOWNSTREAM SLOPES.]

The east and west units have been constructed with a layer of bottom ash on the interior slope of the ash pond and limited riprap on random areas of the interior slopes that require slope protection from erosion and wave action. The exterior slopes consist of vegetative cover. Any erosion that may occur is repaired within a timely period.

5.0 EMBANKMENT CONSTRUCTION 257.73 (d)(1)(iii)

[Describe the specifications for compaction and/or recent boring to give a relative comparison of density.]

The East BAP is primarily incised into native soils with an embankment height of approximately 4 feet (AMEC, 2010). The East BAP embankments are constructed of compacted clay on a 3:1 slope (3 feet horizontal, 1 foot vertical) (Sargent & Lundy, 1983). The soils are primarily of stiff

to very stiff sandy lean clay (CL) and sandy fat clay (CH) with intermittent layers of medium dense to dense silty sand (SM) and clayey sand (SC). The elevation of the top of embankment around the perimeter of the East BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, May 2011). The interior bottom elevation of the East BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Johnson & Pace, June 2011). Based on the subsurface investigation and the engineering properties of the subsurface soils, it is concluded that the East bottom Ash Pond embankments are adequately constructed.

The West BAP embankments have maximum height of approximately 25 feet and are constructed of compacted clay on a slope ranging from 2.5:1 (2.5 feet horizontal, 1 foot vertical) to 3:1 (Sargent & Lundy 1983). The elevation at the top of the embankment around the perimeter of the West BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, 2011). The embankment fill materials are primarily stiff to very stiff lean clay (CL) and/or fat clay (CH), overlying native soils consisting of primarily dense to very dense clayey sand (SC) with layers of dense gravel (GC) and very dense silty clayey sand (SC-SM). The interior bottom elevation of the West BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Akron Consulting, 2012). Based on the slope stability evaluation and the engineering properties of the subsurface soils, it is concluded that the West Bottom Ash Pond embankments are adequately constructed.

6.0 VEGETATION CONTROL 257.73 (d)(1)(iv)

[Describe the maintenance plan for vegetative cover.]

The vegetative slopes/areas are mowed to facilitate inspections and maintain the growth of the vegetative layer; and prevent the growth of woody vegetation.

7.0 SPILLWAY SYSTEM 257.73(d)(1)(v)

[Describe the spillway system and its capacity to pass the Inflow Design Flood as per its Hazard Classification.]

Hydrology and Hydraulic Analysis which includes calculations for each spillway structure are included in Inflow Design Flood Control Plan. The Inflow Design Flood for the East and West Bottom Ash Ponds is the 100-year storm event.

The surface water elevation in the East BAP is controlled by a weir box and a manually operated gate valve installed on a 36-inch diameter discharge pipe at the southwest corner of the pond. Clear water overflow from the East BAP discharges through the 36-inch diameter pipe into a 2.7 acre Clearwater Pond located directly south of the East BAP. Water in the Clearwater Pond is either pumped (re-circulated) back into the boiler ash hopper, or gravity discharged through a pipe at the southwest corner of the Clearwater Pond into an unnamed intermittent tributary of Hatley Creek via outfall 006 in accordance with Texas Pollutant discharge Elimination system (TPDES) Permit no. WQ0002496000.

The surface water elevation in the West BAP is controlled by a weir box and a manually operated gate valve installed on a 36-inch-diameter discharge pipe at the southeast corner of the pond. Clear water overflow from the West BAP discharges through the 36-inch diameter pipe into a 2.7 acre Clearwater Pond located southeast of the West BAP. Water in the Clearwater Pond is either pumped (re-circulated) back into the boiler ash hopper, or gravity discharged through a pipe at the southwest corner of the Clearwater Pond into an unnamed intermittent tributary of Hatley Creek via outfall 006 in accordance with Texas Pollutant discharge Elimination system (TPDES) Permit no. WQ0002496000.

Based on the Hydrology and Hydraulic analysis the East and West BAP's spillway system can handle the 100-year storm event.

8.0 BURIED HYDRAULIC STRUCTURES 257.73 (d)(1)(vi)

[Describe the condition of the sections of any hydraulic structure that in buried beneath and/or in the embankment.]

Clear water overflow from the East BAP discharges through a 36-inch diameter corrugated steel pipe that passes into a 2.7 acre Clearwater Pond located directly south of the East BAP. The 36-inch diameter corrugated steel pipe passes under the embankment that separates the

East Bottom Ash Pond from the clear water pond. In 2012 when the clear Water pond was completely drained exposing the out fall end of the pipe, the 36 CMP appeared to be in stable and functional condition.

Clear water overflow from the West BAP discharges through a 36-inch diameter corrugated steel pipe that passes into a 2.7 acre Clearwater Pond located directly southeast of the West BAP. The 36-inch diameter corrugated steel pipe passes under the embankment that separates the West Bottom Ash Pond from the clear water pond. In 2012 when the clear Water pond was completely drained exposing the out fall end of the pipe, the 36 CMP appeared to be in stable and functional condition.

9.0 SUDDEN DRAWDOWN 257.73 (d)(1)(vii)

[If the downstream slope is susceptible to inundation, discuss the stability due to a sudden drawdown.]

The downstream slope of the Bottom Ash dikes will not be inundated from any adjacent water bodies.

Appendix E

The most recent safety factor assessment required at § 257.73(e)

PERIODIC SAFETY FACTOR ASSESSMENT

CFR 257.73(e)(1)

East Bottom Ash Pond

Pirkey Power Plant

Hallsville, Texas

October, 2016

Prepared for: Southwest Electric Power Company – Pirkey Power Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

Document ID Number: GERS-16-143

PERIODIC SAFETY FACTOR ASSESSMENT
CFR 257.73(e)(1)
PIRKEY POWER PLANT
EAST BOTTOM ASH PONDS

PREPARED BY _____ DATE 10/14/2016
Brett A. Dreger, P.E.

REVIEWED BY _____ DATE 10-14-2016
Shahriyar S. Baig, P.E.

APPROVED BY _____ DATE 10/14/2016
Gary F. Zych, P.E.
Department Manager – AEP Geotechnical Engineering

I certify to the best of my knowledge, information, and belief that the information contained in this the safety factor assessment meets the requirements of 40 CFR 257.73(e)(1).

1.0 INTRODUCTION

In April of 2015, the USEPA formally published national regulations for disposal of coal combustion Residuals (CCR) from electric utilities. As part of the rule, the owner or operator of the CCR unit must Obtain a certification from a qualified professional engineer stating that the CCR impoundments are in accordance with the rules. This report provides the documentation needed to fulfill the requirements of 40 CFR § 257.73(e), *Periodic Safety Factor Assessments*

2.0 PROJECT INFORMATION

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas. It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for storing CCR materials called the East Bottom Ash Pond (East BAP) and the West Bottom Ash Pond (West BAP).

The East BAP is incised on three sides with a splitter dike on the west side. The splitter dike is shared with West BAP and its stability is covered under the West BAP stability report titled Initial Safety Factor Assessment – West Bottom Ash Pond. A copy of the West BAP Safety Factor Assessment report is attached.

Initial Safety Factor Assessment – West Ash Pond

Pirkey Power Generating Station
Hallsville, Texas

Auckland Project No. 2015-008C (Revision No. 2)
January 14, 2016

Prepared For:

American Electric Power Company
1 Riverside Plaza
Columbus, Ohio 43215

Prepared By:

Auckland Consulting, LLC
Jacksonville, Texas

TBPE Firm Registration No. F-16721
Expires 2/29/2016

Table of Contents

Appendix

1.0 Introduction and Embankment Information

1.1 Introduction

The following report and evaluation provides the Initial Safety Factor Assessment of the West Ash Pond, an existing CCR impoundment (as defined by 40 CFR §257.2) located at the Pirkey Power Station near Hallsville, Texas. In accordance with 40 CFR §257.73(e)(1)(i) through (iv) this initial assessment provides field and laboratory data, model outputs (detailing multiple stability conditions) and summary of safety factors for the West Ash Pond. In accordance with 40 CFR §257.73(e)(2) this report provides the Initial Safety Factor Assessment certification for the West Ash Pond.

1.2 Referenced Information and Data

Soils data, comprised of field and laboratory testing, utilized in the preparation of this assessment were completed by ETTL Engineers and Consultants, Inc. and documented in the report *Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas* dated October 12, 2010. Based on a review of the provided field and laboratory data, it appears to be accurate and appropriate for use in the initial structural stability assessment of the West Ash Pond [40 CFR §257.73(e)(1)]. Furthermore, based on a recent site visit (October 2015), no modifications or elevation alterations have been made to the embankment since the referenced investigation. No additional field or laboratory activities were conducted. Soil data utilized in this evaluation is provided in the Appendix of this report.

To supplement existing data collected in the above reference report, an additional eight (8) Cone Penetrometer Test (CPT) soundings were advanced both along the crest and southern toe of the West Ash Pond. Sounding depths ranged between approximately 14 feet and 40 feet before encountering refusal. The data collected generally supports the findings from the 2010 study and confirms that embankment and foundation soils are relatively consistent. The location of and data from these CPT soundings are provided in the Appendix of this report.

The impoundment pool elevation data cited herein were provided in a separate hydrology and hydraulic (H&H) analysis report completed by Akron Consulting, LLC titled *Hydrology & Hydraulic Report, East & West Ash Ponds, H.W. Pirkey Power Plant – Hallsville, Texas,* dated December 15, 2015 (not included herein). The referenced report generally meets the demonstration requirements of 40 CFR §257.82(a).

Embankment profile dimensions and elevations were determined by using existing information provided by the client or representatives of the client. This information is also included in the Appendix of this report.

1.3 Embankment Evaluation Criteria

Based on information provided by the client, the existing embankment is constructed of lean clay (CL) and fat clay (CH) with existing side slopes (both up- and downstream) of approximately 3:1 (H:V), maximum embankment height of 20 feet and top of dam elevation of 358.0 feet (MSL). The upstream base elevation of the impoundment is approximately 347.0 feet (MSL). The crest width of the embankment is approximately 25 feet. Two (2) critical sections were evaluated for this initial safety factor assessment. Section No. 1 represents the northwest corner of the West Ash embankment and Section No. 2 represents the southern berm of the embankment.

It is our understanding that the maximum storage elevation of impounded CCR ash is 355.0 feet (MSL); however, the facility is managed to maintain an ash level less than this maximum level. The downstream toe of the West Ash Pond is not adjacent to other water bodies and therefore not subject to 40 CFR §257.73(d)(1)(A)(3)(vii).

In accordance with 40 CFR §257.73(e)(1)(i) and (ii), the maximum storage pool elevation for the West Ash Pond as determined by the 25-year, 24-hour storm event is 354.81 feet (MSL). For the purposes of this evaluation, the maximum storage pool elevation of 355.0 feet (MSL) was utilized. Likewise, the maximum (or flood) surcharge loading elevation as determined by the 100-year, 24-hour event is 355.01 feet (MSL), for this evaluation a maximum surcharge loading elevation of 355.0 feet (MSL) was utilized. Storage pool elevations were determined in accordance with 40 CFR §257.82(a).

2.0 Slope Stability Analyses

2.1 General

Soil parameters used for stability analyses of the existing embankment are based on findings of previous laboratory and field testing programs. The probable failure planes were analyzed using the analytical slope stability software, SLIDE by Rocscience, Inc. Methods of evaluation used in SLIDE are considered to be limited equilibrium methods of analysis, where each individual shear plane is evaluated to determine the resulting shear stress at the point of failure. For the purposes of this evaluation the Bishop Method of analysis, which analyzes circular failure planes through the slope was utilized.

Per 40 CFR §257.73(e)(1)(i) through (iii), three (3) modeled scenarios (presented below) were utilized to evaluate the stability of the existing embankment: steady state seepage (long term) condition under maximum storage pool, steady state seepage (long term) condition under maximum surcharge pool, and steady state seepage condition with seismic loading under maximum storage pool conditions. The following minimum factors of safety (FS) and soil stress parameters were utilized in modeling. Minimum factors of safety are based on demonstration requirements provided in 40 CFR §257.73(e)(1).

Summary of Embankment Condition and Factor of Safety		
Embankment Condition	**Soil Parameters**	**Minimum Factor of Safety**
Steady State Seepage – Maximum Pool	Effective Stress	1.50
Steady State Seepage – Surcharge Pool	Effective Stress	1.40
Steady State Seepage (Seismic) – Maximum Pool	Total Stress	1.00
NOTE: Minimum factors of safety based on demonstration requirements provided in 40 CFR §257.82 (e)(1).		

For evaluation of steady state seepage (long term) conditions with seismic, peak ground acceleration for this location was obtained from the USGS National Seismic Hazard Mapping Project (http://earthquake.usgs.gov/hazards). Based on the seismic survey data, the anticipated site specific peak ground acceleration (PGA) of 0.06g (acceleration at rock sites) for two (2) percent probability of exceedance in 50 years (40 CFR Part 257, Preamble page 21384). Correcting for acceleration at soft soil sites (Seismic Site Classification D) yields an estimated PGA of 0.13g. The seismic coefficient (k) used for pseudo static analysis is determined by reducing the estimated PGA by 50% yielding a seismic coefficient of 0.065g.

2.2 Liquefaction Assessment

Liquefaction of soils occurs when horizontal shearing stresses exceed the strength of existing loose, saturated sand. This sudden loss of shear strength and subsequent soil structure is typically associated with earthquake-induced horizontal movement. Recent engineering publications[1] provide criteria to assess liquefaction potential of sands (little to no fines) and clayey soils of low plasticity (e.g. clayey sands, silts). These criteria indicate that water content of fine-grained or cohesive soils needs to be high (≥ 0.85 *Liquid Limit [LL]), a clay fine content (defined as grains smaller than 0.002 mm) of less than 10 percent (< 10%), and relatively low soil density (assessed in terms of SPT blow counts). In addition, the accepted minimum seismic threshold acceleration to cause liquefaction in loose sands is 0.10g, the anticipated site specific PGA for this site is 0.06g.

Native fine grained (or cohesive) material underlying the West Ash Pond generally consist of medium dense to very dense clayey sand (SC), clayey gravel (GC) and silty clayey sand (SC-SM) Based on these soil characteristics and that the West Ash Pond is located in a zone of low peak ground acceleration (PGA), the risk of either embankment or underlying soils liquefying are negligible [40 CFR §257.73(e)(1)(iv)].

[1] Seed, R.B., et al, Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework, 26th Annual ASCE Los Angeles Spring Seminar, April 2003

2.3 Embankment and Foundation Stratigraphy

The models developed for this evaluation are based on the existing embankment geometry, results of field and laboratory testing and hydrologic site information provided by the client and recent field activities. Selection of critical slope sections (Section Nos. 1 and 2) was based on both height and subsurface sensitivity to loading. The following tables provide a summary of soil parameters used for these analyses. Specific soil parameters used for each model are presented in the Appendix.

Summary of Long Term, Total Stress Soil Parameters, Section No. 1:

Material Type	Unit Weight (pcf)	Consolidated-Undrained Cohesion (psf)	Consolidated-Undrained Angle of Internal Friction (degrees)
Embankment Fill	125	450	12
Lean Clay/Fat Clay (CL/CH)	125	530	13
Silty Sand/Clayey Sand (SM/SC)	125	0	28
Ash	100	0	30

NOTE: Properties used for Steady State Seepage with Seismic analysis.

Summary of Long Term, Effective Stress Soil Parameters, Section No. 1

Material Type	Unit Weight (pcf)	Consolidated-Drained Cohesion (psf)	Consolidated-Drained Angle of Internal Friction (degrees)
Embankment Fill	125	590	16
Lean Clay/Fat Clay (CL/CH)	125	320	17
Silty Sand/Clayey Sand (SM/SC)	125	430	28
Ash	100	0	30

NOTE: Properties used for Steady State Seepage analysis. Consolidated-drained conditions determined based on pore pressure measurements made during Consolidated-Undrained (CU) triaxial testing.

Summary of Long Term, Total Stress Soil Parameters, Section No. 2			
Material Type	**Unit Weight (pcf)**	**Consolidated-Undrained Cohesion (psf)**	**Consolidated-Undrained Angle of Internal Friction (degrees)**
Embankment Fill	125	450	12
Lean Clay/Fat Clay (CL/CH)	125	530	13
Clayey Sand/Silty Sand (SC/SM)	125	0	28
Lean Clay (CL)	125	260	20
Ash	100	0	30
NOTE: Properties used for Steady State Seepage with Seismic analysis.			

Summary of Long Term, Effective Stress Soil Parameters, Section No. 2			
Material Type	**Unit Weight (pcf)**	**Consolidated-Drained Cohesion (psf)**	**Consolidated-Drained Angle of Internal Friction (degrees)**
Embankment Fill	125	590	16
Lean Clay/Fat Clay (CL/CH)	125	320	17
Clayey Sand/Silty Sand (SC/SM)	125	0	28
Lean Clay (CL)	125	290	22
Ash	100	0	30
NOTE: Properties used for Steady State Seepage analysis. Consolidated-drained conditions determined based on pore pressure measurements made during Consolidated-Undrained (CU) triaxial testing.			

2.4 Seepage Analysis Parameters

The analysis of embankment seepage is based on laboratory results and estimated values for permeability for various embankment and native foundation soils. These soil parameters were utilized in the models to establish a long term steady state condition and corresponding phreatic surface in the embankment. Hydraulic conductivity test results are provided in the Appendix. Hydraulic conductivity properties utilized in the seepage analysis are provided in the below table.

Hydraulic Conductivity of Embankment Soils, Section Nos. 1 and 2	
Material Type	**Permeability (ft/sec)**
Embankment Fill	1×10^{-8}
Lean Clay/Fat Clay (CL/CH)	1×10^{-8}
Clayey Sand/Silty Sand (SC/SM)	1×10^{-5}
Lean Clay (CL)	1×10^{-8}
Ash	1×10^{-4}

2.5 Stability Analysis Results

The following tables provides the results of the stability analysis for each of the conditions cited herein, as required by 40 CFR §257.73(e)(1)(i) through (iii). The graphical representations of each analysis are included in the Appendix.

Summary of Stability Analyses – Safety Factors, Section No. 1		
Modeled Condition	**Factor of Safety**	
	Actual	**Minimum**
Steady State Seepage – Maximum Pool	2.21	1.50
Steady State Seepage – Surcharge Pool	2.21	1.40
Steady State Seepage with Seismic – Maximum Pool	1.35	1.00

Summary of Stability Analyses – Safety Factors, Section No. 2		
Modeled Condition	**Factor of Safety**	
	Actual	**Minimum**
Steady State Seepage – Maximum Pool	1.83	1.50
Steady State Seepage – Surcharge Pool	1.83	1.40
Steady State Seepage with Seismic – Maximum Pool	1.50	1.00

Based on the findings of this analysis, the evaluated embankments appear to be stable under the modeled conditions and demonstrate the minimum safety factors, as required by 40 CFR §257.73(e)(1)(i) through (iii).

3.0 Report Limitations

This report has been prepared for the exclusive use of our client for the specific application to the project discussed and has been prepared in accordance with the generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. The analyses contained in the report are based on the data obtained from the referenced soil borings performed within the project site. This report does not reflect variations that may occur between borings or across the site. Soil borings do not necessarily reflect strata variations that may exist at other locations within the project site.

4.0 Initial Structural Stability Assessment Certification

By means of this certification, (i) I have reviewed the requirements of 40 CFR §257.73(e)(1) – *Periodic Safety Factor Assessments*, (ii) I or my agent has visited and examined the facility, (iii) the referenced data used in this evaluation to the best of my knowledge appears correct and appropriate for use, (iv) and this Initial Safety Factor Assessment for the West Ash Pond (Pirkey Power Station) has been prepared to the best of my knowledge in accordance with §257.73(e)(1).

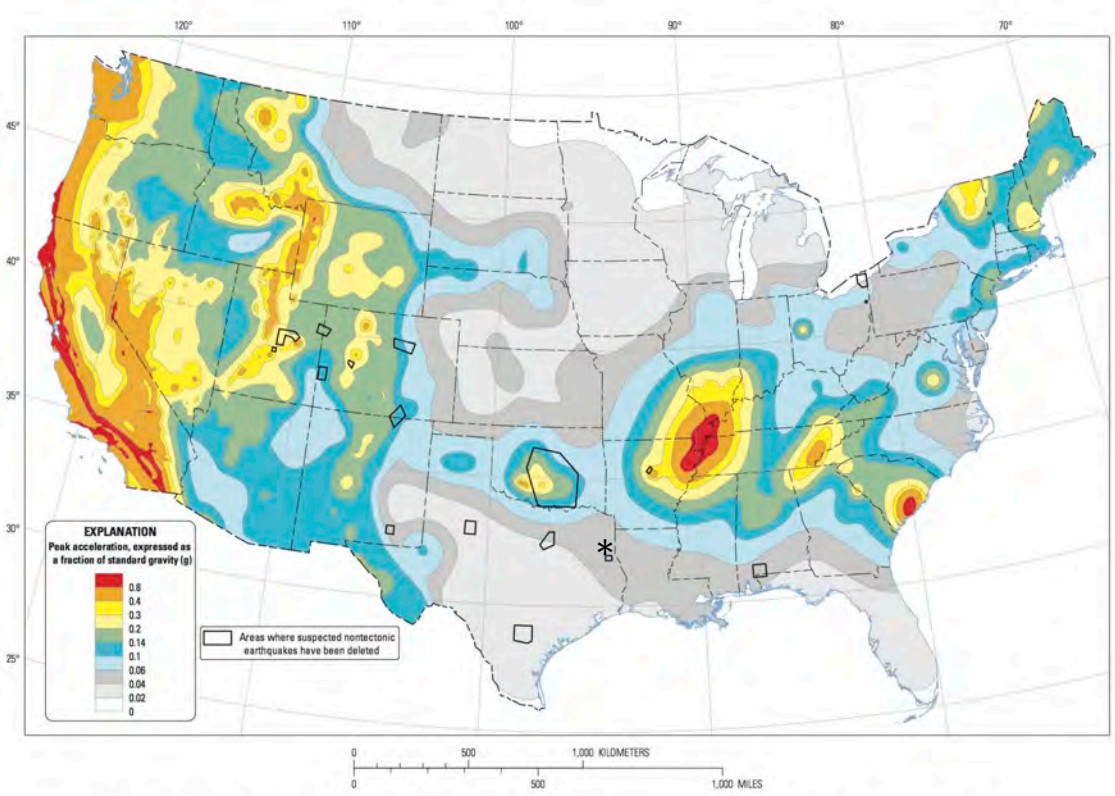
By: _____

Dated: January 14, 2016

TBPE Firm Registration No. F-16721
Expires 2/29/2016

Appendix

Stability Analyses
Reference Data



Two-percent probability of exceedance in 50 years map of peak ground acceleration

* Approximate location of Pirkey Power Generating Station

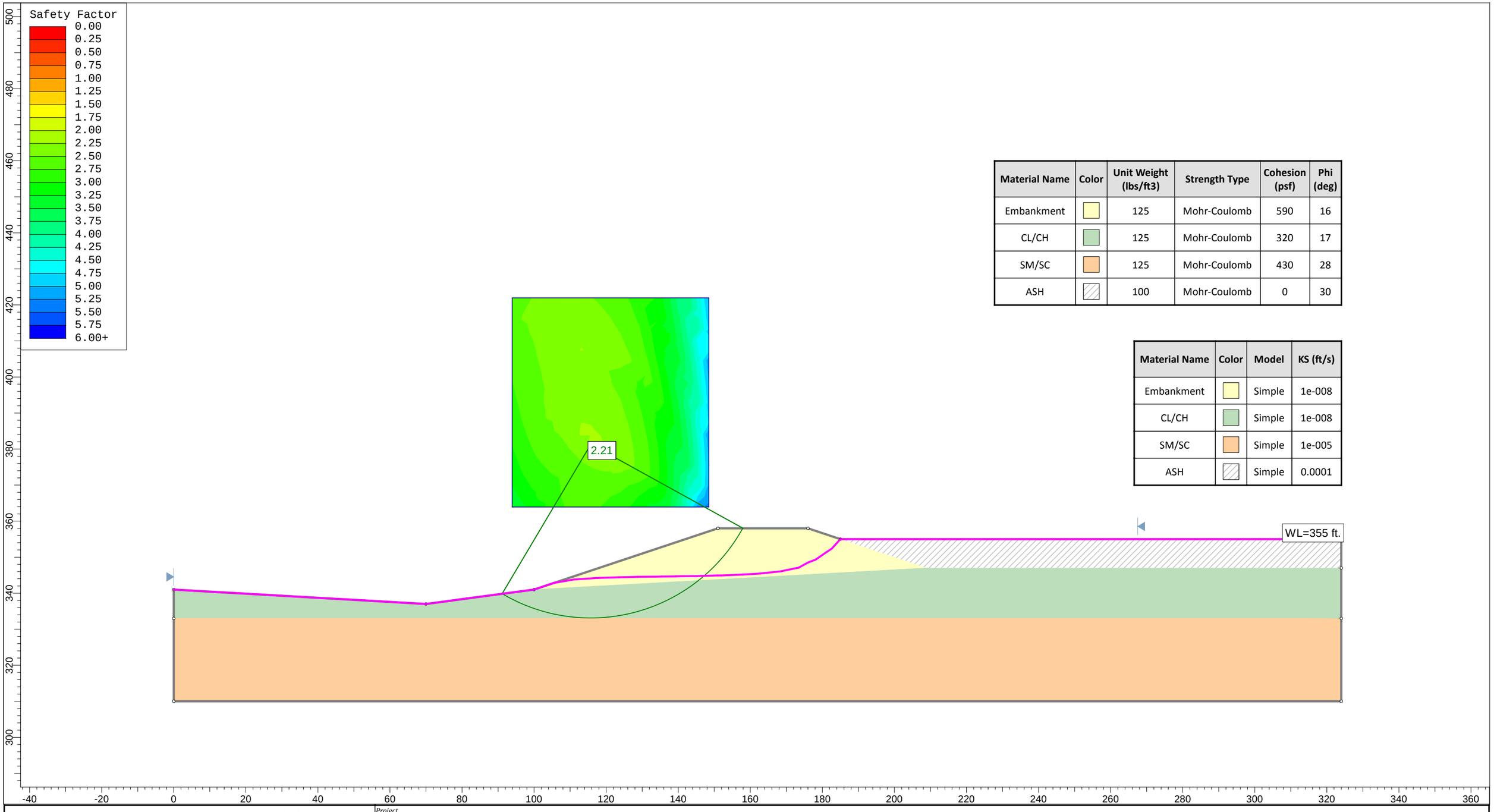
Provided by USGS National Seismic Hazard Mapping Project.

Seismic Probability Map	
Scale: N/A	**Pirkey Power Generating Station** **Initial Safety Factor Assessment - West Ash Pond** **Hallsville, Texas**
Auckland Project No. 2015-008C	

Provided by Google Earth.

Cone Penetrometer Test (CPT) Location Map

Scale: N/A	**Pirkey Power Generating Station** **Initial Safety Factor Assessment - West Ash Pond** **Hallsville, Texas**
Auckland Project No. 2015-008C	



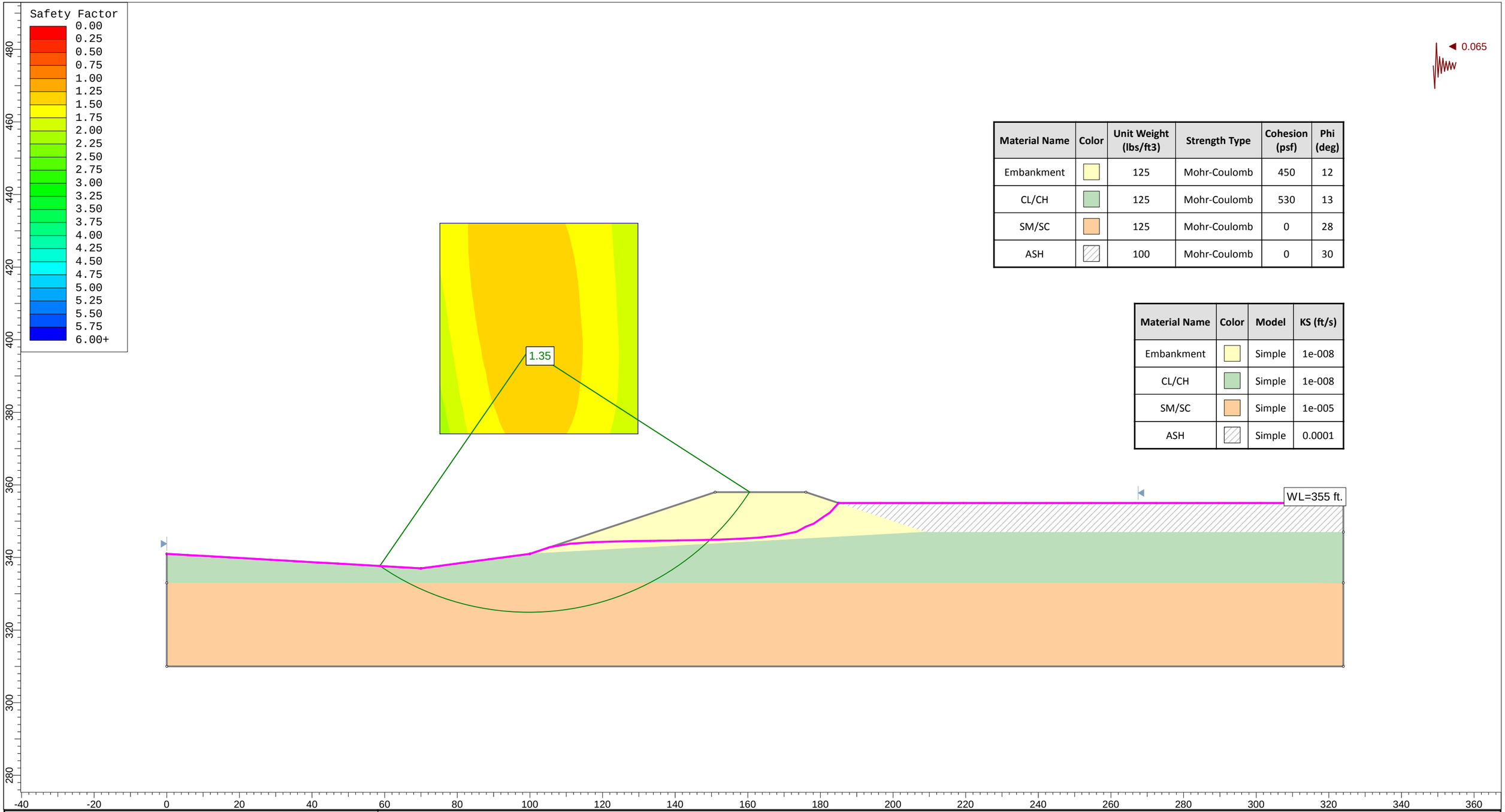
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment		125	Mohr-Coulomb	590	16
CL/CH		125	Mohr-Coulomb	320	17
SM/SC		125	Mohr-Coulomb	430	28
ASH		100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment		Simple	1e-008
CL/CH		Simple	1e-008
SM/SC		Simple	1e-005
ASH		Simple	0.0001

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 1		
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool		
Drawn By	JJT	*Company*	
Date	12/15/2015	*File Name*	WEST ASH_Section 1_SSS_25yr.slim



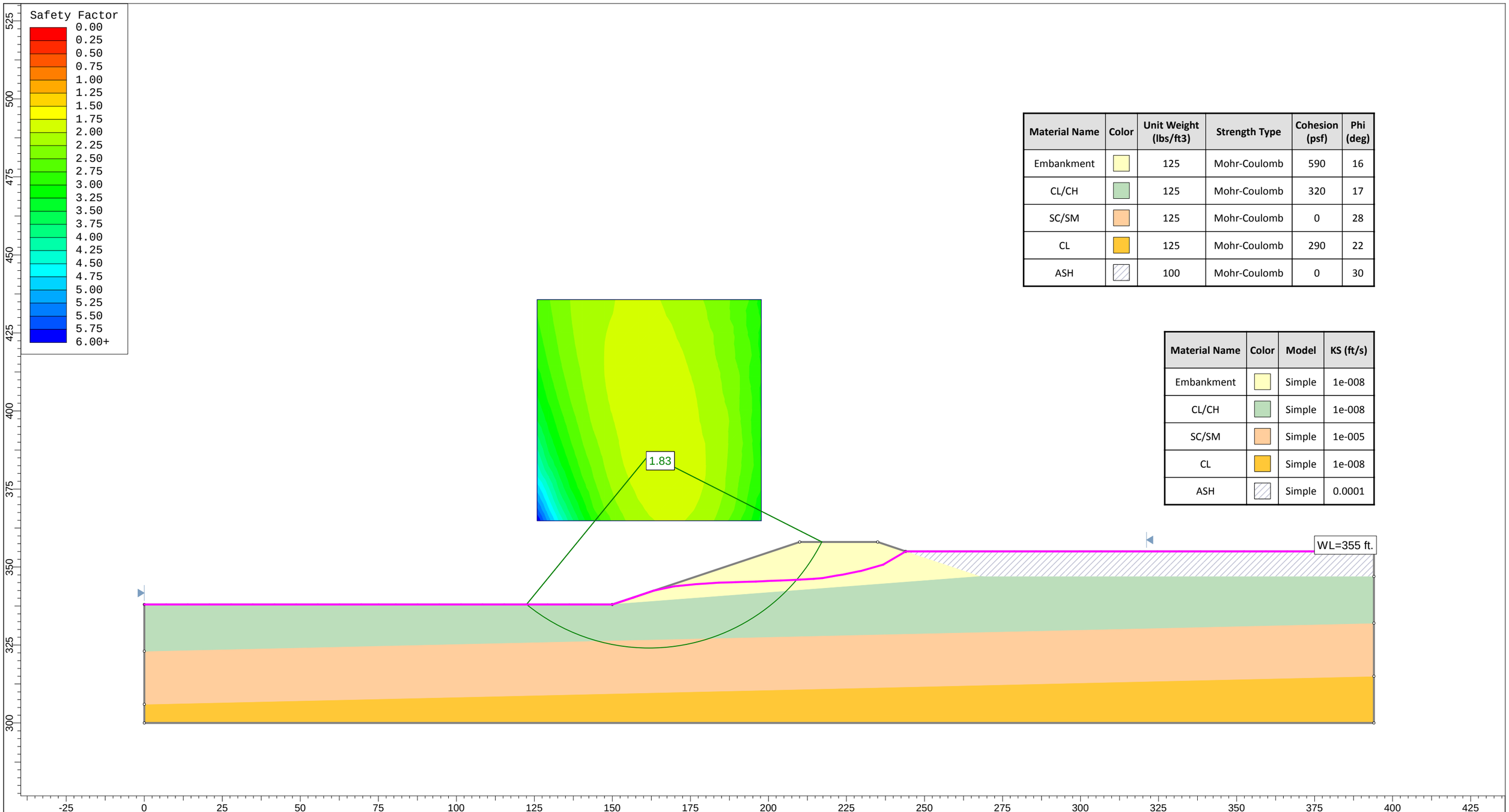
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment		125	Mohr-Coulomb	450	12
CL/CH		125	Mohr-Coulomb	530	13
SM/SC		125	Mohr-Coulomb	0	28
ASH		100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment		Simple	1e-008
CL/CH		Simple	1e-008
SM/SC		Simple	1e-005
ASH		Simple	0.0001

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 1
Analysis Description	Steady State Seepage at Maximum Pool, Seismic Analysis
Drawn By	JJT
Company	
Date	12/23/2015
File Name	WEST ASH_Section 1_SSS_25yr_seismic.slim



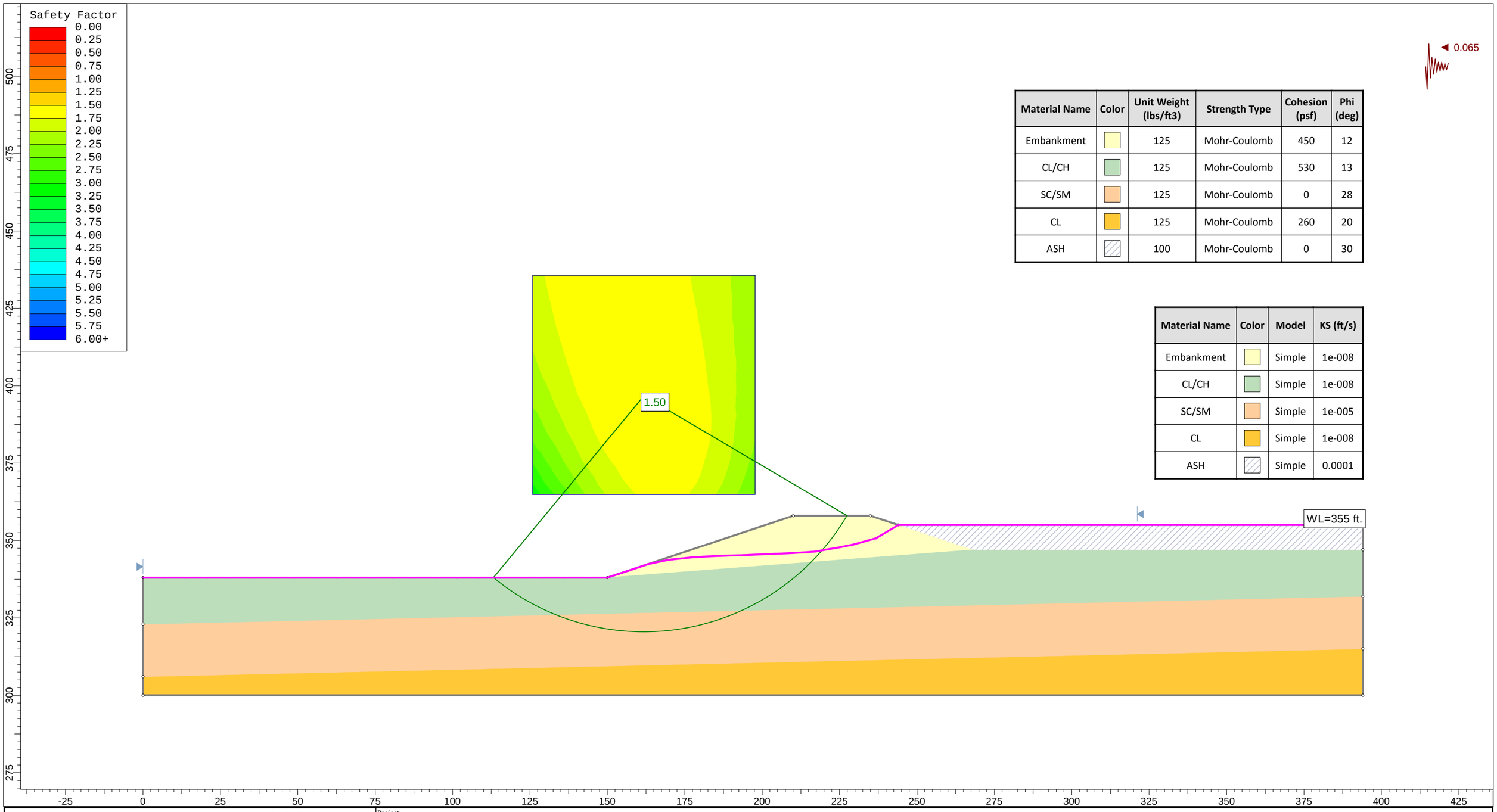
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment		125	Mohr-Coulomb	590	16
CL/CH		125	Mohr-Coulomb	320	17
SC/SM		125	Mohr-Coulomb	0	28
CL		125	Mohr-Coulomb	290	22
ASH		100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment		Simple	1e-008
CL/CH		Simple	1e-008
SC/SM		Simple	1e-005
CL		Simple	1e-008
ASH		Simple	0.0001

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

Project	Pirkey Power Station - West Ash Pond, Section No. 2		
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool		
Drawn By	JJT	*Company*	
Date	12/15/2015	*File Name*	WEST ASH_Section 2_SSS_25yr.slim

SLIDEINTERPRET 6.036



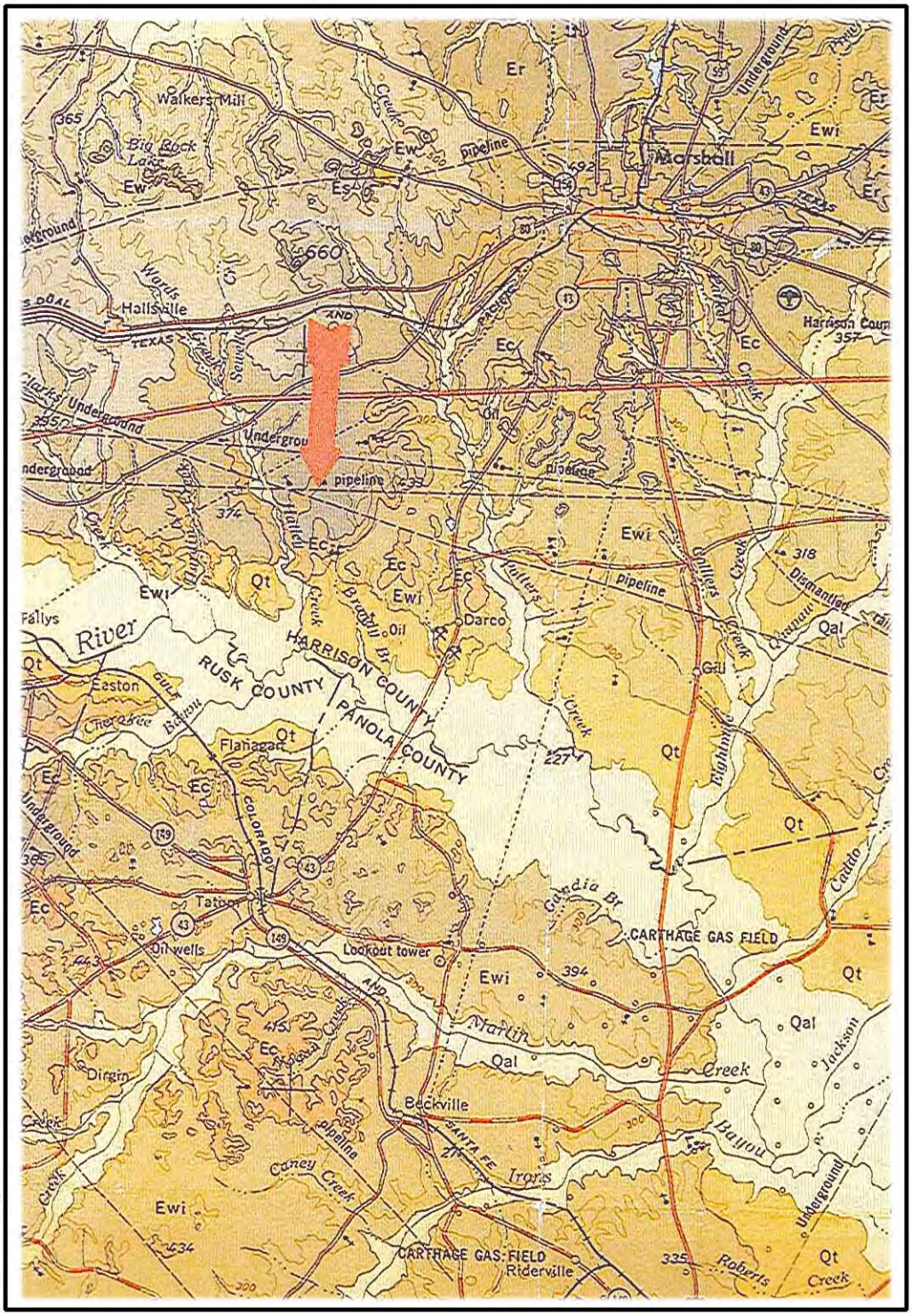
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment		125	Mohr-Coulomb	450	12
CL/CH		125	Mohr-Coulomb	530	13
SC/SM		125	Mohr-Coulomb	0	28
CL		125	Mohr-Coulomb	260	20
ASH		100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment		Simple	1e-008
CL/CH		Simple	1e-008
SC/SM		Simple	1e-005
CL		Simple	1e-008
ASH		Simple	0.0001

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

Project	Pirkey Power Station - West Ash Pond, Section No. 2		
Analysis Description	Steady State Seepage at Maximum Pool, Seismic Analysis		
Drawn By	JJT	*Company*	
Date	12/23/2015	*File Name*	WEST ASH_Section 2_SSS_25yr_seismic.slim

SLIDEINTERPRET 6.036



EXPLANATION

SEDIMENTARY ROCKS

QUATERNARY — Pleistocene-Recent

Qal — Alluvium
Flood-plain deposits

Qt — Fluviatile terrace deposits undivided

Ctg / Ca — Sparta Sand
Quartz sand, fine to medium-grained, light gray to brownish gray, slightly cohesive from silt and clay matrix, massive, locally cross-bedded, interbeds of sandy clay more abundant upward, locally carbonaceous; weathers various shades of light gray, at base hard, brown, ferruginous sandstone; lower part 170± feet thick, upper part absent. Locally includes Tyler Greensand Member, Ctg, quartz-glauconite greensand, greyish green, massive, locally cross-bedded; weathers dark reddish brown, abundant ironstone concretions

Ew — Weches Formation
Glauconitic and quartz sand, greyish green to greyish olive green, thin bedded, locally cross-bedded to lenticular, clay interbeds light brown to moderate light grey, silty, micaceous, thin bedded; weathers moderate to dark reddish brown, locally forms limonitic and siderotic iron ore and clay ironstone concretions; marine megafossils in southern part; 0± feet thick, range 0–50 feet

Eqc — Queen City Sand
Quartz sand, fine grained to locally medium grained, light gray to brownish gray, locally carbonaceous, and clay, gray to brown, silty, slightly lignitic, sand mud abundant to west; weathers red and white mottled, ironstone concretions and ledges common; local beds of glauconitic-quartz greensand, cross-bedded, weathers to ferruginous ledges and rubble; 100–400 feet thick, thins southeastward

Er — Reklaw Formation
Upper 100± feet, clay, brownish black to brownish gray, silty, micaceous, carbonaceous, laminated, interbeds of moderate reddish-brown clay; weathers light brown, ironstone concretions common; a few marine fossils. Lower 15± feet, quartz sand, fine to very fine grained, greyish green, glauconitic, argillaceous, massive, locally cross-bedded; weathers moderate brown to dark yellowish orange with clay ironstone ledges and rubble; fossils, clay ironstone, and clay decrease northward

EOCENE — TERTIARY

Ecc — Carrizo Sand
Upper part, very fine sand, silt, clayey silt, silty clay, medium to dark gray, carbonaceous; weathers moderate yellowish brown to dark reddish brown, indurated ledges of dark brown ironstone common. Lower part, quartz sand, fine to medium grained, light brownish gray, weakly cohesive, massive, locally cross-bedded; weathers light gray to various shades of red. Thickness 30–500 feet

Ewi — Wilcox Group undivided
Mostly silty and sandy clay, various shades of gray, local beds of clay, lignite, silt, and quartz sand, in part carbonaceous, laminated to massive, locally cross-bedded; weathers to various shades of gray, brown, yellow, and red. Calcareous siltstone and ironstone concretions common; abundant plant fossils, a few marine fossils in southeastern part; 300–1,000 feet thick.

Ec — Eocene rocks undivided
Reklaw Formation, Carrizo Sand, Wilcox Group, and Midway Group on Brooks dome, not separately shown

Ewp — Wills Point Formation
Clay, medium bluish gray, greenish gray, greyish green, brownish gray, silt increases upward, laminated to locally massive, glauconite near base, rough calcareous siltstone concretions common in upper part, locally lignitic in upper part, thin bed of oolitic limestone near middle; weathers medium gray to yellowish gray; fossiliferous; 300± feet thick

Ek — Kincaid Formation
Clay, medium gray to dark gray, greenish gray, brownish gray, glauconitic, calcareous, silty, locally phosphatic near base, thin beds of limestone in upper part, gray, hard, detrital; weathers medium gray; fossiliferous; 180± feet thick

Kke — Kemp Clay
Clay, dark gray to bluish gray, calcareous, silty, glauconitic, calcareous concretions common; weathers dark greenish gray and black; upper part only cross cut

Kur — Upper Cretaceous rocks undivided
Navarro Group, Taylor Group, and Austin Chalk on Brooks dome not separately shown

Upper Cretaceous — CRETACEOUS

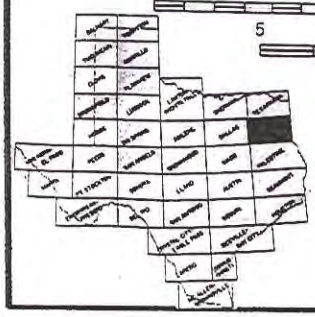
Scale 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

5 0 5 10 Nautical Miles

CONTOUR INTERVAL 100 FEET
WITH SUPPLEMENTARY CONTOURS AT 50 FOOT INTERVALS



ETTL ENGINEERS & CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PLATE 2

SITE SURFACE GEOLOGY

JOB No.: G3241-095

DATE: DEC. 2009

SCALE: 1:250,000

LOG OF BORING W-1

PROJECT: Pirkey Power Plant
Hallsville. Texas

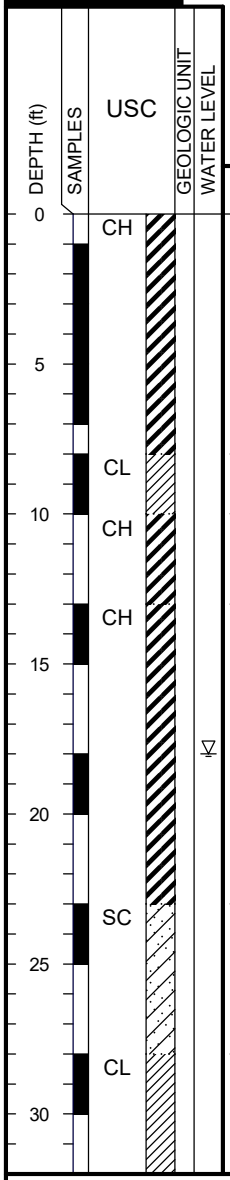
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

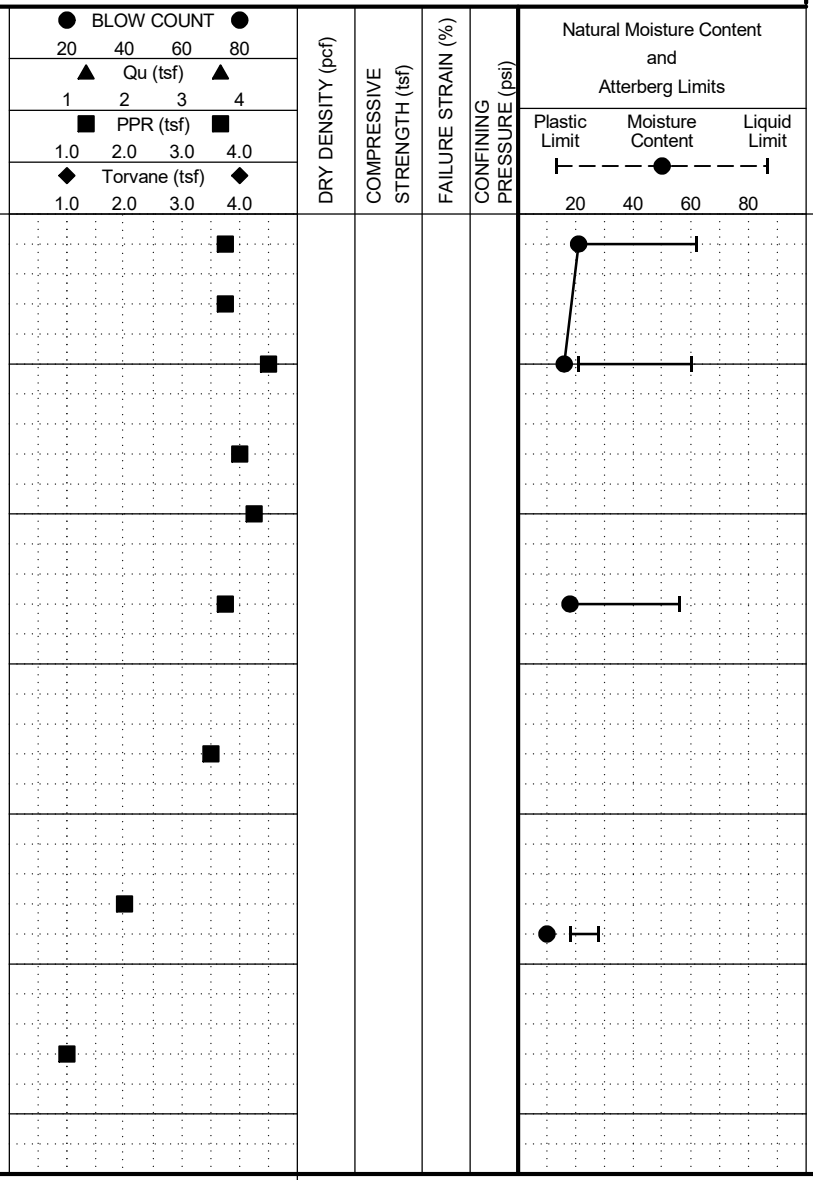
SURFACE ELEVATION 356.5

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421



MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CH FAT CLAY WITH SAND(CH) tan and red	P=3.75					21	62	21	41	79	+40 Sieve=6%, +4 Sieve=0%
	P=3.75										
--red	P=4.5					16	60	21	39	75	+40 Sieve=7%, +4 Sieve=1%
CL SANDY LEAN CLAY(CL) reddish yellow	P=4.0										
CH FAT CLAY(CH) red and tan	P=4.25										
CH FAT CLAY WITH SAND(CH) red and yellow	P=3.75					18	56	18	38	71	+40 Sieve=5%, +4 Sieve=0%
--red	P=3.5										
SC CLAYEY SAND(SC) reddish brown	P=2.0					10	28	18	10	25	+40Sieve=21%, +4 Sieve=11%
CL LEAN CLAY(CL) red; with sand seams	P=1.0										



Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

LOG OF BORING W-1

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.5

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		SC			CLAYEY SAND(SC) grayish brown	N=32											
					--tannish gray	P=4.15											
40						P=2.8						17	29	19	10	25	+40 Sieve=1%, +4 Sieve=0%
					--gray	N=47											
45																	
		SM SC			SILTY CLAYEY SAND(SM-SC) gray	N=50/6"											
50					Bottom of Boring @ 50'												

FIELD STRENGTH DATA: BLOW COUNT (20 40 60 80); Qu (tsf) (1 2 3 4); PPR (tsf) (1.0 2.0 3.0 4.0); Torvane (tsf) (1.0 2.0 3.0 4.0)

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

LOG OF BORING W-2

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/21/09

SURFACE ELEVATION 341.7

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) stiff; red and gray	N=9										
		--hard	P=4.5+					17	48	19	29	65	+40 Sieve=6%, +4 Sieve=2%
5		--gray, red, and tan	N=50										
	SC	CLAYEY SAND(SC) very dense; red and tan	N=50/5"					16	28	18	10	27	+40 Sieve=7%, +4 Sieve=2%
10													
		--medium dense; tan and gray	P=1.5					19	32	17	15	31	+40Sieve=13%, +4 Sieve=5%
15													
		--very dense; gray and tan	N=62										
20													
		--green	N=50/5"					22	28	19	9	33	+40 Sieve=6%, +4 Sieve=2%
25													
			N=56										
30		Bottom of Boring @ 30'											

FIELD STRENGTH DATA: BLOW COUNT (20 40 60 80); Qu (tsf) (1 2 3 4); PPR (tsf) (1.0 2.0 3.0 4.0); Torvane (tsf) (1.0 2.0 3.0 4.0)

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling. Water level @ 21' and open upon completion.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

LOG OF BORING W-3

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

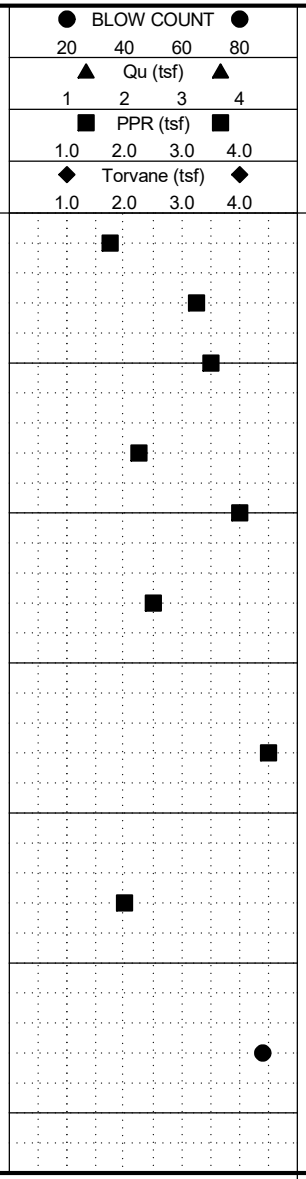
PROJECT: Pirkey Power Plant
Hallsville. Texas

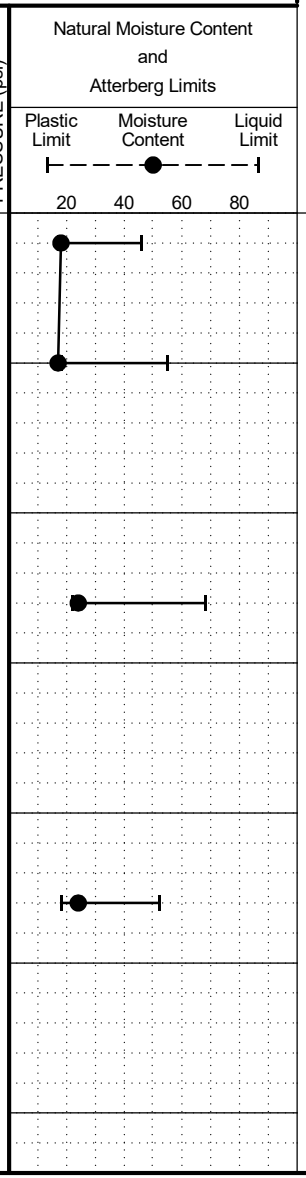
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.3

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) stiff; white and tan	P=1.75	18	46	17	29	61	+40 Sieve=7%, +4 Sieve=2%
	CH	SANDY FAT CLAY(CH) very stiff; red, tan, and white	P=3.25						
5		--white, tan, and red	P=3.5	17	55	18	37	68	+40 Sieve=5%, +4 Sieve=0%
	CL	SANDY LEAN CLAY(CL) very stiff; red and yellow	P=2.25						
10		--hard; red and yellow	P=4.0						
	CH	FAT CLAY WITH SAND(CH) very stiff; red and yellow	P=2.5	24	68	22	46	80	+40 Sieve=6%, +4 Sieve=0%
15		--hard	P=4.5+						
20		--stiff	P=2.0	24	52	18	34	69	+40 Sieve=4%, +4 Sieve=0%
25	SM	SILTY SAND(SM) very dense; yellow and red	N=88						
30									





Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 34' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

LOG OF BORING W-3

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.3

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		CL		▽	SANDY LEAN CLAY(CL) very stiff; gray; with iron oxide cemented sandstone gravel	P=3.25											
40		SC			CLAYEY SAND(SC) very dense; dark gray	P=4.5+						17	33	17	16	38	+40 Sieve=1%, +4 Sieve=0%
45		SM SC			SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated	N=59											
50		SC			CLAYEY SAND(SC) very dense; dark gray	N=50/4"											
					Bottom of Boring @ 50'												

BLOW COUNT 20 40 60 80
Qu (tsf) 1 2 3 4
PPR (tsf) 1.0 2.0 3.0 4.0
Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 34' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

LOG OF BORING W-4

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

SURFACE ELEVATION 338.0

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		SC			CLAYEY SAND(SC) stiff; brown, red, and yellow	N=13										
					--with gravel	N=22					12	31	17	14	35	+40Sieve=31%, +4 Sieve=16%
5					--red and tan; with iron oxide cemented sandstone	N=28										
					--dense; red and white; with clay seams	N=36					15	60	16	44	39	+40Sieve=11%, +4 Sieve=4%
10																
					--medium dense; orangish gray; with gravel	N=12					17	30	14	16	22	+40Sieve=28%, +4 Sieve=17%
15																
		GC		▽	CLAYEY GRAVEL(GC) dense; dark gray	N=43					20	31	16	15	7	+40Sieve=68%, +4 Sieve=52%
20																
		SM			SILTY SAND(SM) dense; dark gray	N=42										
25																
		CL			SANDY LEAN CLAY(CL) very dense; gray	N=84										
30					Bottom of Boring @ 30'											

FIELD STRENGTH DATA: BLOW COUNT (20 40 60 80); Qu (tsf) (1 2 3 4); PPR (tsf) (1.0 2.0 3.0 4.0); Torvane (tsf) (1.0 2.0 3.0 4.0)

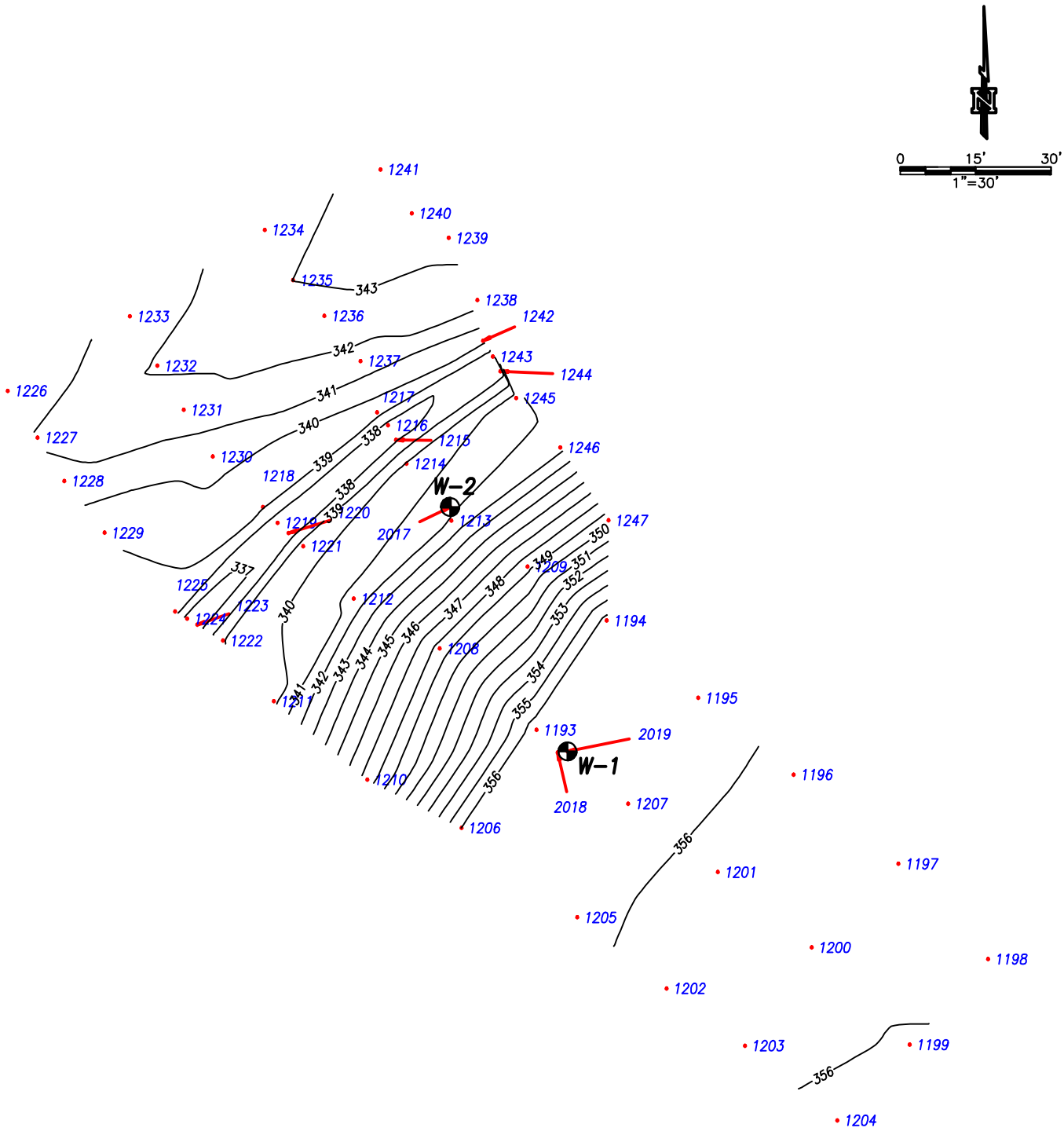
Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 19' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

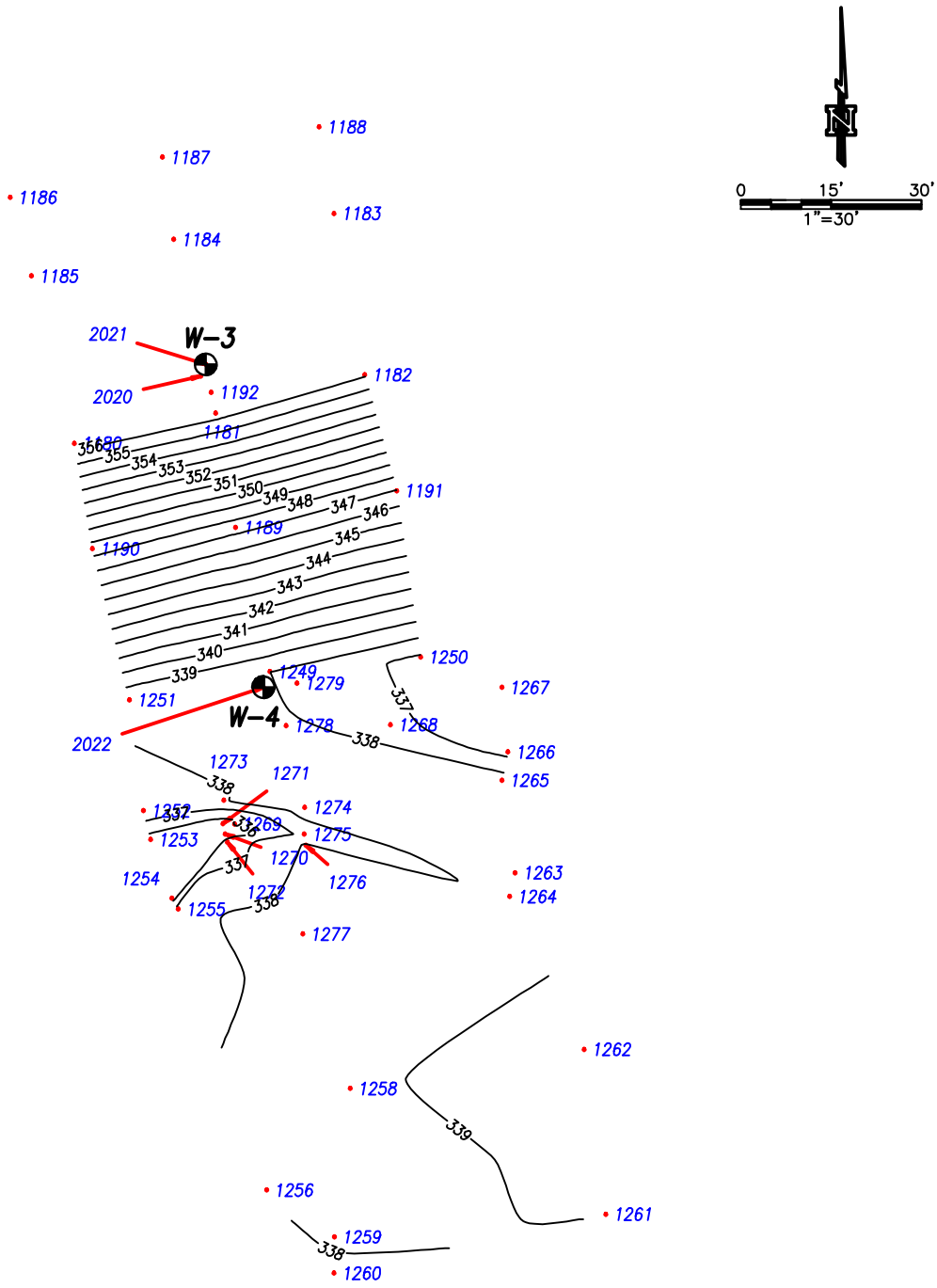
Notes:



JOHNSON & PACE INCORPORATED
ENGINEERING • ARCHITECTURE • SURVEYING
1201 NW LOOP 281, LB1, LONGVIEW,TEXAS 75604
(903)753-0663 FAX (903)753-8803
website: www.johnsonpace.com
JOB NO: 2313-013 FIELD BOOK: XXX/XXX DATE: NOV. 2009

EXHIBIT "1"

W-1 AND W-2 BOREHOLES
PIRKEY POWER PLANT
HALLSVILLE, TEXAS



JOHNSON & PACE INCORPORATED
ENGINEERING • ARCHITECTURE • SURVEYING
1201 NW LOOP 281, LB1, LONGVIEW,TEXAS 75604
(903)753-0663 FAX (903)753-8803
website: www.johnsonpace.com

JOB NO: 2313-013 FIELD BOOK: XXX/XXX DATE: NOV. 2009

EXHIBIT "J"

W-3 AND W-4 BOREHOLES
PIRKEY POWER PLANT
HALLSVILLE, TEXAS

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project :	Pirkey Power Plants Embankments, Hallsville, Texas							
Date:	11/3/2009	Panel Number :		P 2 ; ASTM D 5084				
Project No. :	G 3241-09	Permometer Data						
Boring No.:	W - 2	ap =	0.031416	cm2	Set Mercury to Pipet Rp at	Equilibrium	1.8	cm3
Sample:		aa =	0.767120	cm2		Pipet Rp	**6.7**	cm3
Depth (ft):	13' to 16'	M1 =	0.030180	C = 0.00043252		Annulus Ra	1.5	cm3
Other Location:		M2 =	1.040953	T = 0.203782344				
Material Description :	Tan & Gray Clayey Sand							

SAMPLE DATA

					Before Test		After Test	
Wet Wt. sample + ring or tare :			571.51	g	Tare No.:	T 13	Tare No.:	T 16
Tare or ring Wt. :			0.0	g	Wet Wt.+tare:	660.71	Wet Wt.+tare:	733.72
Wet Wt: of Sample :			571.51	g	Dry Wt.+tare:	588.03	Dry Wt.+tare:	625.10
Diameter :	2.78	in	7.06	cm2	Tare Wt:	219.71	Tare Wt:	151.95
Length :	2.78	in	7.06	cm	Dry Wt.:	368.32	Dry Wt.:	473.15
Area:	6.06	in^2	39.10	cm2	Water Wt.:	72.68	Water Wt.:	108.62
Volume :	16.85	in^3	276.12	cm3	% moist.:	**19.7**	% moist.:	**23.0**
Unit Wt.(wet):	**129.15**	pcf	**2.07**	g/cm^3				
Unit Wt.(dry):	**107.87**	pcf	**1.73**	g/cm^3				

Specific Gravity:	**2.80**	Max Dry Density(pcf) =	107.9147	OMC =	19.732841
		% of max =	100.0	+/- OMC =	0.00
Calculated % saturation:	103.59	Void ratio (e) =	**0.62**	Porosity (n)=	**0.38**

TEST READINGS

Z1(Mercury Height Difference @ t1): 5.1 cm Hydraulic Gradient = 9.12

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZπ (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
11/3/2009	76	4.5	2.1571965	24.5	0.899	2.96E-06	8.40E-03	
11/3/2009	106	4	2.6571965	24.5	0.899	2.86E-06	8.11E-03	
11/3/2009	140	3.5	3.1571965	24.5	0.899	2.87E-06	8.12E-03	
11/3/2009	182	3	3.6571965	24.5	0.899	2.92E-06	8.29E-03	

SUMMARY

ka = 2.90E-06 cm/sec Acceptance criteria = 25 %

ki		Vm		
k1 =	2.96E-06 cm/sec	2.1	%	Vm = | ka-ki | / ka x 100
k2 =	2.86E-06 cm/sec	1.4	%	
k3 =	2.87E-06 cm/sec	1.3	%	
k4 =	2.92E-06 cm/sec	0.7	%	

Hydraulic conductivity	k =	**2.90E-06**	cm/sec	**8.23E-03**	ft/day
Void Ratio	e =	**0.62**			
Porosity	n =	**0.38**			
Bulk Density	γ =	**2.07**	g/cm3	**129.2**	pcf
Water Content	W =	**0.34**	cm3/cm3	(at 20 deg C)	
Intrinsic Permeability	kint =	**2.97E-11**	cm2	(at 20 deg C)	

Liquid Limit LL		
Plastic Limit PL		
Plasticity Index PI		
- 200 Sieve		%
+ No 40 Sieve		%
+ No 4 Sieve		%

Respectfully Submitted

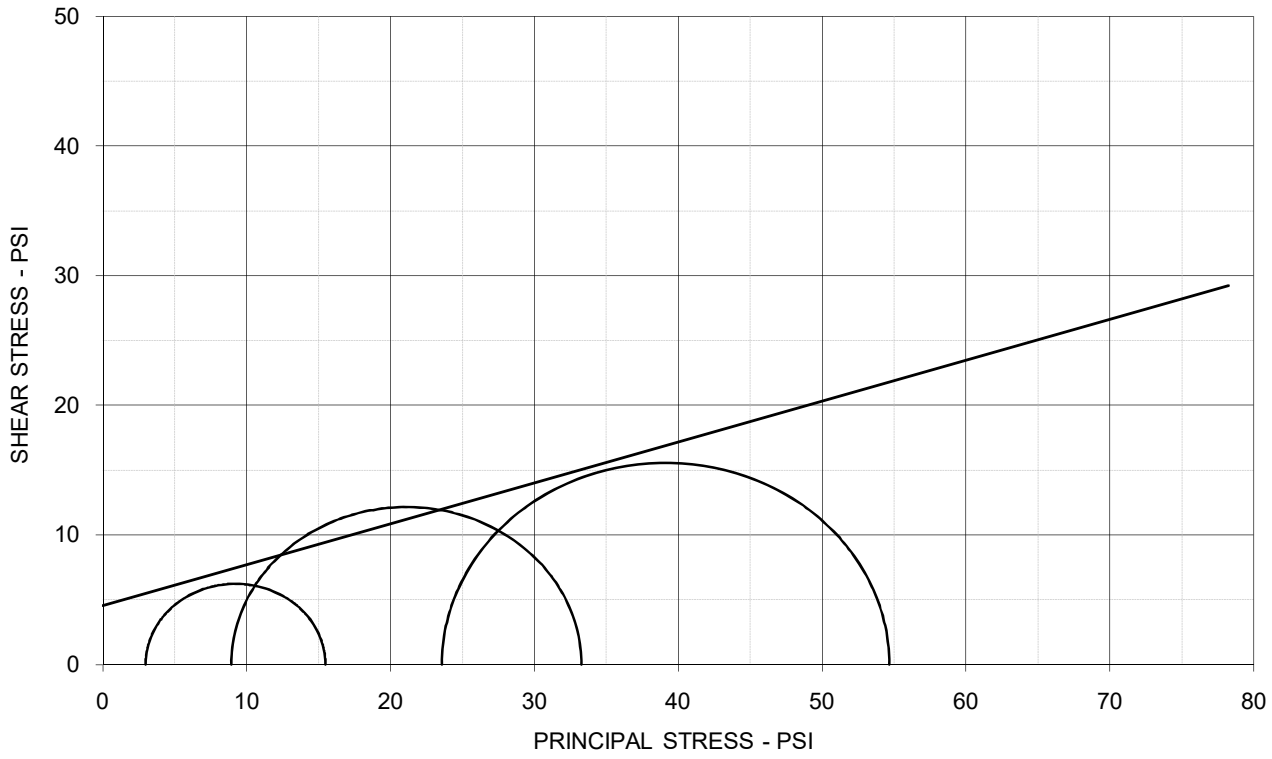
Robert M. Duke, P.E.

210 Beech Street
Texarkana, AR 71854
870-772-0013 Phone
870-216-2413 Fax

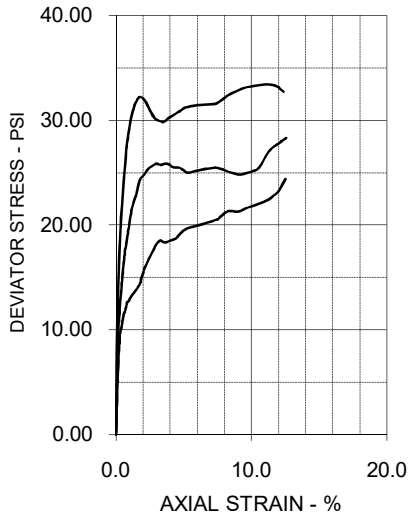
1717 East Erwin
Tyler, Texas 75702
903-595-4421 Phone
903-595-6113 Fax
www.ettlinc.com

707 West Cotton Street
Longview, Texas 75604-5505
903-758-0915 Phone
903-758-8245 Fax

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ' = 17.5 deg	c' = 4.6 psi		
SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	25.3	23.6	23.9	
Dry Density - pcf	96.5	100.5	101.1	
Diameter - inches	2.05	2.02	2.04	
Height - inches	3.98	4.00	3.95	
AT TEST				
Final Moisture - %	28.8	28.1	24.5	
Dry Density - pcf	96.5	102.9	104.0	
Calculated Diameter (in.)	2.07	2.01	2.03	
Height - inches	4.02	3.98	3.91	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.49	24.34	31.06	
Total Pore Pressure - psi	57.0	61.1	66.4	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	2.1	1.5	
σ_1' Failure - psi	15.49	33.26	54.65	
σ_3' Failure - psi	3.00	8.92	23.59	



TEST DESCRIPTION

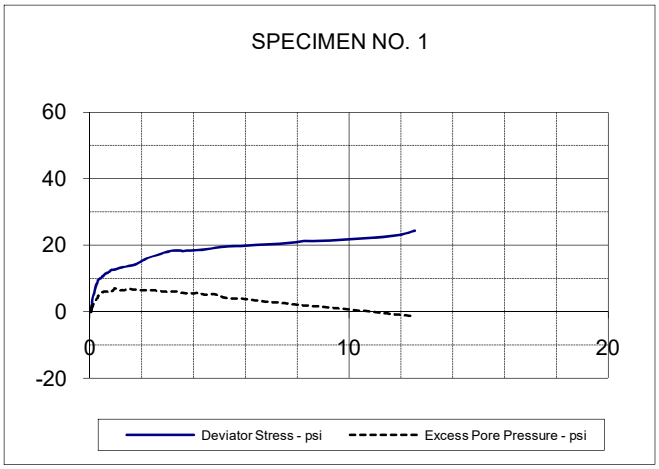
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-1 13' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 5%
LL: 56 PL: 18 PI: 38 Percent -200: 71%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

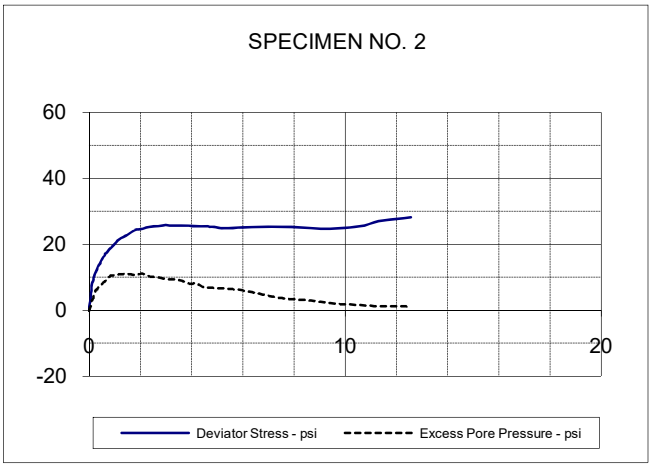
PROJECT INFORMATION

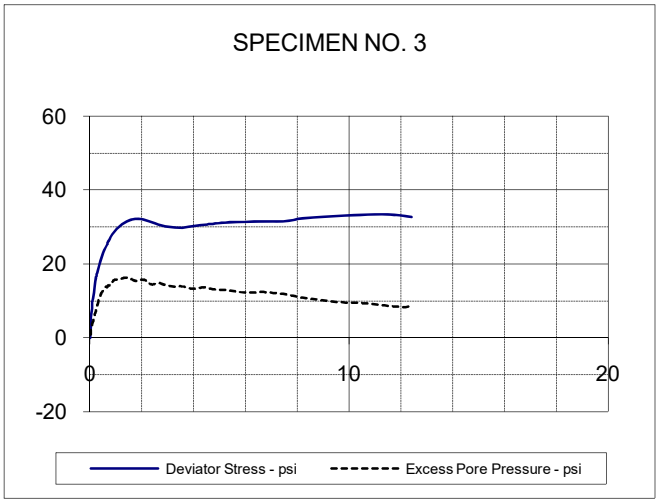
PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

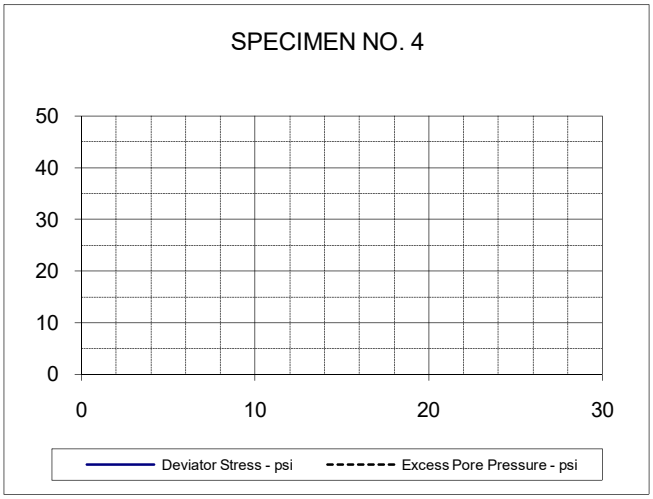
ETTL ENGINEERS & CONSULTANTS

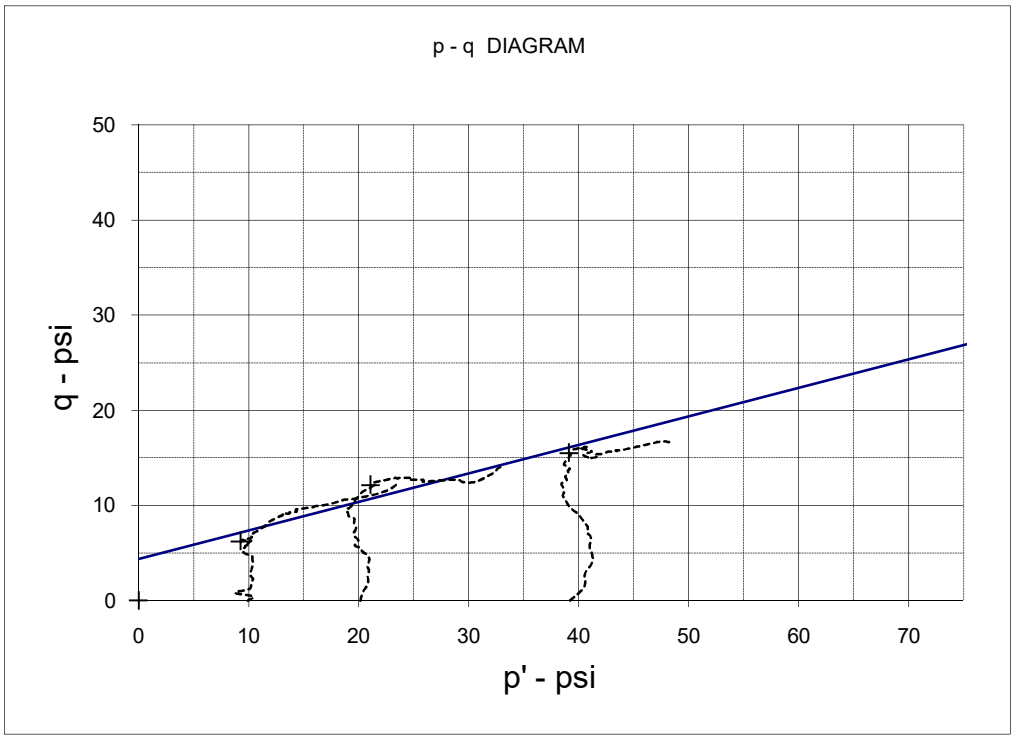
PLATE: B.1









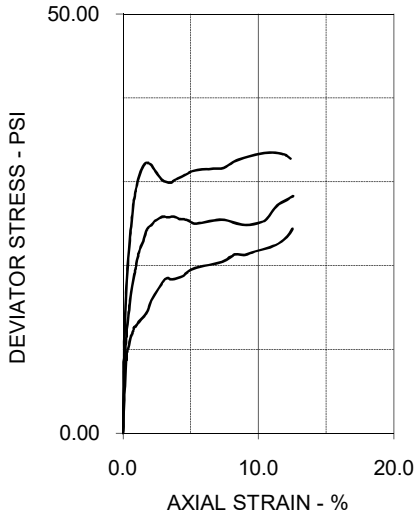


EFFECTIVE STRESS PARAMETERS	R^2 = 0.93	α (deg) = 16.7	a (psi) = 4.4
PROJECT: Pirkey Power Plant Embankments		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3241 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand			

G 3241-095, W-1 13'-20'.xls

TRIAXIAL SHEAR TEST REPORT

TOTAL STRESS PARAMETERS	ϕ = 13.3 deg	c = 3.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	25.3	23.6	23.9	
Dry Density - pcf	96.5	100.5	101.1	
Diameter - inches	2.05	2.02	2.04	
Height - inches	3.98	4.00	3.95	
AT TEST				
Final Moisture - %	28.8	28.1	24.5	
Dry Density - pcf	96.5	102.9	104.0	
Calculated Diameter (in.)	2.07	2.01	2.03	
Height - inches	4.02	3.98	3.91	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.49	24.34	31.06	
Total Pore Pressure - psi	57.0	61.1	66.4	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	2.1	1.5	
σ_1 Failure - psi	22.49	44.34	71.06	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-1 13' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 5%
LL: 56 PL: 18 PI: 38 Percent -200: 71%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

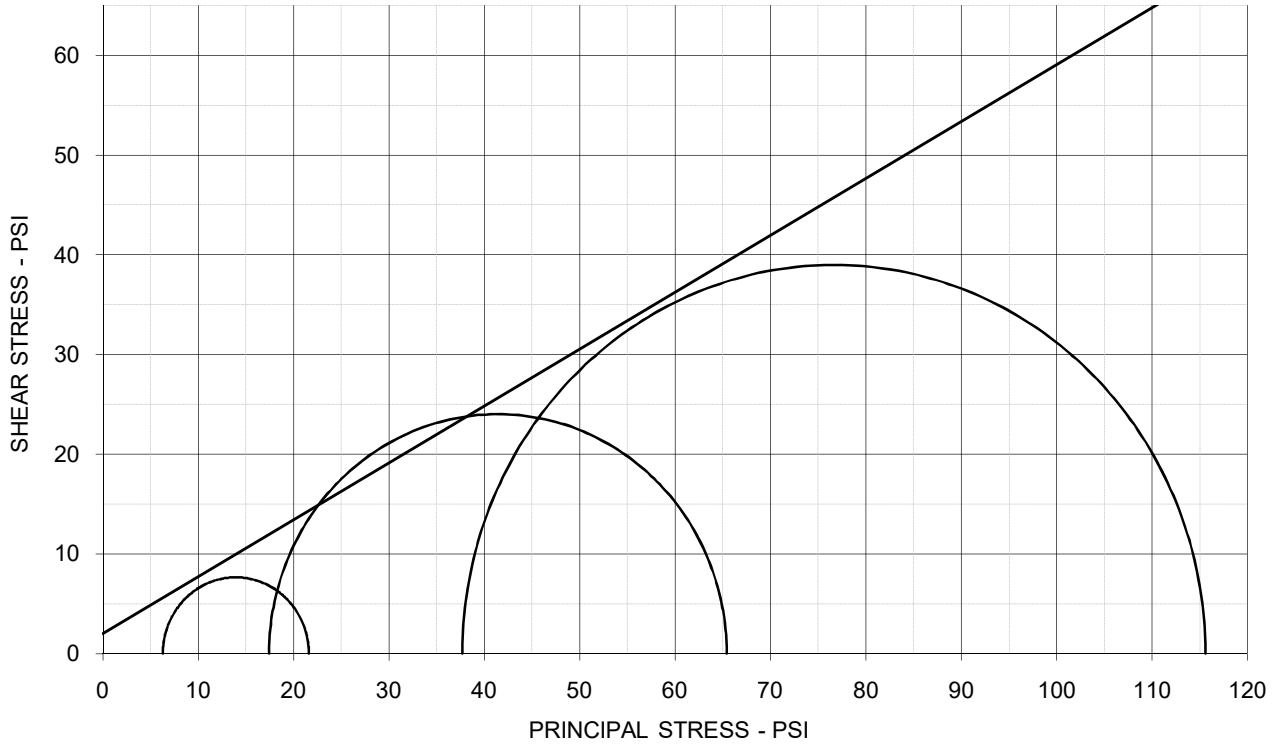
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

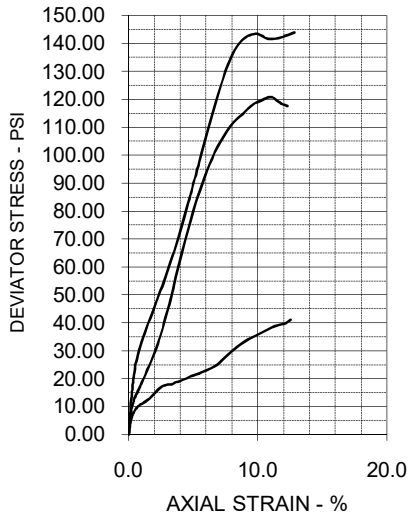
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ' = 29.7 deg	c' = 2.0 psi		
SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	18.7	19.2	18.5	
Dry Density - pcf	108.5	105.5	104.8	
Diameter - inches	2.04	2.04	2.02	
Height - inches	4.25	4.18	4.37	
AT TEST				
Final Moisture - %	21.3	21.7	20.7	
Dry Density - pcf	108.9	106.7	106.7	
Calculated Diameter (in.)	2.03	2.02	2.00	
Height - inches	4.21	4.13	4.31	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.27	47.96	77.89	
Total Pore Pressure - psi	63.7	52.6	52.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.1	3.2	4.3	
σ_1' Failure - psi	21.58	65.38	115.61	
σ_3' Failure - psi	6.31	17.42	37.72	



TEST DESCRIPTION

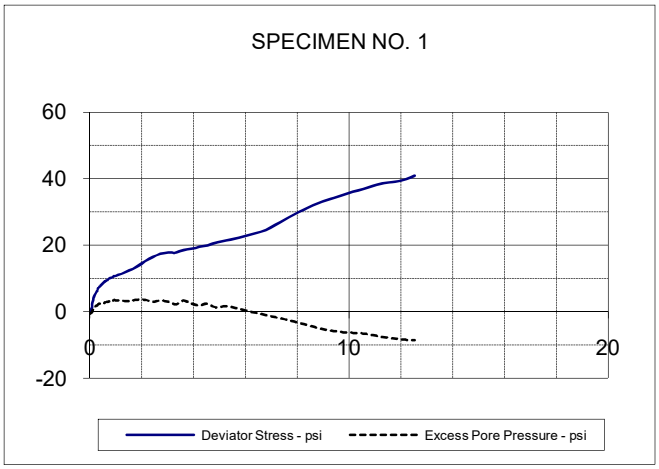
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Dark Gray Clayey Sand
Sampled on Site, W-1 38' to 41' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 1%
LL: 29 PL: 19 PI: 10 Percent -200: 25%
REMARKS: Diameter and Both Ends Trimmed. + # 4 Sieve 0%

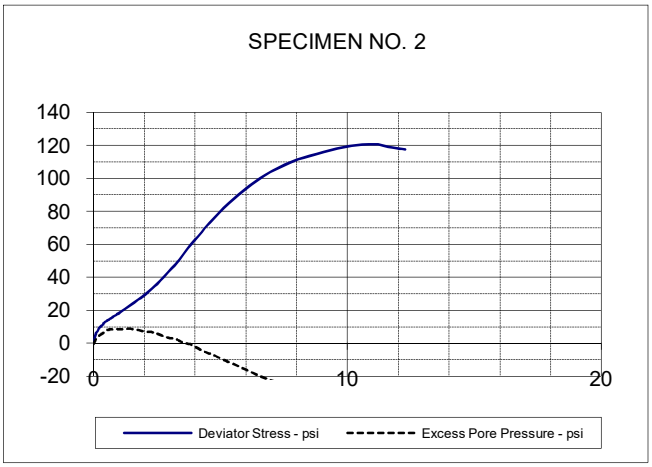
PROJECT INFORMATION

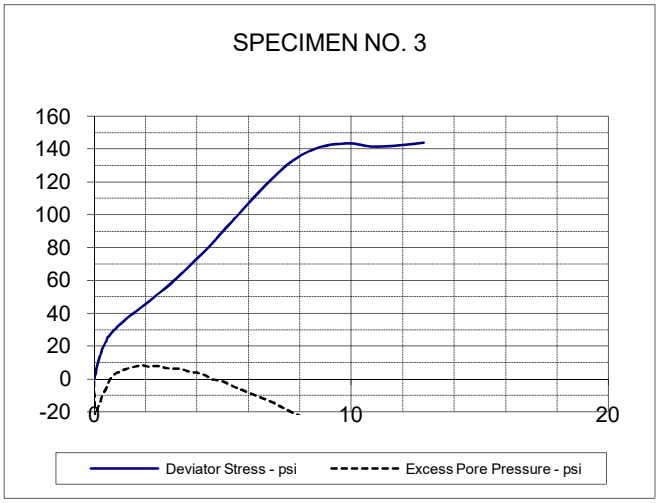
PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

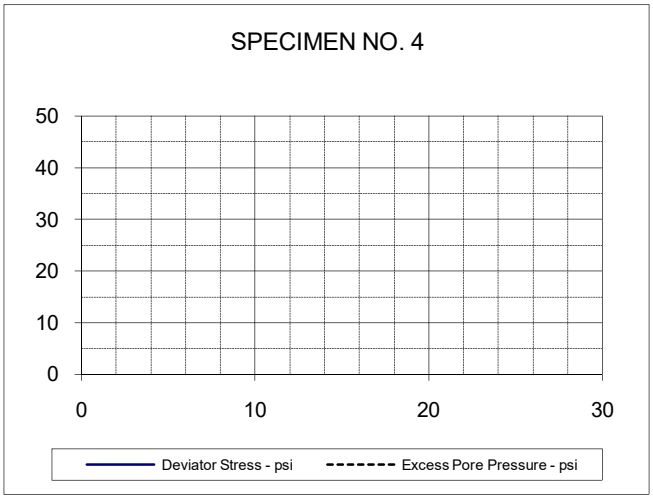
ETTL ENGINEERS & CONSULTANTS

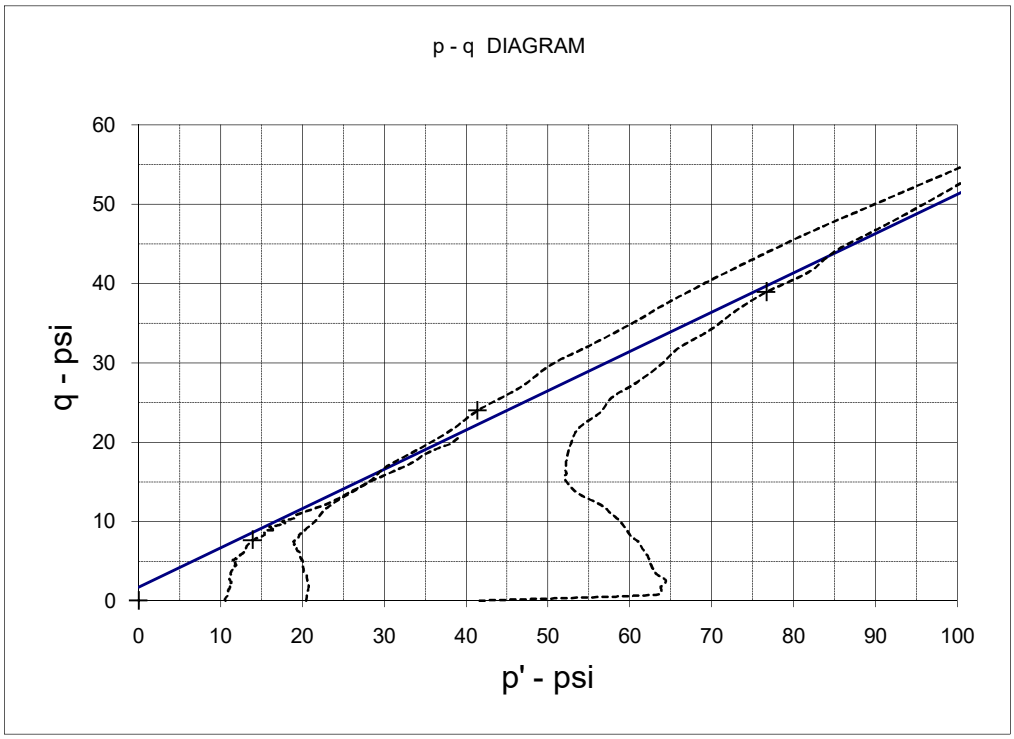
PLATE: B.1









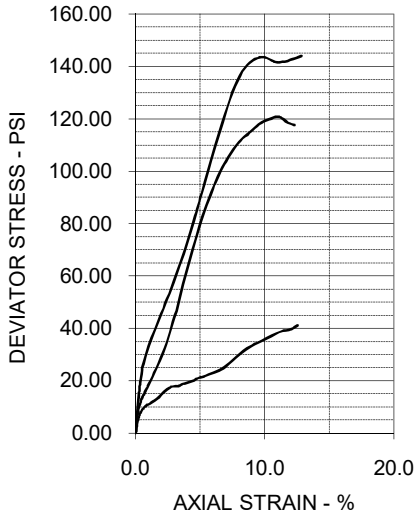


EFFECTIVE STRESS PARAMETERS	R^2 = 0.99	α (deg) = 26.4	a (psi) = 1.7
PROJECT: Pirkey Power Plant Embankments		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3241 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Dark Gray Clayey Sand			

G 3241-095, W-1 38'-41' Native.xls

TRIAXIAL SHEAR TEST REPORT

TOTAL STRESS PARAMETERS	ϕ = 30.4 deg	c = -0.2 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	18.7	19.2	18.5	
Dry Density - pcf	108.5	105.5	104.8	
Diameter - inches	2.04	2.04	2.02	
Height - inches	4.25	4.18	4.37	
AT TEST				
Final Moisture - %	21.3	21.7	20.7	
Dry Density - pcf	108.9	106.7	106.7	
Calculated Diameter (in.)	2.03	2.02	2.00	
Height - inches	4.21	4.13	4.31	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.27	47.96	77.89	
Total Pore Pressure - psi	63.7	52.6	52.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.1	3.2	4.3	
σ_1 Failure - psi	25.27	67.96	117.89	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Dark Gray Clayey Sand
Sampled on Site, W-1 38' to 41' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 1%
LL: 29 PL: 19 PI: 10 Percent -200: 25%
REMARKS: Diameter and Both Ends Trimmed. + # 4 Sieve 0%

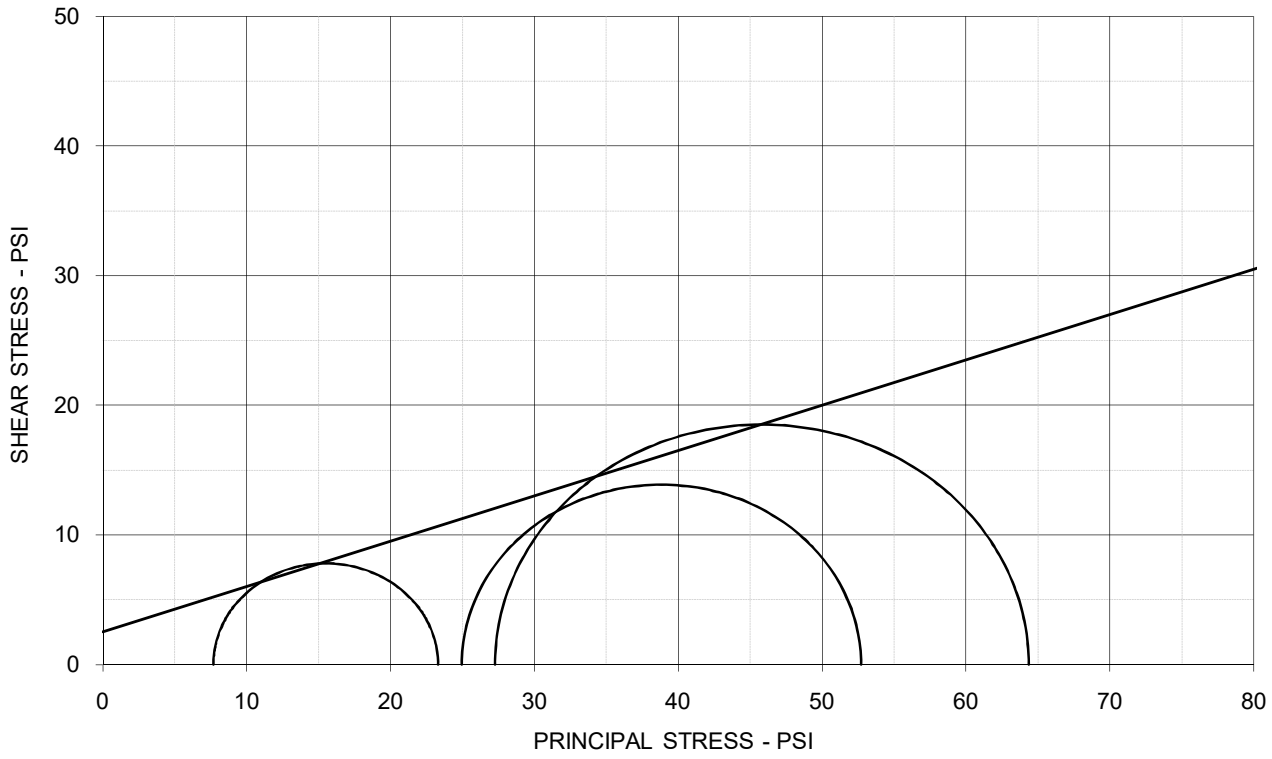
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

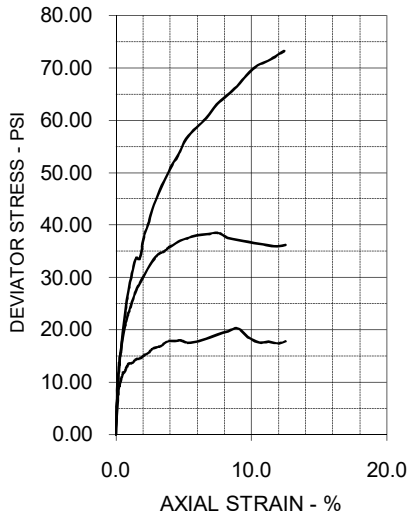
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ' = 19.3 deg	c' = 2.5 psi		
SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.4	21.5	23.6	
Dry Density - pcf	99.0	104.7	98.6	
Diameter - inches	1.99	2.01	2.00	
Height - inches	4.01	3.99	4.01	
AT TEST				
Final Moisture - %	27.8	20.6	27.1	
Dry Density - pcf	99.4	105.8	99.5	
Calculated Diameter (in.)	1.98	2.01	1.99	
Height - inches	3.99	3.97	3.98	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.62	27.77	37.08	
Total Pore Pressure - psi	52.3	45.0	62.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	1.0	4.8	
σ_1' Failure - psi	23.30	52.73	64.35	
σ_3' Failure - psi	7.68	24.96	27.27	



TEST DESCRIPTION

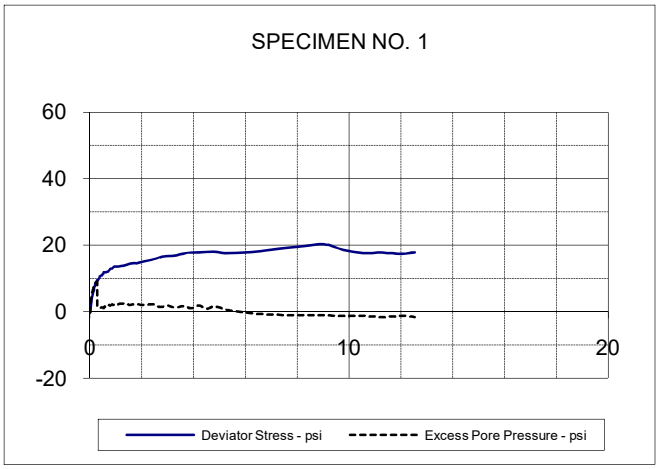
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-3 10' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 6%
LL: 68 PL: 22 PI: 46 Percent -200: 80%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

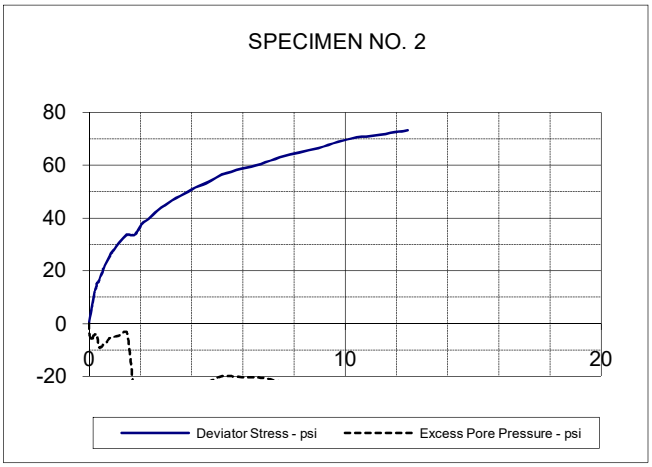
PROJECT INFORMATION

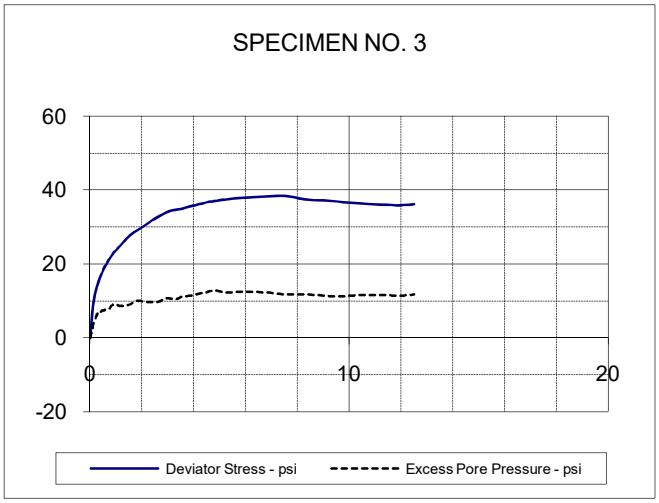
PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

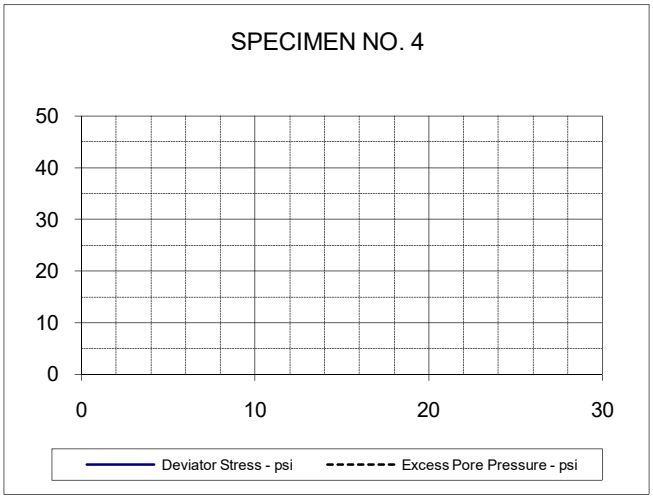
ETTL ENGINEERS & CONSULTANTS

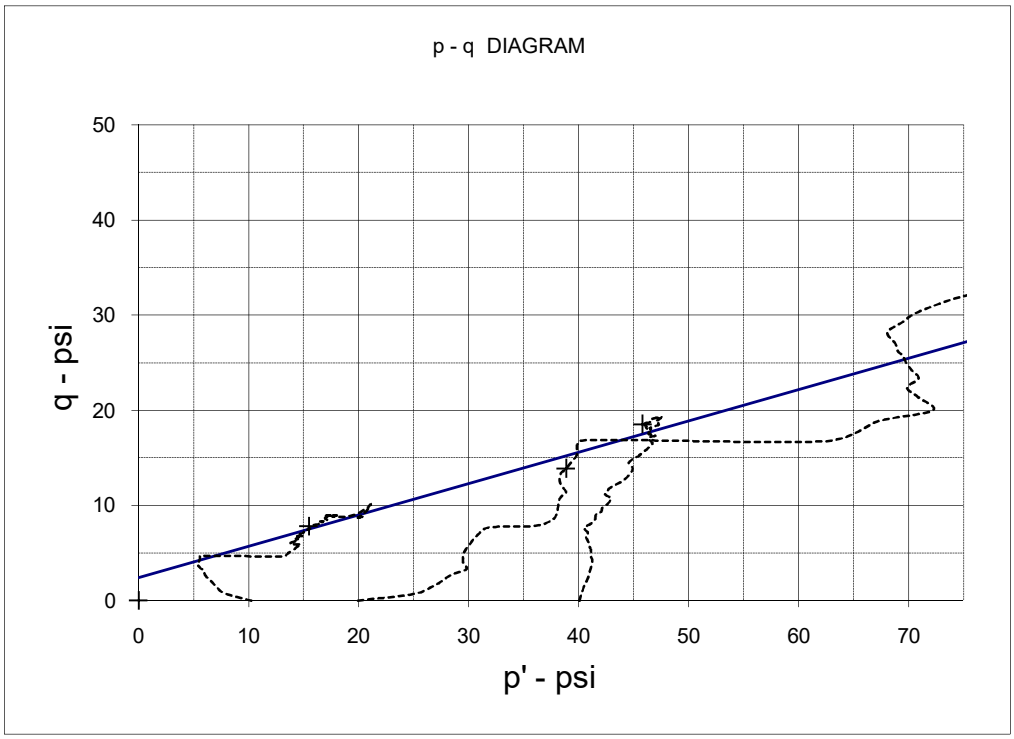
PLATE: B.1







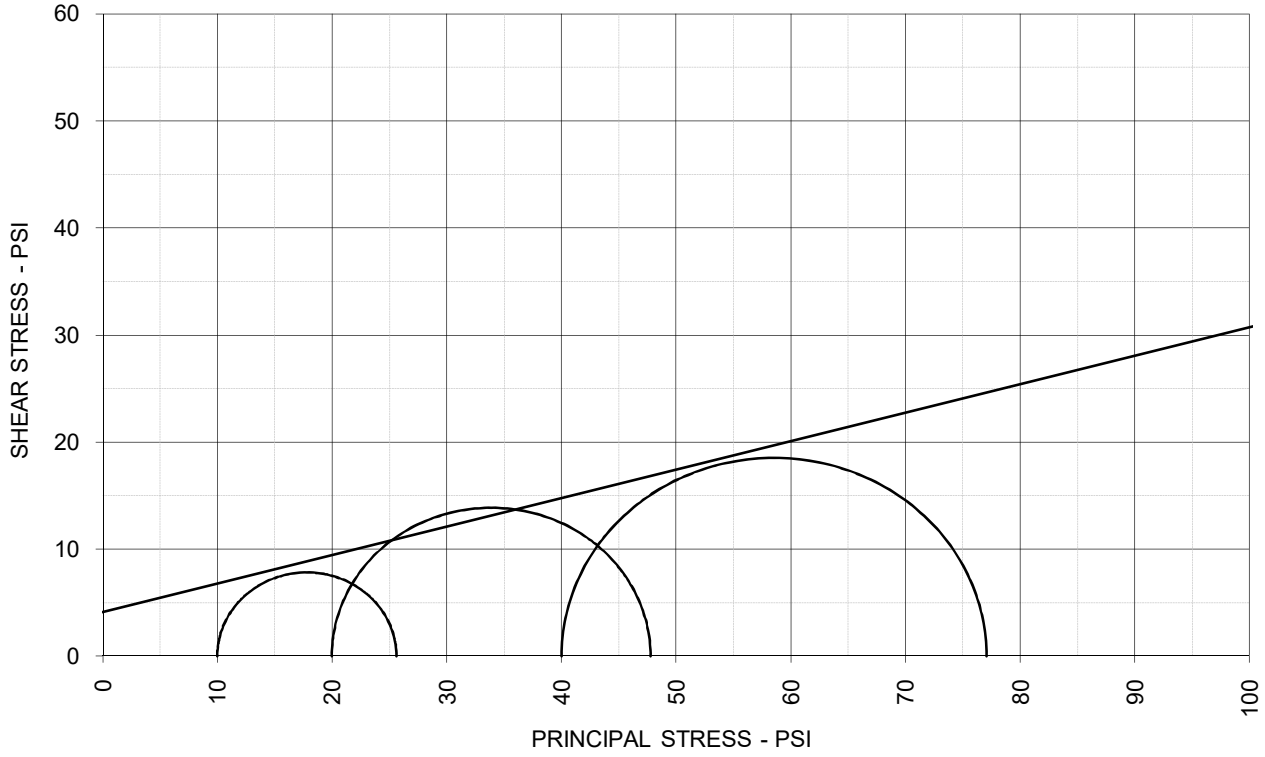




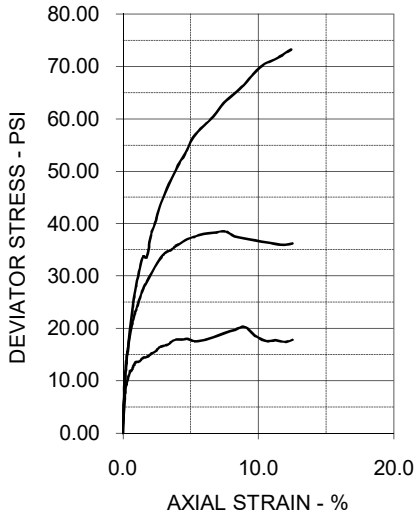
EFFECTIVE STRESS PARAMETERS	R^2 = 0.95	α (deg) = 18.3	a (psi) = 2.4
PROJECT: Pirkey Power Plant Embankments		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3241 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand			

G 3241-095, W-3 10'-20'.xls

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 14.9 deg	c = 4.1 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.4	21.5	23.6	
Dry Density - pcf	99.0	104.7	98.6	
Diameter - inches	1.99	2.01	2.00	
Height - inches	4.01	3.99	4.01	
AT TEST				
Final Moisture - %	27.8	20.6	27.1	
Dry Density - pcf	99.4	105.8	99.5	
Calculated Diameter (in.)	1.98	2.01	1.99	
Height - inches	3.99	3.97	3.98	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.62	27.77	37.08	
Total Pore Pressure - psi	52.3	45.0	62.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	1.0	4.8	
σ_1 Failure - psi	25.62	47.77	77.08	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-3 10' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 6%
LL: 68 PL: 22 PI: 46 Percent -200: 80%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

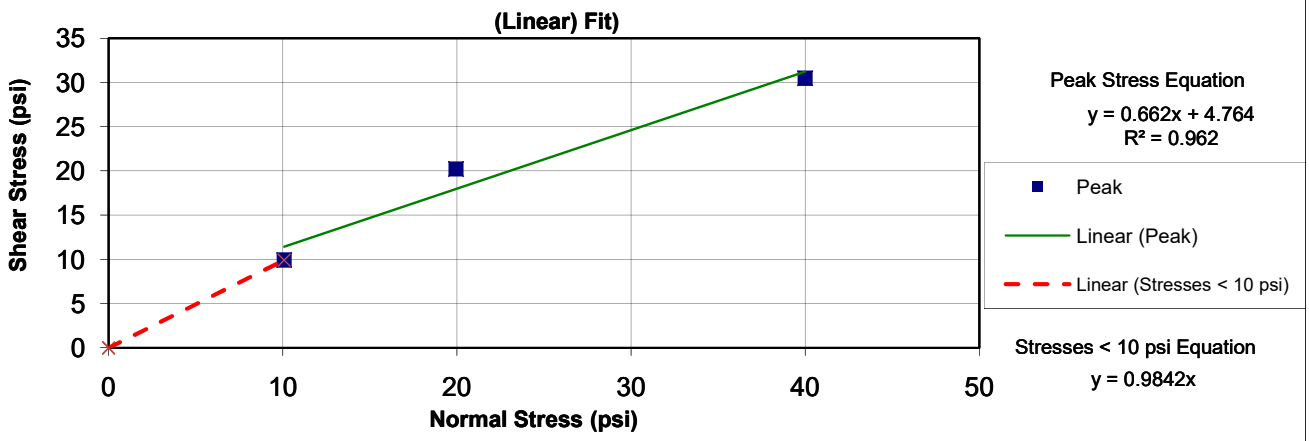
PROJECT INFORMATION

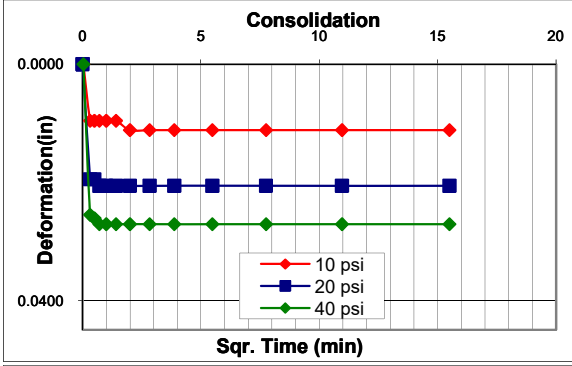
PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

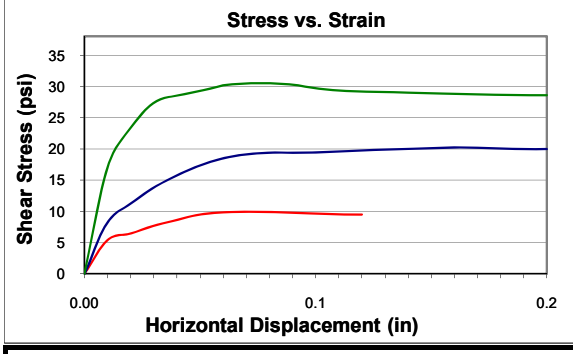
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

ASTM 3080 Direct Shear Test Report







Peak Strength Parameters

	Peak		Residual	
Friction Angle	33.5 (deg)		- (deg)	
Cohesion	4.76 (psi)	686.0 (psf)	- (psi)	- (psf)
Friction Angle Stresses < 10psi			44.5	(deg)
Specimen Number		1	2	3
Initial				
Moisture Content - %		18.5%	18.8%	21.4%
Dry Density- lb/ft^3		103.6	105.7	104.5
Height-inches		1.008	1.008	1.008
Diameter- inches		2.50	2.50	2.50
Final				
Moisture Content - %		24.4%	22.1%	24.1%
Dry Density- lb/ft^3		105.6	172.8	108.2
Height after shear-(inches)		0.997	0.620	0.978
Height after consolidation (inches)		0.997	0.987	0.981
Normal Stress-(psi)		10	20	40
Peak Failure Stress-(psi)		9.92	20.23	30.49
Residual Failure Stress-(psi)		-	-	-
Strain Rate - (inches/min)		0.0029	0.0027	0.0029

Project Information

				LL	PL	PI
Project :	Pirkey Power Plant Embankments			32	17	15
Client:	AEP					
Material Origin:	Hallsville, Tx					
Material Description:	Tan & Brown Clayey Sand with ferric seams			-200%	31	
Job No:	G 3241-095	**Technician:**	Owen Sanderson	**Remarks**		
Boring No:	W-2	**Sample Type:**	Shelby Tube	When Calculating stresses < 10 psi: use appropriate Equation above (assuming no Cohesion)		
Depth:	13'-16'	**Sampling method:**	Shelby Tube			
Date:	October 31, 2009	**Testing Device:**	Soiltest B-124BY 2.5 in. round			

C. Brandon Quinn, P.E.

210 Beech Street
Texarkana, AR 71854
870-772-0013 Phone
870-216-2413 Fax

1717 East Erwin
Tyler, Texas 75702
903-595-4421 Phone
903-595-6113 Fax
www.ettlinc.com

707 West Cotton Street
Longview, Texas 75604-5505
903-758-0915 Phone
903-758-8245 Fax

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

Cone Penetration Test

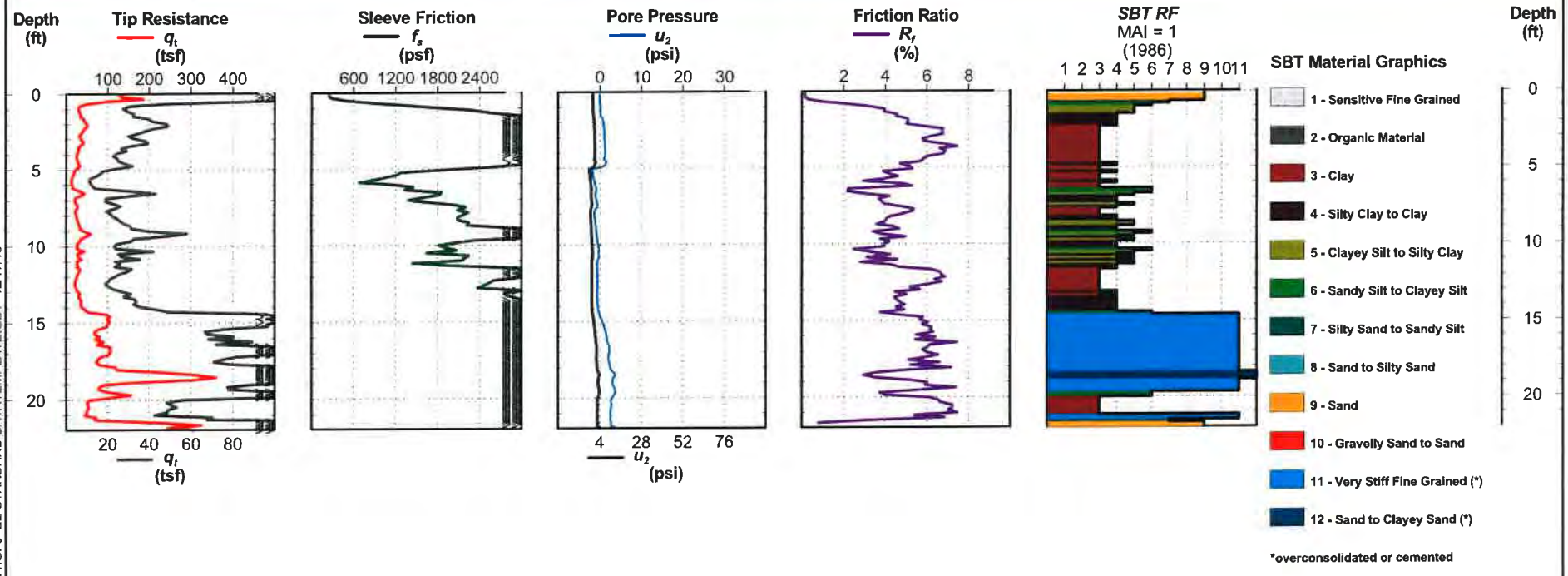
CPT-1

CPT ID/Net Area Ratio: DSG0709 / 0.8

Date: 12/8/15
Operator: P. Thurmond

Latitude: 32.46619
Longitude: -94.48989

Water Depth: See Text
Total Depth: 22.0 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

Cone Penetration Test

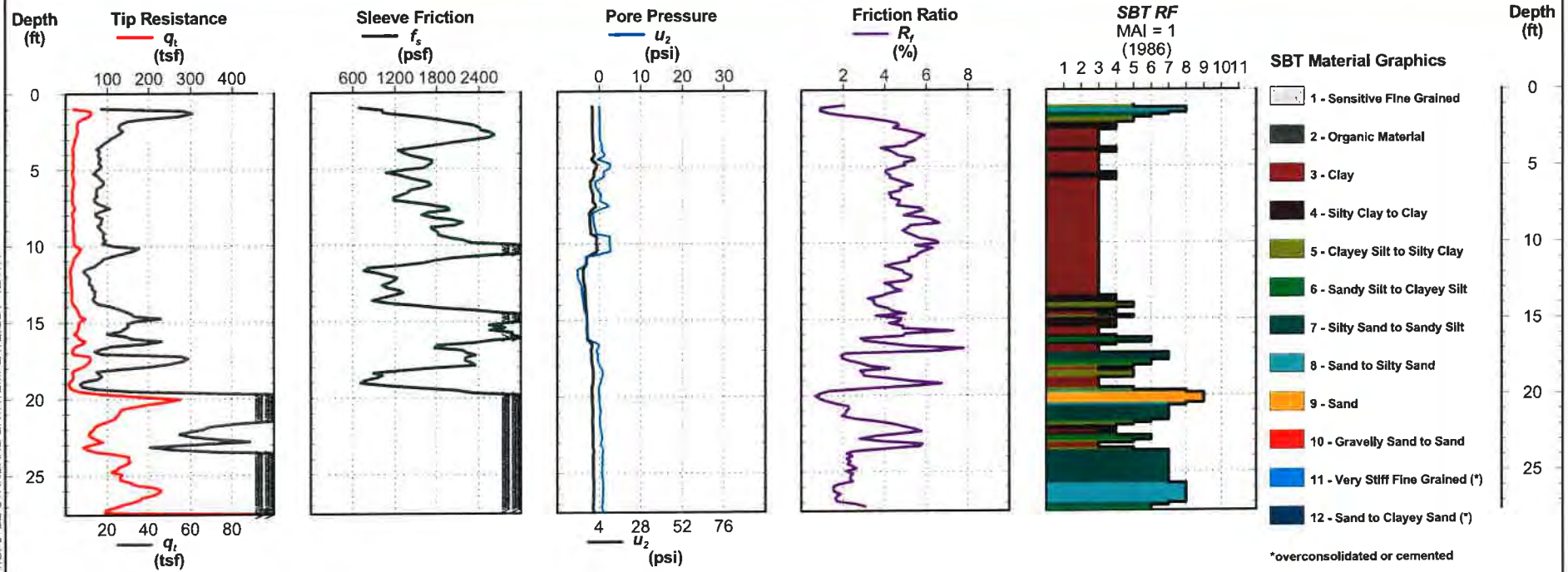
CPT-2

CPT ID/Net Area Ratio: DSG0709 / 0.8

Date: 12/8/15
Operator: P. Thurmond

Latitude: 32.46613
Longitude: -94.49157

Water Depth: See Text
Total Depth: 27.6 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

Cone Penetration Test

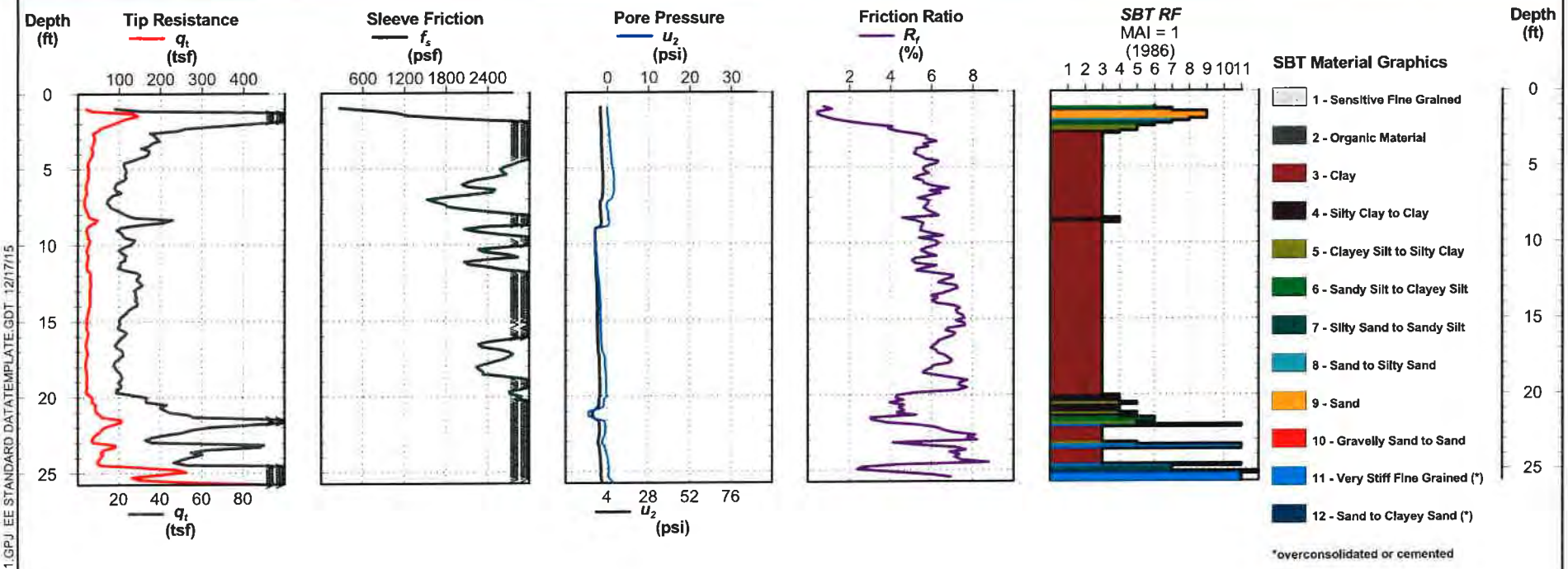
CPT-3

CPT ID/Net Area Ratio: DSG0709 / 0.8

Latitude: 32.46587
Longitude: -94.49313

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 25.8 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

Cone Penetration Test

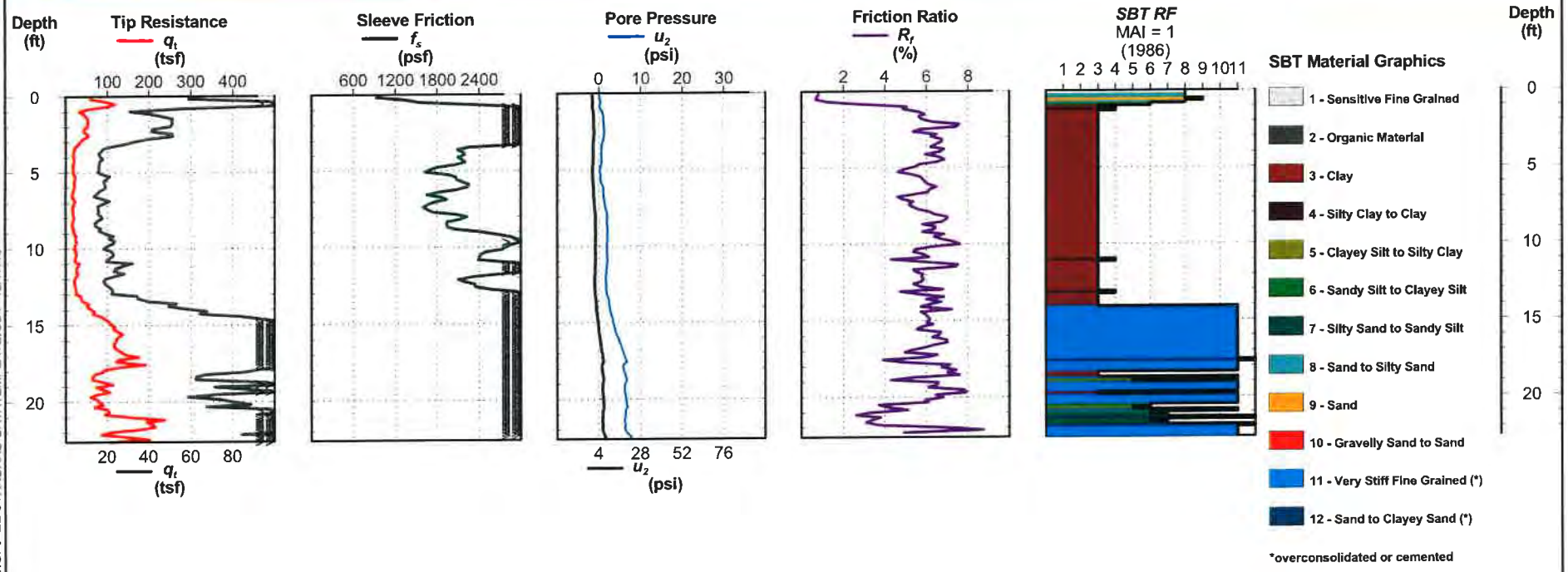
CPT-4

CPT ID/Net Area Ratio: DSG0709 / 0.8

Date: 12/8/15
Operator: P. Thurmond

Latitude: 32.46672
Longitude: -94.49400

Water Depth: See Text
Total Depth: 22.6 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

Cone Penetration Test

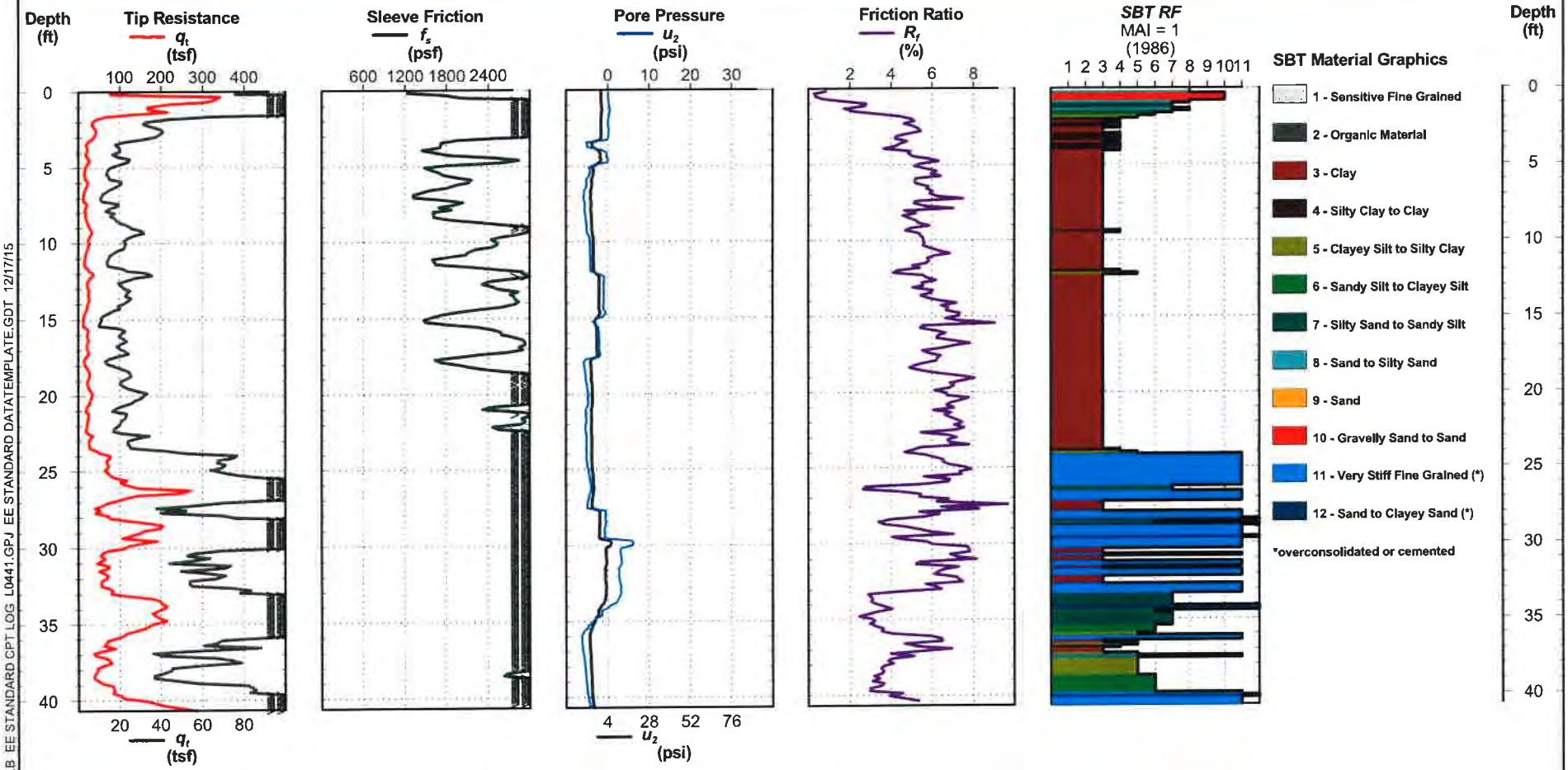
CPT-5

CPT ID/Net Area Ratio: DSG0709 / 0.8

Latitude: 32.46803
Longitude: -94.49390

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 40.7 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

Cone Penetration Test

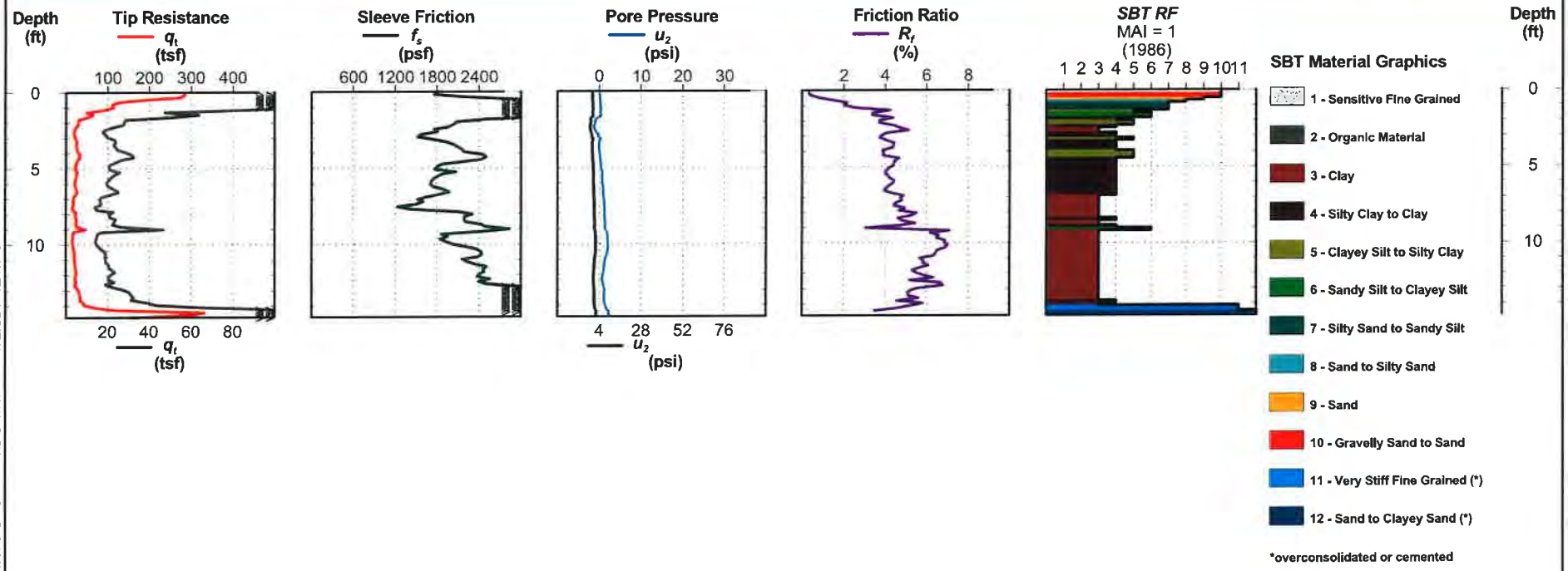
CPT-6

CPT ID/Net Area Ratio: DSG0709 / 0.8

Latitude: 32.46887
Longitude: -94.49243

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 14.8 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

Cone Penetration Test

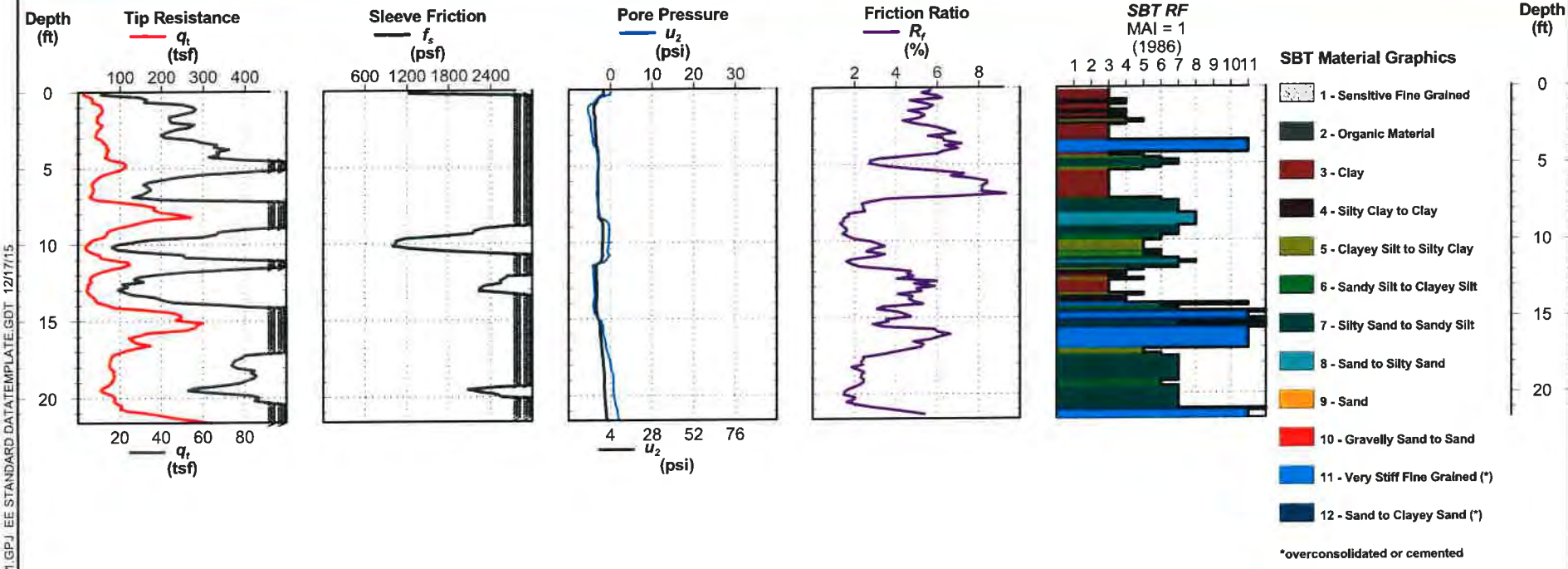
CPT-7

CPT ID/Net Area Ratio: DSG0709 / 0.8

Date: 12/9/15
Operator: P. Thurmond

Latitude: 32.46572
Longitude: -94.49256

Water Depth: See Text
Total Depth: 21.7 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

Cone Penetration Test

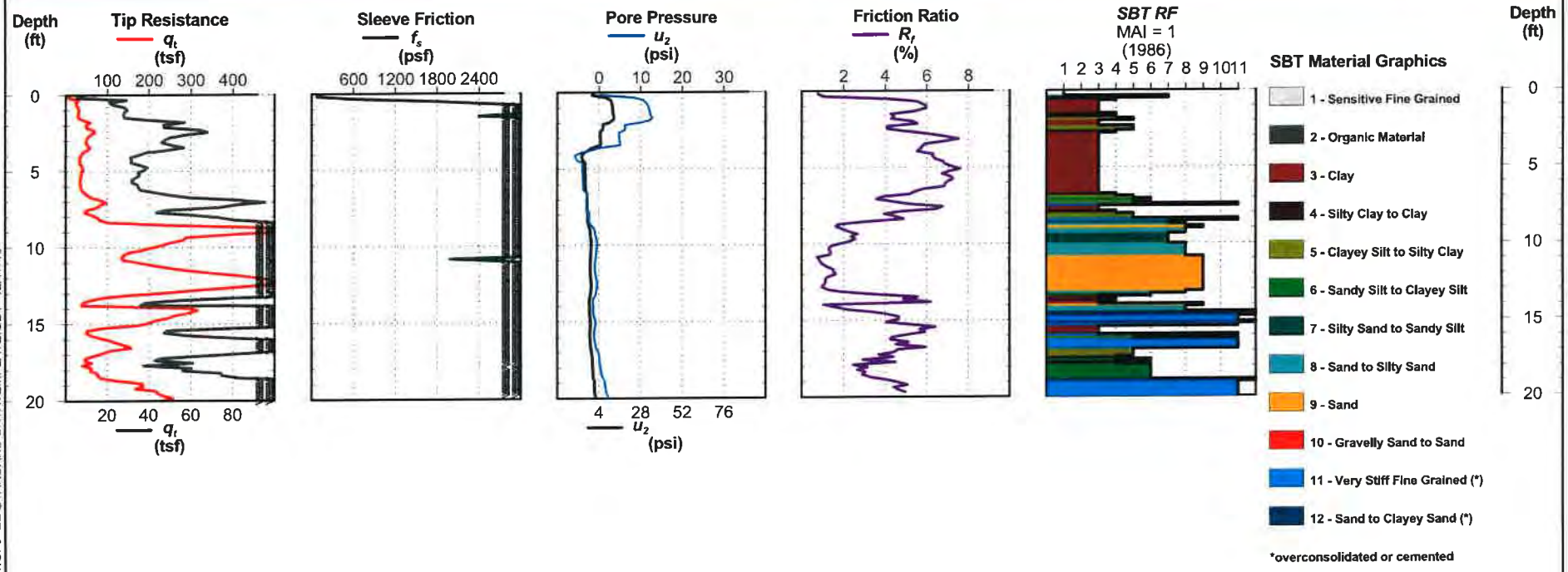
CPT-8

CPT ID/Net Area Ratio: DSG0709 / 0.8

Latitude: 32.46603
Longitude: -94.49087

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 20.0 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

Appendix F

Annual Groundwater Monitoring Report

Annual Groundwater Monitoring Report

Southwestern Electric Power Company

H. W. Pirkey Power Plant

East Bottom Ash Pond CCR Management Unit

Hallsville, Texas

January 2020

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY

An AEP Company

BOUNDLESS ENERGY

Page

Table of Contents

I. Summary

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2020.

In general, the following activities were completed:

- Groundwater samples were collected for AD-2, AD-4, AD-12, AD-18, AD-31, and AD-32 in February, May, and August 2019 and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- The unit was in Assessment monitoring at the beginning of 2019;
- Assessment of Corrective measure was initiated on March 26, 2019;
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-2, AD-31, and AD-32 and for lithium at AD-31 and AD-32 on December 26, 2018. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 24, 2019. An alternate source for lithium was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on July 22, 2019. As result, assessment of corrective measure work stopped and the unit stayed in assessment monitoring.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-2, AD-31, and AD-32 and for lithium at AD-31 and AD-32 on July 12, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 23, 2019.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-2 and AD-32 and for lithium at AD-31 and AD-32 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.
- The unit was in Assessment monitoring at the end of the 2019;
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was

guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in Appendix I;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations (Appendix IV).
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

East BAP Monitoring Wells	
Up Gradient	Down Gradient
AD-4	AD-2
AD-12	AD-31
AD-18	AD-32

III. Monitoring Wells Installed or Decommissioned

Several monitoring wells were installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry in mine spoils. Please see the list below. Well installation reports can be found in Appendix V.

Soil Boring ID	Monitor Well ID
	AD-37
	AD-38
	AD-39
	AD-40
SB-01A	AD-41
SB-04	AD-42
SB-04	AD-43
SB-05	AD-44
SB-05	AD-45
SB-06	AD-46
SB-06	AD-47
SB-07	AD-48
SB-07	AD-49
SB-08	AD-50
SB-08	AD-52
SB-08	AD-53
SB-09	AD-54
SB-09	AD-55
SB-11	AD-56
SB-11	AD-57

Three additional soil borings were installed to better understand the spatial variability of constituents at the site up gradient of the plant. The borings logs can be found in Appendix III in *Alternative Source Demonstration Report Federal CCR Rule* dated July 22, 2019. Two monitor wells were installed at these boring locations B-2 and B-3. Well construction diagrams and well development logs for monitoring wells B-2 and B-3 can also be found in *Alternative Source Demonstration Report Federal CCR Rule* dated July 22, 2019. The well installation reports are included in this report in Appendix V.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event are presented in Appendix I, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., a one round of sampling in February in accordance with 40 CFR 257.95(d)(1). A May sampling event was conducted in accordance with 40 CFR 257.95(b) including all Appendix III parameters and those Appendix IV constituents parameters followed by an August round of sampling in accordance with 40 CFR 257.95(d)(1). Assessment monitoring will continue in 2020.

V. Statistical Evaluation of 2019 Events

The two statistical analysis reports are included in Appendix II.

Statistically significant levels (SSLs) above the groundwater protection standard were identified for cobalt at wells AD-2, AD-31, and AD-32 and for lithium at AD-31 and AD-32 as summarized in *Statistical Analysis Summary East Bottom Ash Pond Report* (7/12/2019) in Appendix II.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-2 and AD-32 and for lithium at AD-31 and AD-32 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the east bottom ash pond SSLs above GWPSs. SSLs above the GWPS were determined for lithium and cobalt on December 26, 2018. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 24, 2019. An alternate source for lithium was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on July 22, 2019.

SSLs above the GWPS were determined for cobalt at wells AD-2, AD-31, and AD-32 and for lithium at AD-31 and AD-32 on July 12, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 23, 2019.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-2 and AD-32 and for lithium at AD-31 and AD-32 on January 3, 2020. An alternate source investigation will be conducted for these SSLs.

The supporting information are found in Appendix III.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

The unit transitioned from detection monitoring to assessment monitoring transition on April 3, 2018. The unit transitioned into assessment of corrective measures on March 26, 2019 since there

was no alternate source identified at that time. An alternate source was later identified for cobalt on April 24, 2019 and lithium on July 22, 2019. Assessment of corrective measures was discontinued and the unit remained in assessment monitoring.

Assessment monitoring will continue in 2020.

Regarding defining an alternate monitoring frequency, no modification of the twice-per-year detection monitoring effort is needed.

VIII. Other Information Required

No other information applies at this time.

IX. Description of Any Problems Encountered in 2019 and Actions Taken

No problems were encountered this year.

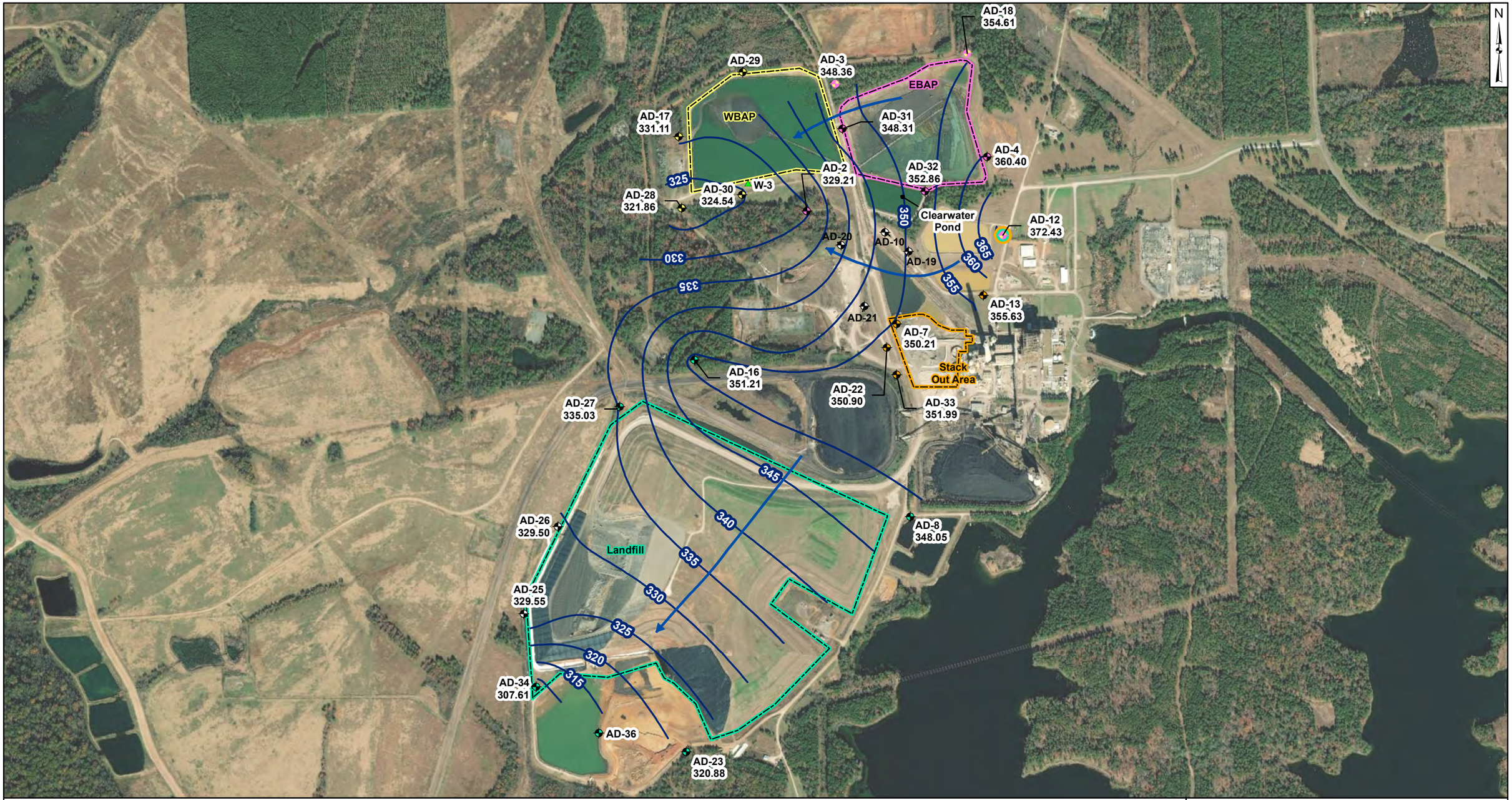
X. A Projection of Key Activities for the Upcoming Year

Key activities for next year include:

- Assessment monitoring sampling will be conducted;
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for any SSLs above GWPS;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the next annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on February 23-28, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in February 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer February 2019

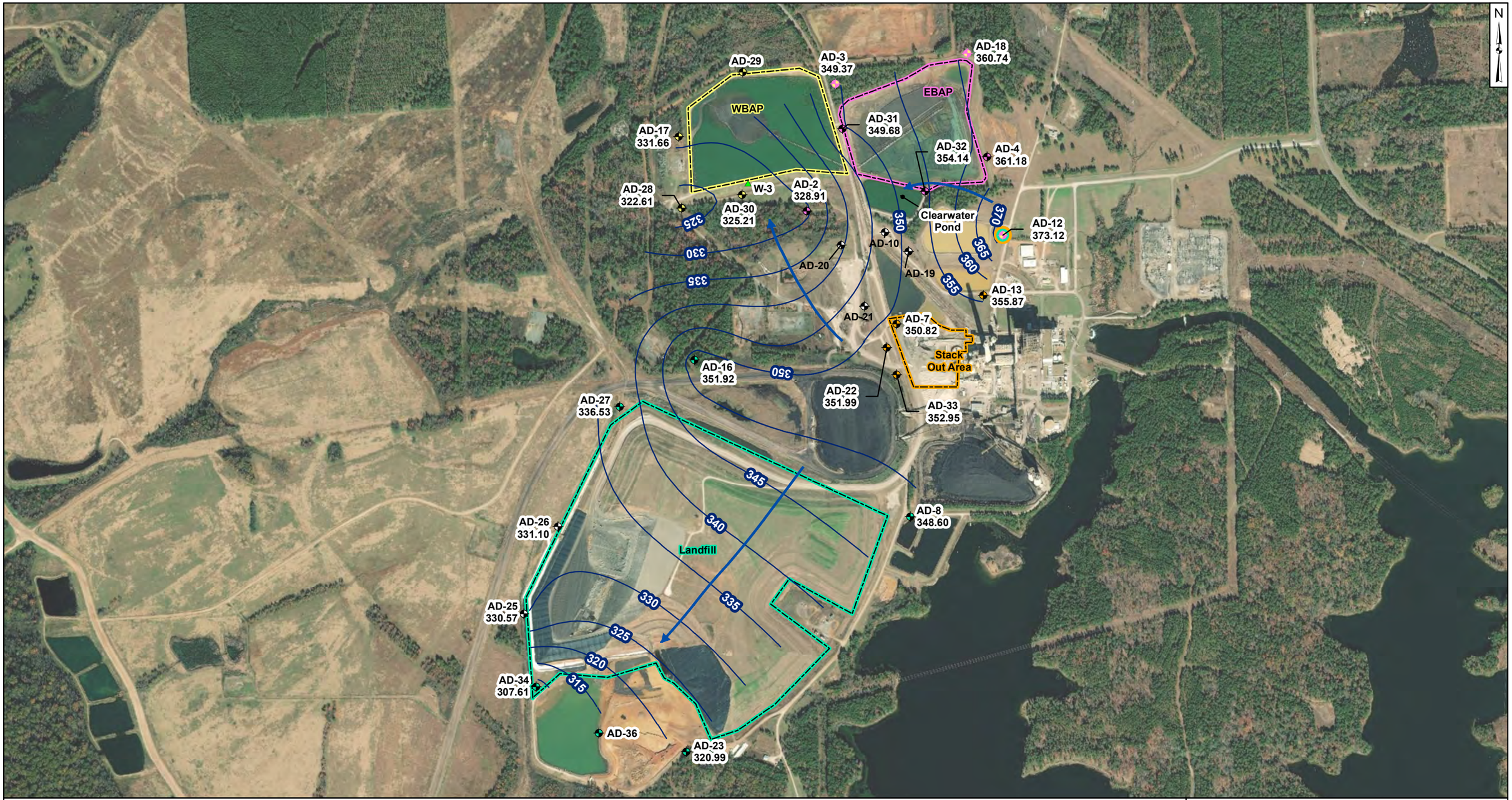
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201902-February.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 21-23, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in May 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer May 2019

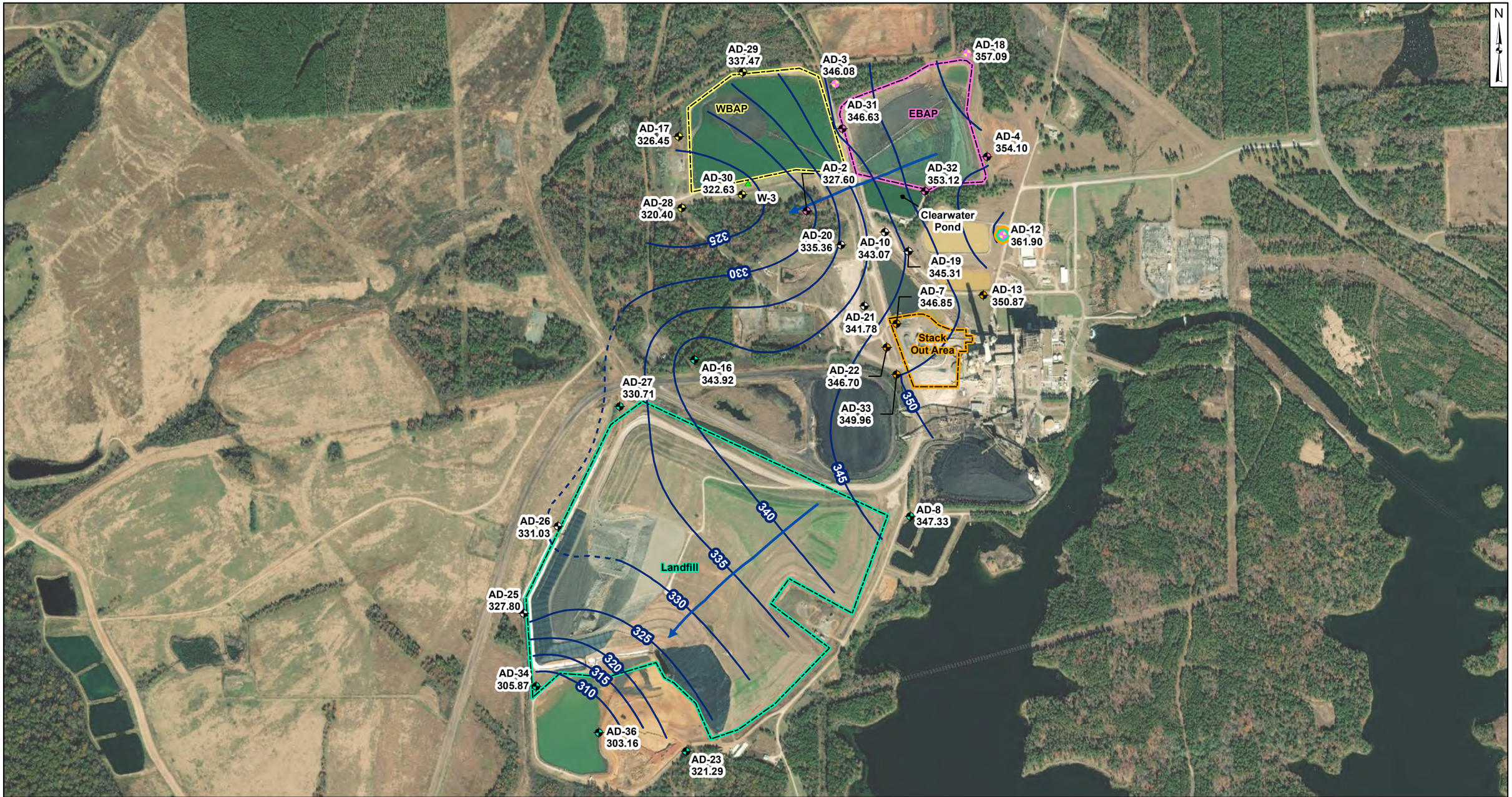
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure **2**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201905-May.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on August 12-16, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in August 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure 3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201908-August.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.

Table 1: Residence Time Calculation Summary
Pirkey East Bottom Ash Pond

Geosyntec Consultants, Inc.

CCR Management Unit	Monitoring Well	Well Diameter (inches)	2019-02		2019-05		2019-08	
			Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
East Bottom Ash Pond	AD-2 [2]	4.0	7.1	17.1	32.3	3.8	6.4	19.0
	AD-4 [1]	4.0	11.6	10.5	10.6	11.5	5.1	23.9
	AD-12 [1]	4.0	34.2	3.6	35.0	3.5	21.2	5.7
	AD-18 [1]	2.0	9.3	6.6	8.9	6.8	7.1	8.5
	AD-31 [2]	2.0	27.3	2.2	30.1	2.0	25.9	2.3
	AD-32 [2]	2.0	20.0	3.0	15.2	4.0	18.5	3.3

Notes:
[1] - Background Well
[2] - Downgradient Well

Table 1 - Groundwater Data Summary: AD-2
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	1.27	1.43	28	<0.083 U	4.4	238	68
7/14/2016	Background	1.34	1.38	28	<0.083 U	4.2	216	71
9/7/2016	Background	1.3	2.65	20	<0.083 U	4.2	216	49
10/13/2016	Background	1.48	1.29	31	<0.083 U	3.6	230	67
11/14/2016	Background	1.36	1.44	28	<0.083 U	3.9	240	72
1/12/2017	Background	1.48	1.6	30	<0.083 U	3.9	244	94
3/1/2017	Background	1.62	1.28	28	<0.083 U	4.1	262	80
4/11/2017	Background	1.65	1.71	50	<0.083 U	4.0	254	88
8/24/2017	Detection	1.46	2.06	24	<0.083 U	4.3	200	64
12/21/2017	Detection	1.38	2.92	24	< 0.083 U	- -	206	64
3/22/2018	Assessment	1.99	1.97	30	<0.083 U	4.2	220	105
8/21/2018	Assessment	2.14	1.65	46	<0.083 U	4.7	312	130
2/28/2019	Assessment	2.25	1.96	31.8	0.1 J	3.5	384	129
5/22/2019	Assessment	2.17	2.19	29.6	0.1 J	4.0	316	137
8/12/2019	Assessment	2.16	3.30	28.4	0.1 J	4.6	306	128

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-2
Pirkey - EBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	38	0.514594 J	<0.07 U	<0.23 U	10	1.446	<0.083 U	<0.68 U	<0.00013 U	0.098	<0.29 U	2.08256 J	<0.86 U
7/14/2016	Background	<0.93 U	<1.05 U	38	0.46511 J	<0.07 U	0.401928 J	11	0.723	<0.083 U	<0.68 U	0.051	0.068	0.862706 J	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	39	0.439699 J	<0.07 U	0.493592 J	10	1.489	<0.083 U	<0.68 U	0.048	0.675	<0.29 U	<0.99 U	1.26444 J
10/13/2016	Background	<0.93 U	<1.05 U	39	0.40165 J	<0.07 U	0.885421 J	11	2.65	<0.083 U	<0.68 U	0.052	0.048	<0.29 U	1.3807 J	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	34	0.367353 J	<0.07 U	<0.23 U	10	2.121	<0.083 U	<0.68 U	0.048	0.154	<0.29 U	1.23147 J	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	37	0.376129 J	<0.07 U	<0.23 U	10	1.656	<0.083 U	<0.68 U	0.052	0.093	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	37	0.413652 J	<0.07 U	<0.23 U	10	1.267	<0.083 U	<0.68 U	0.051	0.037	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	<1.05 U	37	0.435396 J	<0.07 U	0.243798 J	11	0.807	<0.083 U	<0.68 U	0.052	0.028	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	33.28	0.45 J	<0.07 U	<0.23 U	12.43	1.053	<0.083 U	<0.68 U	0.05379	0.042	<0.29 U	1.61 J	<0.86 U
8/21/2018	Assessment	<0.01 U	0.52	29.0	0.428	0.06	0.406	13.6	1.059	<0.083 U	0.338	0.0479	0.02 J	0.06 J	1.1	0.096
2/28/2019	Assessment	0.02 J	0.53	26.1	0.5 J	0.06	0.1 J	13.9	1.261	0.1 J	0.355	0.0591	0.027	<0.4 U	1.5	<0.1 U
5/22/2019	Assessment	<0.4 U	<0.6 U	25.6	<0.4 U	<0.2 U	<0.8 U	15.5	0.832	0.1 J	<0.4 U	0.0542	0.063	<8 U	0.9 J	<0.1 U
8/12/2019	Assessment	<0.02 U	0.35	22.8	0.402	0.06	0.292	13.0	1.812	0.1 J	0.288	0.056	0.044	<0.4 U	0.8	0.1 J

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-4
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.02	1.63	4	<0.083 U	5.4	148	23
7/14/2016	Background	0.02	2.32	4	<0.083 U	4.9	157	20
9/8/2016	Background	0.02	2.37	5	<0.083 U	4.9	136	20
10/13/2016	Background	0.03	2.87	6	<0.083 U	4.1	164	19
11/15/2016	Background	0.04	2.71	5	<0.083 U	4.3	152	19
1/12/2017	Background	0.03	2.94	5	<0.083 U	4.8	148	18
3/1/2017	Background	0.03	2.86	4	<0.083 U	4.7	148	18
4/10/2017	Background	0.04	1.91	5	<0.083 U	4.4	140	21
8/24/2017	Detection	0.06229	2.04	5	<0.083 U	4.6	94	20
3/22/2018	Assessment	0.0331	1.41	3	<0.083 U	4.8	132	23
8/21/2018	Assessment	0.018	2.38	7	<0.083 U	4.8	158	21
2/28/2019	Assessment	0.021	1.57	3.56	0.11	4.9	192	22.9
5/23/2019	Assessment	0.021	1.71	3.31	0.15	5.0	150	24.6
8/14/2019	Assessment	<0.02 U	1.97	6.22	0.12	5.5	146	21.7

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-4
Pirkey - EBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	3.95918 J	75	1	0.133362 J	0.396808 J	8	0.729	<0.083 U	<0.68 U	0.013	0.00891 J	<0.29 U	1.79183 J	<0.86 U
7/14/2016	Background	<0.93 U	8	127	1	<0.07 U	3	9	4.271	<0.083 U	<0.68 U	0.041	0.037	<0.29 U	1.73546 J	1.87362 J
9/8/2016	Background	<0.93 U	5	123	1	0.111076 J	2	8	0.193	<0.083 U	<0.68 U	0.04	0.01151 J	<0.29 U	<0.99 U	<0.86 U
10/13/2016	Background	<0.93 U	11	183	0.830588 J	<0.07 U	7	7	2.381	<0.083 U	<0.68 U	0.034	0.01005 J	<0.29 U	1.60451 J	0.868603 J
11/15/2016	Background	<0.93 U	<1.05 U	114	0.53145 J	<0.07 U	0.446412 J	6	1.072	<0.083 U	<0.68 U	0.035	0.01268 J	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	149	0.406228 J	<0.07 U	0.305795 J	4.5062 J	2.599	<0.083 U	<0.68 U	0.03	0.01146 J	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	131	0.354085 J	<0.07 U	<0.23 U	4.45689 J	1.089	<0.083 U	<0.68 U	0.033	0.01224 J	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	94	0.915299 J	0.0796 J	0.240917 J	8	0.684	<0.083 U	<0.68 U	0.047	0.00554 J	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	66.74	1.15	0.26 J	<0.23 U	9.39	1.283	<0.083 U	<0.68 U	0.05374	<0.005 U	<0.29 U	1.99 J	<0.86 U
8/21/2018	Assessment	<0.01 U	1.30	121	0.400	0.02 J	0.198	4.43	1.331	<0.083 U	0.098	0.0294	0.005 J	<0.02 U	0.04 J	0.096
2/28/2019	Assessment	<0.02 U	0.26	70.5	0.9 J	0.01 J	0.1 J	6.92	0.818	0.11	0.106	0.0513	<0.005 U	<0.4 U	0.03 J	<0.1 U
5/23/2019	Assessment	<0.4 U	<0.6 U	61.7	0.5 J	<0.2 U	1 J	7.86	0.5173	0.15	<0.4 U	0.0516	<0.005 U	<8 U	<0.6 U	<0.1 U
8/14/2019	Assessment	<0.02 U	0.17	73.5	1.04	<0.01 U	0.08 J	6.52	0.833	0.12	0.06 J	0.0484	<0.005 U	<0.4 U	0.04 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - EBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	<0.083 U	4.4	94	4
7/13/2016	Background	0.03	0.26	6	<0.083 U	3.1	75	4
9/7/2016	Background	0.04	0.343	6	<0.083 U	3.9	63	7
10/12/2016	Background	0.03	0.271	7	< 1 U	3.4	92	8
11/14/2016	Background	0.04	0.331	8	<0.083 U	2.6	80	6
1/11/2017	Background	0.03	0.315	7	<0.083 U	4.8	76	6
2/28/2017	Background	0.04	0.434	5	<0.083 U	3.6	50	4
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	72	7
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	52	6
3/21/2018	Assessment	0.01397	0.269	5	<0.083 U	4.2	<2 U	3
8/20/2018	Assessment	0.017	0.338	10	<0.083 U	4.4	94	4
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	36	3.6
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	80	4.0
8/12/2019	Assessment	<0.02 U	0.278	7.24	0.06 J	4.9	90	2.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - EBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	26	0.219521 J	<0.07 U	0.710981 J	1.58207 J	0.2073	<0.083 U	<0.68 U	<0.00013 U	<0.005 U	<0.29 U	1.73953 J	<0.86 U
7/13/2016	Background	<0.93 U	<1.05 U	23	0.190337 J	<0.07 U	0.68835 J	1.29444 J	2.909	<0.083 U	<0.68 U	0.008	<0.005 U	<0.29 U	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	30	0.232192 J	<0.07 U	0.353544 J	1.66591 J	0.881	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	<1.05 U	27	0.149553 J	<0.07 U	0.529033 J	1.56632 J	0.257	< 1 U	<0.68 U	0.012	<0.005 U	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	28	0.152375 J	<0.07 U	0.32826 J	1.47282 J	0.767	<0.083 U	<0.68 U	0.013	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	<1.05 U	23	0.126621 J	<0.07 U	0.650158 J	1.09495 J	1.536	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	<1.05 U	26	0.149219 J	<0.07 U	0.325811 J	1.29984 J	0.416	<0.083 U	<0.68 U	0.009	<0.005 U	<0.29 U	<0.99 U	0.994913 J
4/11/2017	Background	<0.93 U	<1.05 U	24	0.159412 J	<0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	<0.68 U	0.008	0.01364 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	25.82	0.16 J	<0.07 U	1.05	1.49 J	0.784	<0.083 U	<0.68 U	0.00722	<0.005 U	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	<0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	<0.083 U	0.089	0.0143	<0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	<0.4 U	<0.6 U	22.5	<0.4 U	<0.2 U	<0.8 U	1.37	0.225	0.09	<0.4 U	0.00688	<0.005 U	<8 U	<0.6 U	<2 U
5/21/2019	Assessment	<0.4 U	<0.6 U	21.7	<0.4 U	<0.2 U	<0.8 U	1.15	0.201	0.09	<0.4 U	0.00576	<0.005 U	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.07 J	23.8	0.154	<0.01 U	0.204	1.3	0.237	0.06 J	0.08 J	0.00829	<0.005 U	<0.4 U	0.2 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-18
Pirkey - EBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.01	0.548	8	<0.083 U	4.5	108	7
7/14/2016	Background	0.01	0.409	8	<0.083 U	4.7	116	7
9/8/2016	Background	0.01	0.343	8	<0.083 U	4.7	110	8
10/13/2016	Background	0.02	0.56	7	<0.083 U	4.1	124	10
11/15/2016	Background	0.02	0.59	7	<0.083 U	4.4	134	7
1/12/2017	Background	0.01	0.415	7	<0.083 U	4.7	128	10
3/1/2017	Background	0.01	0.224	6	<0.083 U	4.1	108	7
4/10/2017	Background	0.01	0.304	7	<0.083 U	4.1	102	8
8/24/2017	Detection	0.0278	0.435	8	<0.083 U	4.9	68	8
3/22/2018	Assessment	0.01642	0.292	6	<0.083 U	5.4	100	6
8/21/2018	Assessment	0.012	0.321	10	<0.083 U	5.1	118	8
2/28/2019	Assessment	<0.02 U	0.490	8.19	0.02 J	5.0	84	6.1
5/23/2019	Assessment	0.013	0.684	8.82	0.02 J	5.2	104	10.6
8/13/2019	Assessment	<0.02 U	0.647	8.49	0.01 J	5.2	90	6.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-18
Pirkey - EBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	<0.93 U	<1.05 U	157	0.262755 J	0.109247 J	1	1.82932 J	0.847	<0.083 U	<0.68 U	0.004	0.01536 J	<0.29 U	1.71074 J	<0.86 U
7/14/2016	Background	<0.93 U	3.77261 J	139	0.243326 J	<0.07 U	3	2.16037 J	3.264	<0.083 U	<0.68 U	0.02	0.064	0.41347 J	2.45009 J	<0.86 U
9/8/2016	Background	<0.93 U	<1.05 U	115	0.226343 J	<0.07 U	0.779959 J	1.09947 J	1.105	<0.083 U	<0.68 U	0.019	0.03	<0.29 U	<0.99 U	<0.86 U
10/13/2016	Background	<0.93 U	<1.05 U	112	0.192611 J	<0.07 U	0.631027 J	2.24885 J	1.161	<0.083 U	<0.68 U	0.026	0.01416 J	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	94	0.107171 J	<0.07 U	0.724569 J	1.66054 J	1.486	<0.083 U	<0.68 U	0.017	0.029	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	99	0.169196 J	<0.07 U	0.411433 J	1.62881 J	0.976	<0.083 U	<0.68 U	0.026	0.01887 J	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	99	0.105337 J	<0.07 U	0.572874 J	0.976724 J	0.468	<0.083 U	<0.68 U	0.017	0.01086 J	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	105	0.130316 J	<0.07 U	0.967681 J	0.98157 J	0.648	<0.083 U	<0.68 U	0.019	0.0096 J	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	97.75	0.09 J	<0.07 U	<0.23 U	0.97 J	0.942	<0.083 U	<0.68 U	0.01647	0.006 J	<0.29 U	1.53 J	<0.86 U
8/21/2018	Assessment	0.02 J	1.01	99.8	0.129	0.02 J	0.809	1.18	1.108	<0.083 U	0.280	0.0175	0.014 J	0.08 J	0.2	0.060
2/28/2019	Assessment	<0.4 U	<0.6 U	106	<0.4 U	<0.2 U	<0.8 U	1.11	0.615	0.02 J	0.7 J	0.0177	0.009 J	<8 U	<0.6 U	<2 U
5/23/2019	Assessment	<0.4 U	<0.6 U	131	<0.4 U	<0.2 U	<0.8 U	1.47	0.492	0.02 J	<0.4 U	0.0209	0.009 J	<8 U	<0.6 U	<0.1 U
8/13/2019	Assessment	<0.02 U	0.45	100	0.118	0.02 J	0.212	1.25	0.473	0.01 J	0.2 J	0.0183	0.023 J	<0.4 U	0.09 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-31
Pirkey - EBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.08	10.4	18	<0.083 U	4.5	286	63
7/13/2016	Background	0.03	4.27	18	<0.083 U	3.5	245	66
9/7/2016	Background	0.03	3.47	18	<0.083 U	3.7	260	60
10/12/2016	Background	0.04	4.41	18	<0.083 U	4.0	276	62
11/14/2016	Background	0.04	4.7	18	<0.083 U	3.2	266	66
1/11/2017	Background	0.03	4.43	19	<0.083 U	4.4	252	79
2/28/2017	Background	0.04	3.89	14	<0.083 U	3.6	212	68
4/11/2017	Background	0.04	3.64	16	<0.083 U	3.6	252	69
8/23/2017	Detection	0.01752	2.24	18	<0.083 U	4.5	228	52
12/21/2017	Detection	- -	- -	20	<0.083 U	- -	224	58
3/22/2018	Assessment	0.04078	3.11	16	<0.083 U	4.5	260	76
8/21/2018	Assessment	0.022	2.86	25	<0.083 U	4.9	274	72
2/28/2019	Assessment	0.03 J	2.77	18.8	0.1 J	5.0	74	74.8
5/23/2019	Assessment	0.021	3.29	18.7	0.13	5.1	240	79.9
8/12/2019	Assessment	<0.02 U	2.86	21.6	0.16	4.1	250	70.0

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-31
Pirkey - EBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	93	712	10	0.858875 J	212	50	7.32	<0.083 U	57	0.077	1.797	0.893978 J	1.84045 J	<0.86 U
7/13/2016	Background	<0.93 U	3.41559 J	69	1	<0.07 U	10	11	3.38	<0.083 U	<0.68 U	0.096	0.32	0.316083 J	1.11301 J	<0.86 U
9/7/2016	Background	<0.93 U	4.34007 J	88	2	<0.07 U	15	11	2.345	<0.083 U	<0.68 U	0.094	0.284	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	6	76	1	<0.07 U	14	11	3.88	<0.083 U	1.54023 J	0.097	0.347	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	11	125	2	0.174662 J	30	14	3.202	<0.083 U	3.93298 J	0.096	0.523	0.401556 J	1.03392 J	<0.86 U
1/11/2017	Background	<0.93 U	3.92088 J	77	1	<0.07 U	12	10	2.725	<0.083 U	<0.68 U	0.093	0.384	<0.29 U	<0.99 U	1.01921 J
2/28/2017	Background	<0.93 U	<1.05 U	44	0.998308 J	<0.07 U	3	9	2.684	<0.083 U	<0.68 U	0.09	0.138	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	3.31744 J	73	1	0.0944 J	12	11	3.521	<0.083 U	<0.68 U	0.097	0.333	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	3.32 J	70.83	1.24	0.12 J	9.62	11.12	2.955	<0.083 U	<0.68 U	0.09732	1.389	<0.29 U	1.98 J	<0.86 U
8/21/2018	Assessment	0.02 J	1.92	57.7	0.729	0.06	2.39	9.29	4.13	<0.083 U	1.41	0.0556	1.112	0.24	2.5	0.113
2/28/2019	Assessment	<0.4 U	<0.6 U	33.1	1 J	<0.2 U	<0.8 U	9.38	3.156	0.1 J	<0.4 U	0.0864	0.01 J	<8 U	<0.6 U	<2 U
5/23/2019	Assessment	<0.4 U	<0.6 U	37.9	0.9 J	<0.2 U	<0.8 U	10.3	3.4	0.13	<0.4 U	0.0928	0.057	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.53	35.0	0.850	0.06	0.365	8.69	2.196	0.16	0.325	0.0875	1.027	<0.4 U	0.4	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-32
Pirkey - EBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.708	7.41	12	<0.083 U	4.3	206	124
7/13/2016	Background	5.23	33.9	32	0.67 J	3.3	835	461
9/7/2016	Background	5.78	37.4	35	<0.083 U	3.1	884	479
10/12/2016	Background	4.26	27.1	29	0.8585 J	3.3	720	430
11/14/2016	Background	5.52	35.9	34	0.7468 J	3.0	922	621
1/11/2017	Background	5.05	40	35	<0.083 U	3.9	894	683
2/28/2017	Background	2.73	18.4	19	<0.083 U	3.1	490	285
4/11/2017	Background	1.46	11	15	0.4468 J	3.2	372	200
8/23/2017	Detection	0.716	7.15	14	1.962	4.3	288	115
12/21/2017	Detection	2.56	17.1	22	0.5932 J	- -	504	324
3/21/2018	Assessment	0.628	6.32	15	<0.083 U	4.1	288	113
8/21/2018	Assessment	2.45	17.8	28	<0.083 U	3.9	548	321
2/28/2019	Assessment	0.679	6.62	17.5	0.40	3.2	222	121
5/21/2019	Assessment	0.555	5.35	18.6	0.31	3.2	292	105
8/12/2019	Assessment	1.77	13.3	24.9	0.67	4.0	448	228

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-32
Pirkey - EBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	3.77019 J	35	3	0.293016 J	5	27	2.501	<0.083 U	<0.68 U	0.016	0.925	<0.29 U	<0.99 U	<0.86 U
7/13/2016	Background	<0.93 U	13	58	8	0.729634 J	18	74	6.41	0.67 J	<0.68 U	0.119	13.916	0.76212 J	3.88793 J	<0.86 U
9/7/2016	Background	<0.93 U	3.25886 J	35	8	0.601583 J	6	70	4.846	<0.083 U	<0.68 U	0.111	1.68	<0.29 U	<0.99 U	1.09263 J
10/12/2016	Background	<0.93 U	10	50	7	0.589066 J	15	65	17.32	0.8585 J	<0.68 U	0.972	7.285	<0.29 U	1.93488 J	<0.86 U
11/14/2016	Background	<0.93 U	6	37	9	0.78793 J	8	75	3.731	0.7468 J	<0.68 U	0.114	3.624	<0.29 U	<0.99 U	1.078 J
1/11/2017	Background	<0.93 U	6	37	7	0.602157 J	9	69	4.342	<0.083 U	<0.68 U	0.115	7.202	<0.29 U	<0.99 U	0.991051 J
2/28/2017	Background	<0.93 U	4.56273 J	30	5	0.389491 J	5	45	4.001	<0.083 U	<0.68 U	0.095	7.927	<0.29 U	2.53854 J	<0.86 U
4/11/2017	Background	<0.93 U	<1.05 U	26	4	0.440252 J	3	35	4.32	0.4468 J	<0.68 U	0.095	2.755	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	3.05 J	41.25	3.17	0.55 J	5.38	25.8	4.922	<0.083 U	<0.68 U	0.103	6.4	<0.29 U	2.18 J	<0.86 U
8/21/2018	Assessment	0.01 J	4.81	17.2	3.70	0.47	0.646	43.5	6.01	<0.083 U	0.714	0.0689	2.649	0.04 J	15.0	0.238
2/28/2019	Assessment	<0.4 U	2 J	28.9	3.34	0.2 J	2 J	25.0	4.67	0.40	<0.4 U	0.0919	1.135	<8 U	3 J	<2 U
5/21/2019	Assessment	<0.4 U	0.8 J	35.6	2.77	0.3 J	1 J	23.5	5.37	0.31	0.4 J	0.0897	1.371	<8 U	1 J	0.2 J
8/12/2019	Assessment	<0.02 U	3.43	38.5	3.65	0.40	1.7	33.7	5.70	0.67	0.996	0.0964	4.127	<0.4 U	7.3	0.2 J

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
EAST BOTTOM ASH POND
H.W. Pirkey Plant
Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

July 12, 2019

CHA8473

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the East Bottom Ash Pond (EBAP), an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, calcium, chloride, total dissolved solids (TDS), and sulfate at the EBAP. An alternative source was not identified at the time, so two assessment monitoring events were conducted at the EBAP in 2018, in accordance with 40 CFR 257.95. SSLs were identified for cobalt at wells AD-2, AD-31, and AD-32 and for lithium at AD-31 and AD-32. An alternative source demonstration (ASD) was successfully completed for cobalt (Geosyntec, 2019).

A semi-annual assessment monitoring event was also completed in February 2019, with the results of the February 2019 event documented in this report. The groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The February 2019 monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. SSLs were identified for cobalt and lithium. Thus, either the unit will move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, one set of samples was collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(d)(1). Although antimony, fluoride, lead, molybdenum, and thallium were not detected at any locations during the March 2018 screening event, samples from the February 2019 semi-annual sampling event were analyzed for all Appendix III and Appendix IV parameters. A summary of data collected during this assessment monitoring event may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.14 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the EBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained to meet the requirements of 40 CFR 257.95(d)(1) were screened for potential outliers. No outliers were identified.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95%

confidence. Non-parametric tolerance limits were calculated for arsenic, barium, beryllium, cadmium, cobalt, and selenium due to apparent non-normal distributions, for antimony, fluoride, lead, molybdenum, and thallium due to a high non-detect frequency, and for chromium and mercury due to both an apparent non-normal distribution and a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey EBAP:

- LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.0100 mg/L), AD-31 (0.00943 mg/L), and AD-32 (0.0333 mg/L).

- LCLs for lithium exceeded the GWPS of 0.052 mg/L at AD-31 (0.077 mg/L) and AD-32 (0.075 mg/L).

As a result, the Pirkey EBAP will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring

2.2.3 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations. Prediction limits were calculated for the Appendix III parameters to represent background values. As described in the January 2018 *Statistical Analysis Summary* report (Geosyntec, 2018), intrawell tests were used to evaluate potential SSIs for pH, whereas interwell tests were used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS.

Prediction limits for the interwell tests were recalculated using data collected during the February 2019 assessment monitoring event. Three data points (i.e., one sample from three background wells) were added to the background dataset for each interwell test. New data were tested for outliers prior to being added to the background dataset. The updated prediction limits were calculated for a one-of-two retesting procedure, as during detection monitoring. The values of the updated prediction limits were similar to the values of the prediction limits calculated during detection monitoring. The revised interwell prediction limits were used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS.

For the intrawell tests, limited data made it possible to add only one data point (i.e., one sample from each compliance well) to each background dataset. Because one sample result is insufficient to compare against the existing background dataset, the prediction limits were not updated for the intrawell tests at this time. The intrawell prediction limits calculated during detection monitoring were used to evaluate potential SSIs for pH.

Data collected during the February 2019 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.047 mg/L at AD-2 (2.25 mg/L) and AD-32 (0.679 mg/L).
- The calcium concentration exceeded the interwell UPL of 2.94 mg/L at AD-32 (6.62 mg/L).
- Chloride concentrations exceeded the interwell UPL of 9.23 mg/L at AD-2 (31.8 mg/L), AD-31 (18.8 mg/L), and AD-32 (17.5 mg/L).
- The reported pH value exceeded the intrawell UPL of 4.9 SU at AD-31 (5.0 SU).
- Sulfate concentrations exceeded the interwell UPL of 23.0 mg/L at AD-2 (129 mg/L), AD-31 (74.8 mg/L), and AD-32 (121 mg/L).
- TDS concentrations exceeded the interwell UPL of 178 mg/L at AD-2 (384 mg/L) and AD-32 (222 mg/L).

While the prediction limits were calculated assuming a one-of-two testing procedure, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the UPL based on previous results. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey EBAP during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the February 2019 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. SSLs were identified for cobalt and lithium. Appendix III parameters were also evaluated, with exceedances identified for boron, calcium, chloride, pH, sulfate, and TDS.

Based on this evaluation, the Pirkey EBAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – Pirkey Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – East Bottom Ash Pond, H.W. Pirkey Power Plant, Hallsville, Texas. January 3, 2018.

Geosyntec. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, East Bottom Ash Pond. April.

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09-007. March 2009.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - East Bottom Ash Pond

Geosyntec Consultants

Parameter	Unit	AD-2	AD-4	AD-12	AD-18	AD-31	AD-32
		2/28/2019	2/28/2019	2/27/2019	2/28/2019	2/28/2019	2/28/2019
Antimony	µg/L	0.0200 J	0.100 U	2.00 U	2.00 U	2.00 U	2.00 U
Arsenic	µg/L	0.530	0.260	2.00 U	2.00 U	2.00 U	2.00 J
Barium	µg/L	26.1	70.5	22.5	106	33.1	28.9
Beryllium	µg/L	0.500 J	0.900 J	2.00 U	2.00 U	1.00 J	3.34
Boron	mg/L	2.25	0.0210	0.0300 J	0.100 U	0.0300 J	0.679
Cadmium	µg/L	0.0600	0.0100 J	1.00 U	1.00 U	1.00 U	0.200 J
Calcium	mg/L	1.96	1.57	0.400 J	0.490	2.77	6.62
Chloride	mg/L	31.8	3.56	6.08	8.19	18.8	17.5
Chromium	µg/L	0.100 J	0.100 J	4.00 U	4.00 U	4.00 U	2.00 J
Cobalt	µg/L	13.9	6.92	1.37	1.11	9.38	25.0
Combined Radium	pCi/L	1.26	0.818	0.225	0.615	3.16	4.67
Fluoride	mg/L	0.100 J	0.110	0.0900	0.0200 J	0.100 J	0.400
Lead	µg/L	0.355	0.106	2.00 U	0.700 J	2.00 U	2.00 U
Lithium	mg/L	0.0591	0.0513	0.00688	0.0177	0.0864	0.0919
Mercury	mg/L	0.0000270	0.0000250 U	0.0000250 U	0.00000900 J	0.0000100 J	0.00114
Molybdenum	µg/L	2.00 U	2.00 U	40.0 U	40.0 U	40.0 U	40.0 U
Selenium	µg/L	1.50	0.0300 J	4.00 U	4.00 U	4.00 U	3.00 J
Total Dissolved Solids	mg/L	384	192	36.0	84.0	74.0	222
Sulfate	mg/L	129	22.9	3.60	6.10	74.8	121
Thallium	µg/L	0.500 U	0.500 U	10.0 U	10.0 U	10.0 U	10.0 U
pH	SU	3.45	4.90	5.17	5.02	5.00	3.23

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.
J: Estimated value. Parameter was detected in concentrations below the reporting limit.
-: Not sampled

Table 2: Groundwater Protection Standards
Pirkey Plant - East Bottom Ash Pond

Geosyntec Consultants, Inc.

Constituent Name	MCL	CCR Rule-Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.002
Arsenic, Total (mg/L)	0.01		0.011
Barium, Total (mg/L)	2		0.18
Beryllium, Total (mg/L)	0.004		0.0012
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.007
Cobalt, Total (mg/L)	n/a	0.006	0.0094
Combined Radium, Total (pCi/L)	5		3.64
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.052
Mercury, Total (mg/L)	0.002		0.000064
Molybdenum, Total (mg/L)	n/a	0.1	0.002
Selenium, Total (mg/L)	0.05		0.004
Thallium, Total (mg/L)	0.002		0.0019

Notes:
Grey cell indicates calculated UTL is higher than MCL.
MCL = Maximum Contaminant Level
RSL = Regional Screening Level
Calculated UTL (Upper Tolerance Limit) represents site-specific background values.
The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3: Appendix III Data Summary
Pirkey Plant - East Bottom Ash Pond

Geosyntec Consultants, Inc.

Parameter	Units	Description	AD-2	AD-31	AD-32
			2/28/2019	2/27/2019	2/28/2019
Boron	mg/L	Interwell Background Value (UPL)	0.047		
		Detection Monitoring Result	**2.25**	0.030	**0.679**
Calcium	mg/L	Interwell Background Value (UPL)	2.94		
		Detection Monitoring Result	1.96	2.77	**6.62**
Chloride	mg/L	Interwell Background Value (UPL)	9.23		
		Detection Monitoring Result	**31.8**	**18.8**	**17.5**
Fluoride	mg/L	Interwell Background Value (UPL)	1.0		
		Detection Monitoring Result	0.1	0.1	0.4
pH	SU	Intrawell Background Value (UPL)	4.6	4.9	4.5
		Intrawell Background Value (LPL)	3.4	2.7	2.3
		Detection Monitoring Result	3.5	**5.0**	3.2
Sulfate	mg/L	Interwell Background Value (UPL)	23.0		
		Detection Monitoring Result	**129**	**74.8**	**121**
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	178		
		Detection Monitoring Result	**384**	74.0	**222**

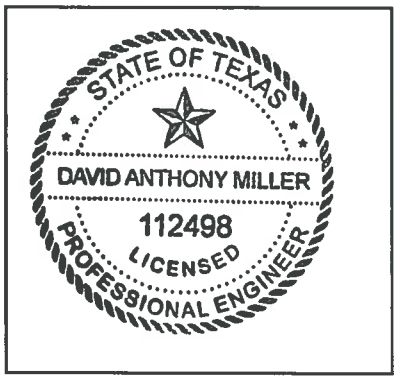
Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.



DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

112498	TEXAS	07.12.19
License Number	Licensing State	Date

ATTACHMENT B
Statistical Analysis Output

GROUNDWATER STATS CONSULTING

July 10, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
150 E. Wilson Bridge Rd., #232
Worthington, OH 43085

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the evaluation of groundwater data from the February 2019 sample event for American Electric Power Company's Pirkey EBAP. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling at each of the wells below began at Pirkey EBAP for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following: upgradient wells AD-4, AD-12, and AD-18; and downgradient wells AD-2, AD-31, and AD-32A.

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and

- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Values in background which have previously been flagged as outliers may be seen in a lighter font and disconnected symbol on the graphs. During the August 2019 event, a value of 0.015 mg/L was reported for selenium at well AD-32. That value was flagged as an outlier during this analysis since the reported value during the February 2019 event was significantly lower (0.003 mg/L) and similar to historical concentrations. A summary of flagged values follows this letter (Figure B).

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 resample plan were constructed for boron, calcium, chloride, fluoride, sulfate and TDS; and intrawell prediction limits combined with a 1-of-2 resample plan were constructed for pH (Figure C and D, respectively). The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data are screened for any newly suspected outliers or obvious trending patterns using time series plots. All values flagged as outliers may be seen on the Outlier Summary report following this letter. No obvious trending patterns were observed in the upgradient wells.

Intrawell prediction limits utilize the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the background data set will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified, and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is

considered a false positive result; therefore, no further action is necessary. Prediction limits exceedances were noted for several of the Appendix III parameters, and the results of those findings may be found in the Prediction Limit Summary tables following this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether data are statistically increasing, decreasing or stable (Figure E). No statistically significant trends were noted, except for statistically significantly increasing trends for boron and sulfate in well AD-2. The Trend Test Summary Table follows this letter.

Evaluation of Appendix IV Parameters

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure F). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure G).

Note that the reporting limit during the February 2019 event for molybdenum at wells AD-12, AD-18, AD-31 and AD-32 was 0.04 mg/L compared to a historical reporting limit of 0.002 mg/L. Wells AD-2 and AD-4, however, had a reporting limit of 0.002 mg/L during this event. A substitution of 0.04 mg/L was used for all nondetects for molybdenum. This value is lower than the CCR Rule level of 0.1 mg/L.

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, CCR-Rule specified levels or ACL as discussed above (Figure H). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. A few confidence intervals exceedances were noted for cobalt and lithium. A summary of the confidence interval results follows this letter.

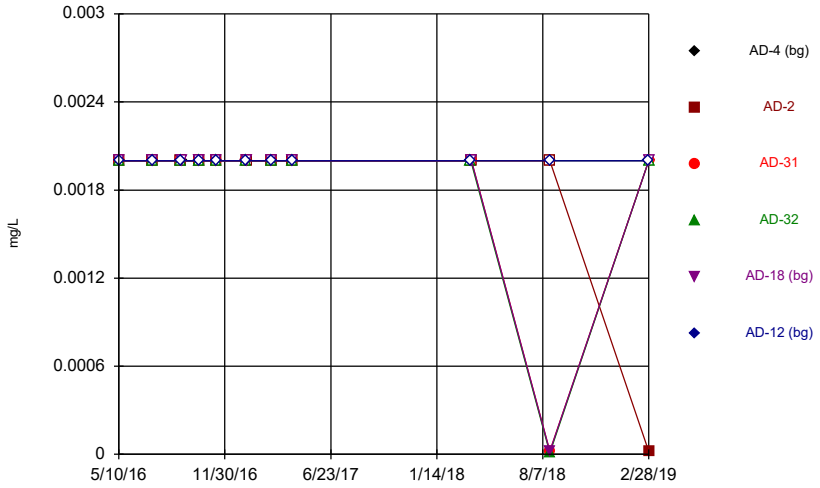
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey EBAP. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

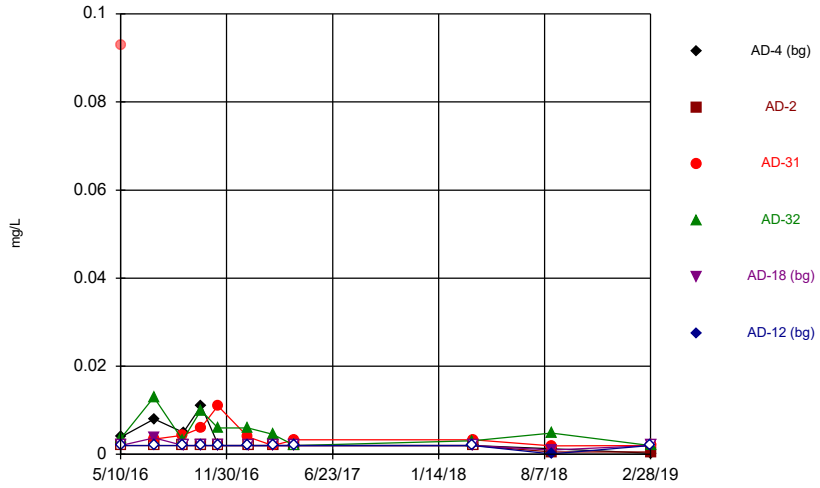
Time Series



Constituent: Antimony, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

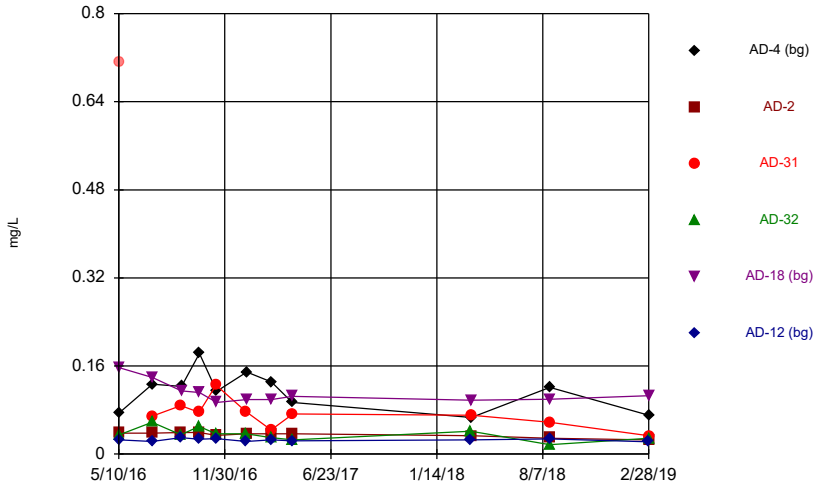
Time Series



Constituent: Arsenic, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

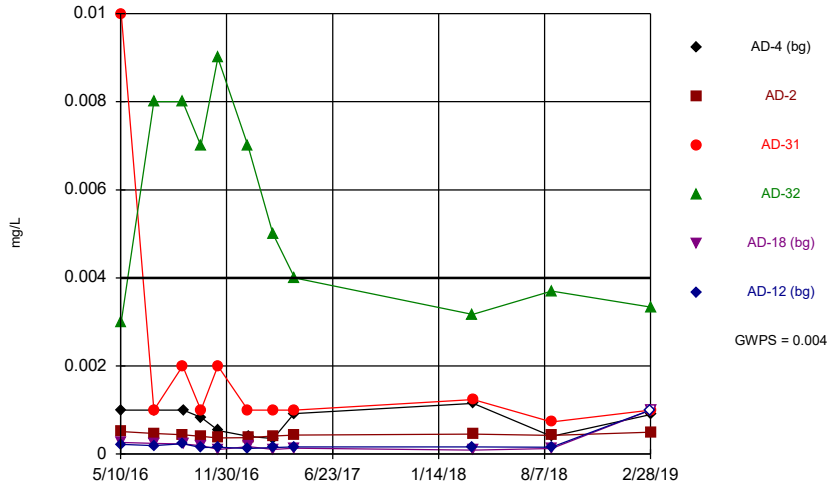
Time Series



Constituent: Barium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

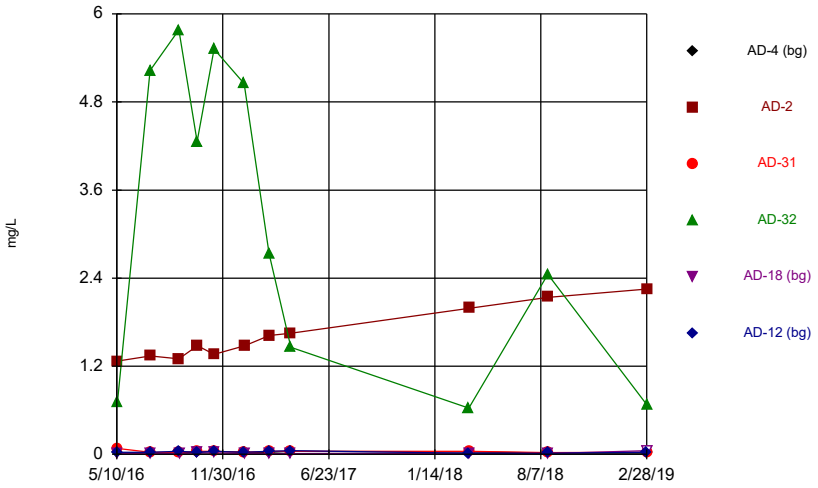
Time Series



Constituent: Beryllium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

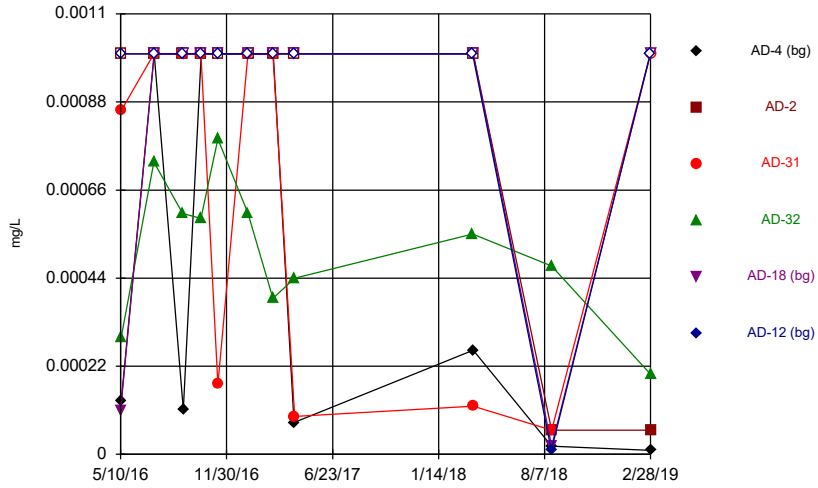
Time Series



Constituent: Boron, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

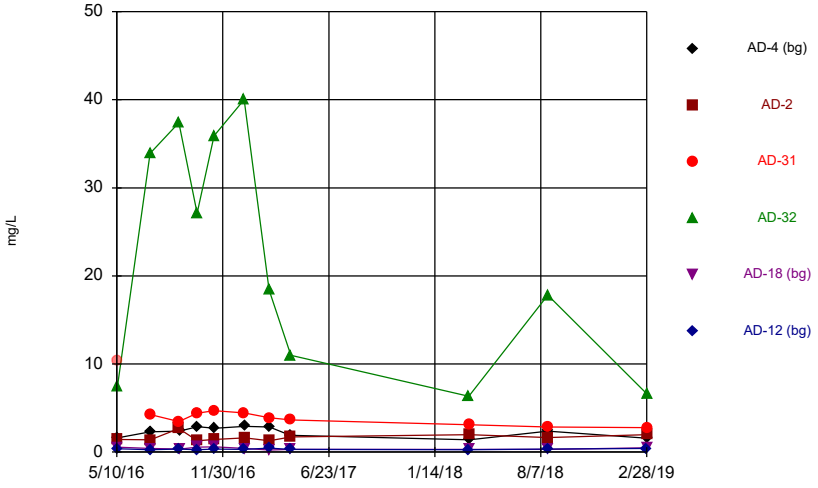
Time Series



Constituent: Cadmium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

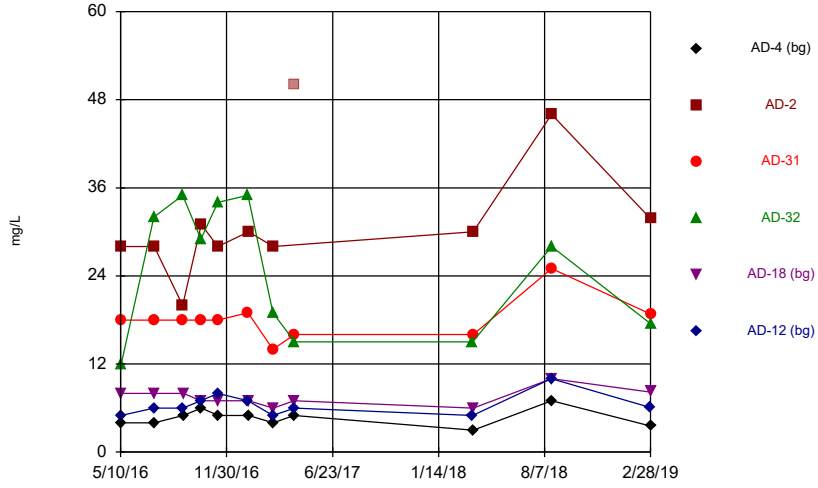
Time Series



Constituent: Calcium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

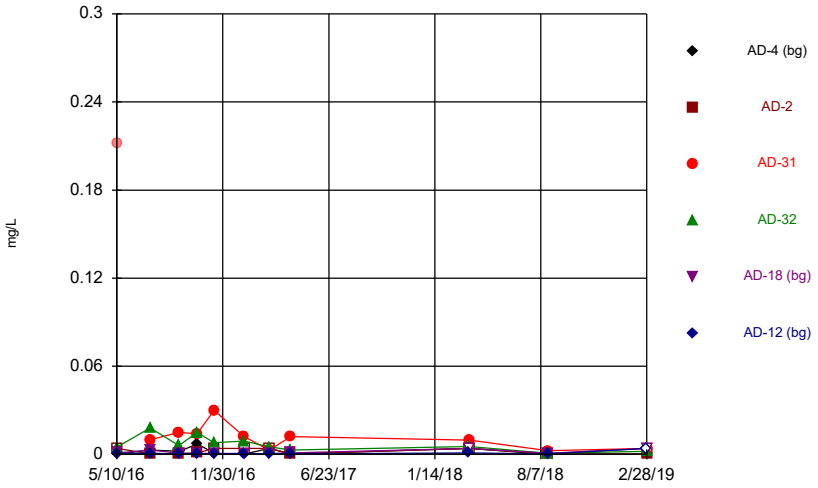
Time Series



Constituent: Chloride, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

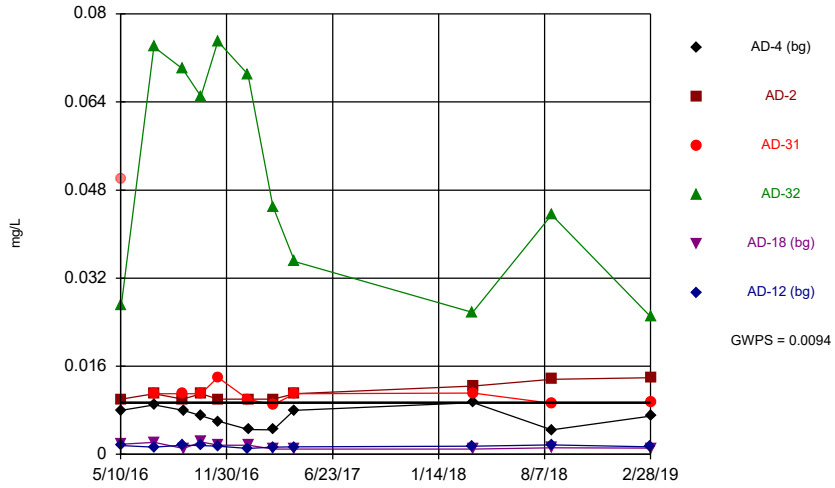
Time Series



Constituent: Chromium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

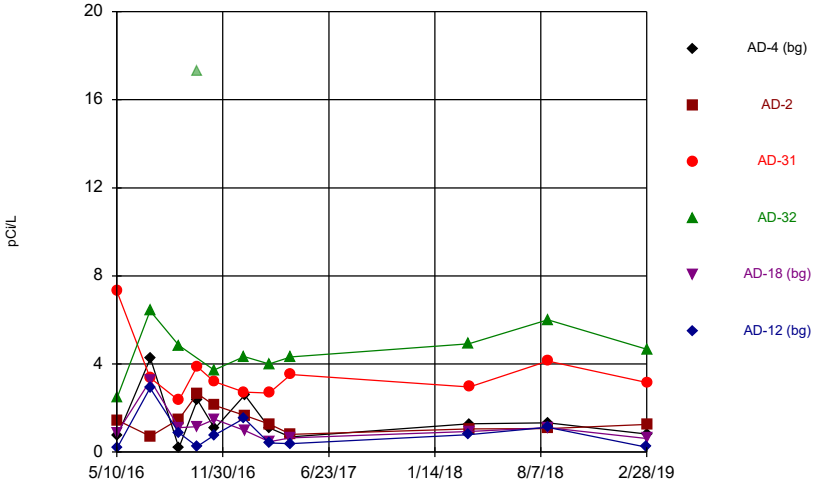
Time Series



Constituent: Cobalt, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

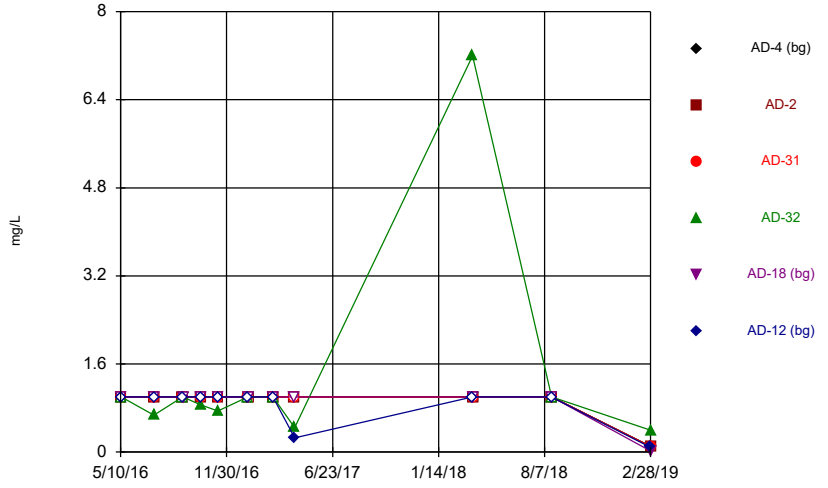
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

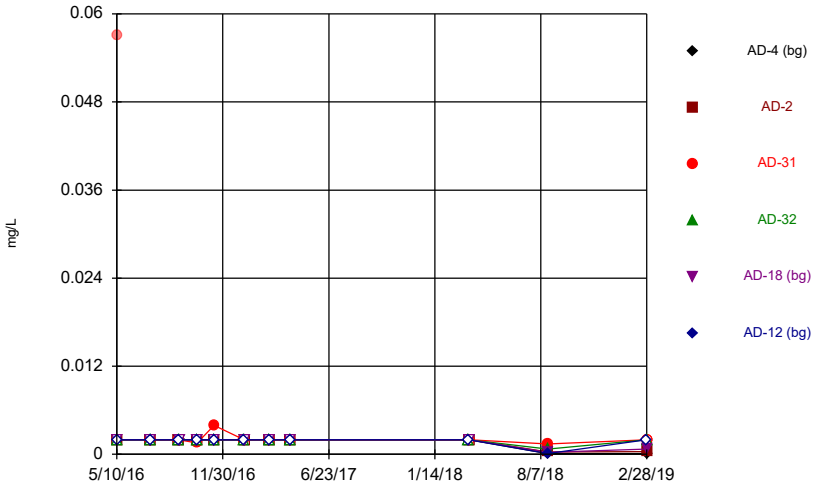
Time Series



Constituent: Fluoride, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

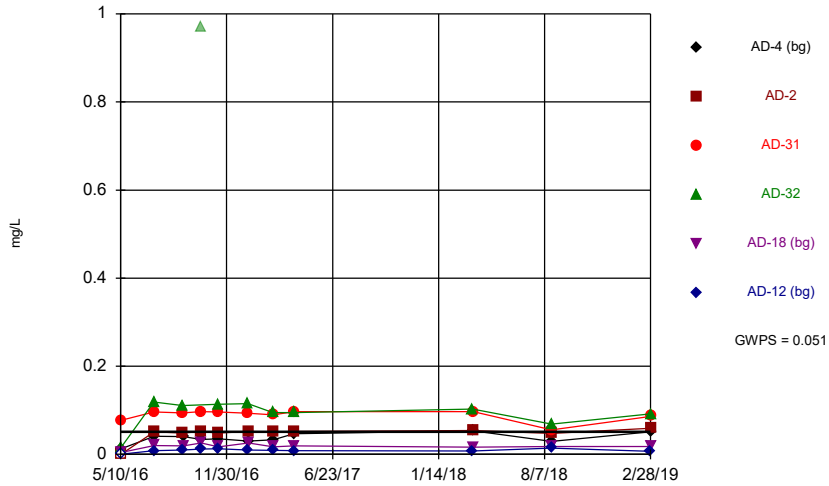
Time Series



Constituent: Lead, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

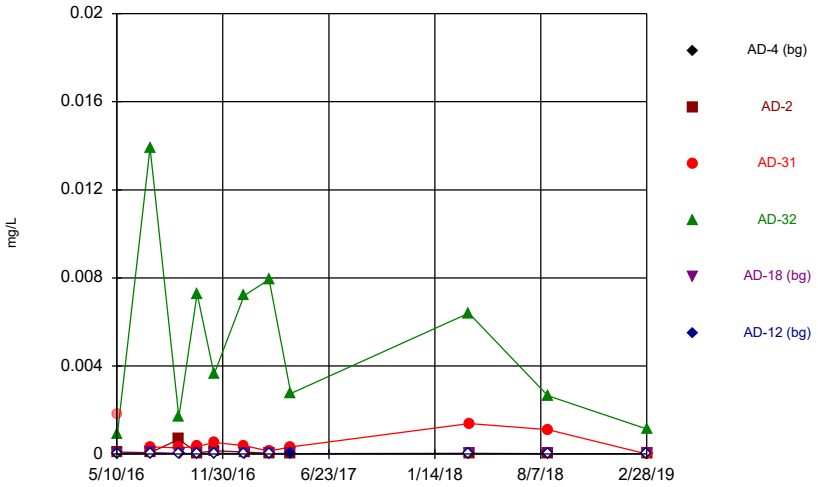
Time Series



Constituent: Lithium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

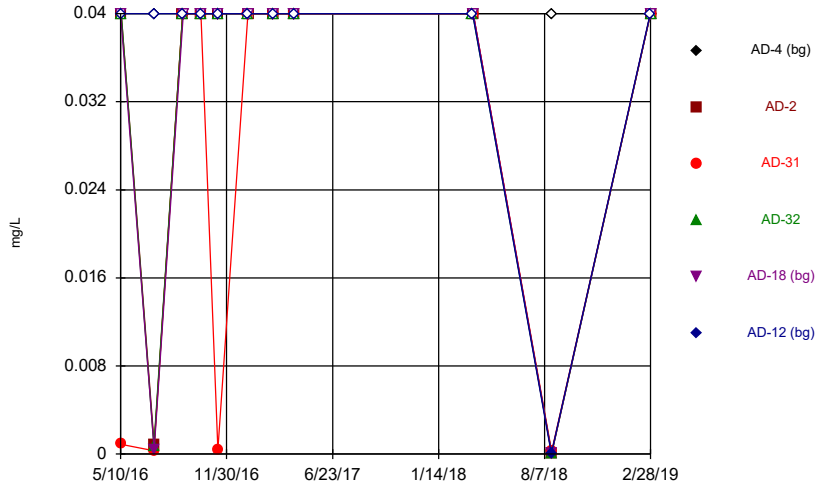
Time Series



Constituent: Mercury, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

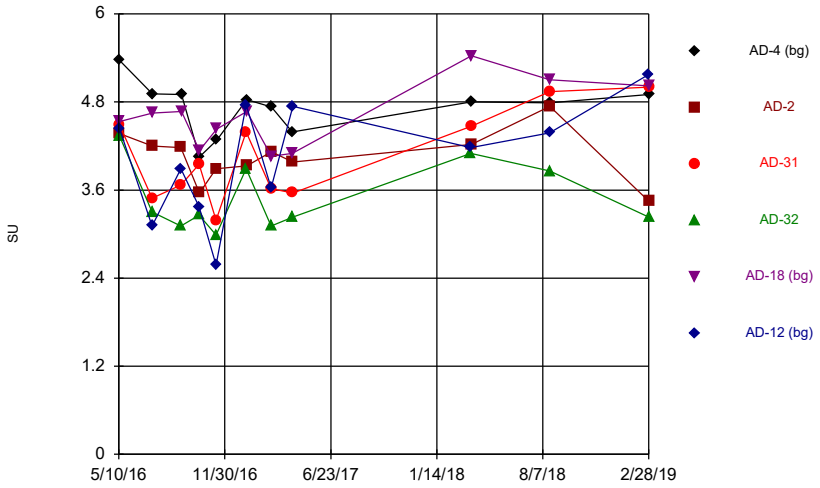
Time Series



Constituent: Molybdenum, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

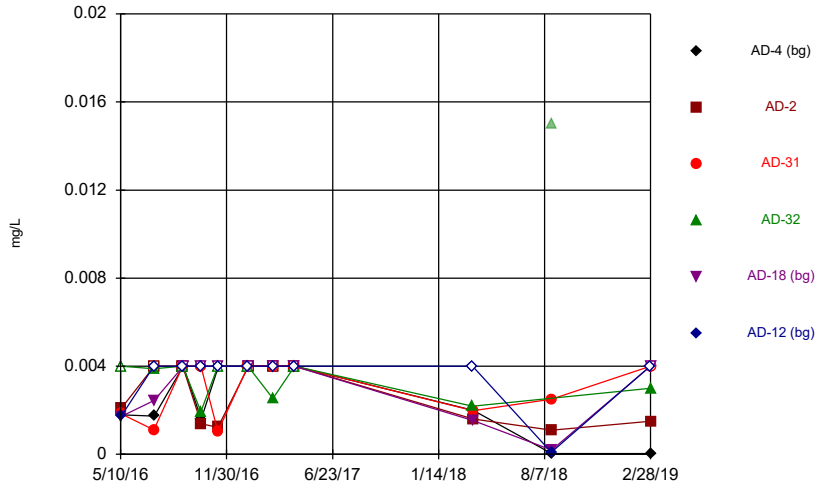
Time Series



Constituent: pH, field Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

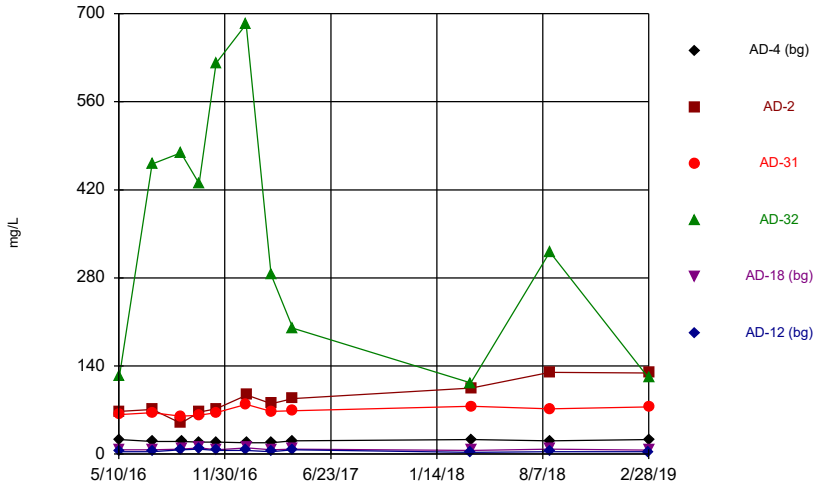
Time Series



Constituent: Selenium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

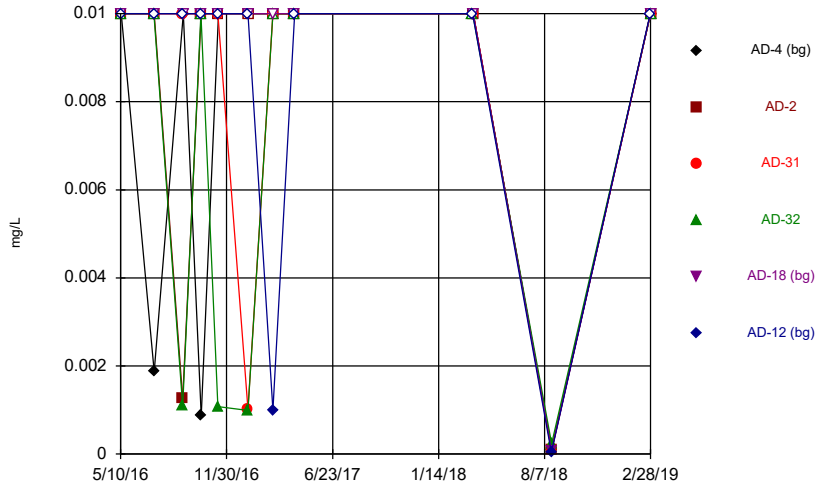
Time Series



Constituent: Sulfate, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

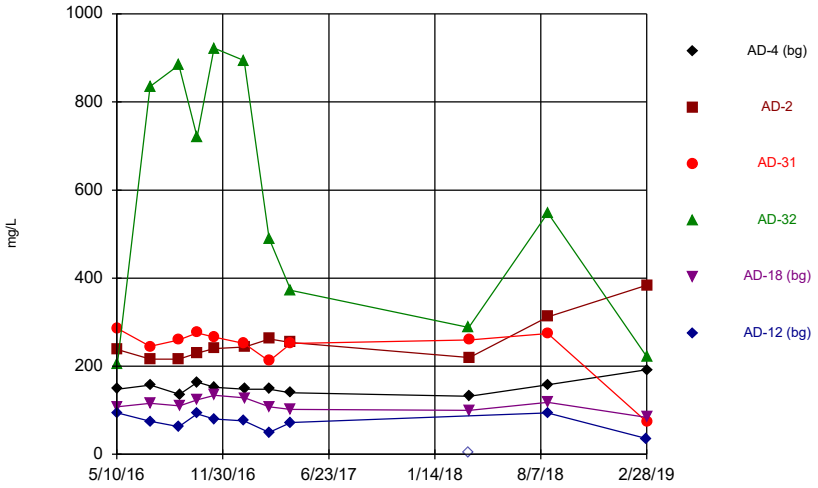
Time Series



Constituent: Thallium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Outlier Summary

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 12:46 PM

	AD-31 Arsenic, total (mg/L)	AD-31 Barium, total (mg/L)	AD-31 Calcium, total (mg/L)	AD-2 Chloride, total (mg/L)	AD-31 Chromium, total (mg/L)	AD-31 Cobalt, total (mg/L)	AD-32 Combined Radium 226 + 228 (pCi/L)	AD-31 Lead, total (mg/L)	AD-32 Lithium, total (mg/L)	AD-31 Mercury, total (mg/L)
5/11/2016	0.093 (o)	0.712 (o)	10.4 (o)		0.212 (o)	0.05 (o)		0.057 (o)		0.001797 (o)
10/12/2016							17.32 (o)		0.972 (o)	
4/11/2017				50 (o)						
3/21/2018										
8/21/2018										

	AD-32 Selenium, total (mg/L)	AD-12 Total Dissolved Solids [TDS] (mg/L)
5/11/2016		
10/12/2016		
4/11/2017		
3/21/2018		<5 (o)
8/21/2018	0.015 (o)	

Interwell Prediction Limit Summary - Significant Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 12:37 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-2**	**0.04655**	**n/a**	**2/28/2019**	**2.25**	**Yes**	**33**	**0.0252**	**0.012**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-32**	**0.04655**	**n/a**	**2/28/2019**	**0.679**	**Yes**	**33**	**0.0252**	**0.012**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Calcium, total (mg/L)	**AD-32**	**2.94**	**n/a**	**2/28/2019**	**6.62**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Chloride, total (mg/L)	**AD-2**	**9.23**	**n/a**	**2/28/2019**	**31.8**	**Yes**	**33**	**6.207**	**1.699**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-31**	**9.23**	**n/a**	**2/28/2019**	**18.8**	**Yes**	**33**	**6.207**	**1.699**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-32**	**9.23**	**n/a**	**2/28/2019**	**17.5**	**Yes**	**33**	**6.207**	**1.699**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Sulfate, total (mg/L)	**AD-2**	**23**	**n/a**	**2/28/2019**	**129**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Sulfate, total (mg/L)	**AD-31**	**23**	**n/a**	**2/28/2019**	**74.8**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Sulfate, total (mg/L)	**AD-32**	**23**	**n/a**	**2/28/2019**	**121**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Total Dissolved Solids [TDS] (mg/L)	**AD-2**	**178.4**	**n/a**	**2/28/2019**	**384**	**Yes**	**32**	**113.7**	**36.26**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Total Dissolved Solids [TDS] (mg/L)	**AD-32**	**178.4**	**n/a**	**2/28/2019**	**222**	**Yes**	**32**	**113.7**	**36.26**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**

Interwell Prediction Limit Summary - All Results

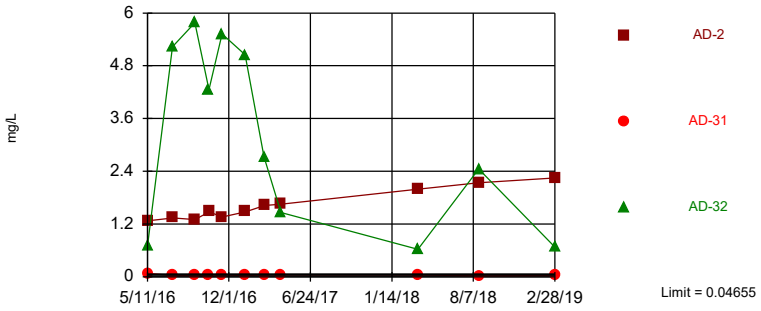
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 12:37 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-2**	**0.04655**	**n/a**	**2/28/2019**	**2.25**	**Yes**	**33**	**0.0252**	**0.012**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	AD-31	0.04655	n/a	2/28/2019	0.03	No	33	0.0252	0.012	3.03	None	No	0.002505	Param Inter 1 of 2
Boron, total (mg/L)	**AD-32**	**0.04655**	**n/a**	**2/28/2019**	**0.679**	**Yes**	**33**	**0.0252**	**0.012**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Calcium, total (mg/L)	AD-2	2.94	n/a	2/28/2019	1.96	No	33	n/a	n/a	0	n/a	n/a	0.001673	NP Inter (normality) 1 of 2
Calcium, total (mg/L)	AD-31	2.94	n/a	2/28/2019	2.77	No	33	n/a	n/a	0	n/a	n/a	0.001673	NP Inter (normality) 1 of 2
Calcium, total (mg/L)	**AD-32**	**2.94**	**n/a**	**2/28/2019**	**6.62**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Chloride, total (mg/L)	**AD-2**	**9.23**	**n/a**	**2/28/2019**	**31.8**	**Yes**	**33**	**6.207**	**1.699**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-31**	**9.23**	**n/a**	**2/28/2019**	**18.8**	**Yes**	**33**	**6.207**	**1.699**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-32**	**9.23**	**n/a**	**2/28/2019**	**17.5**	**Yes**	**33**	**6.207**	**1.699**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Fluoride, total (mg/L)	AD-2	1	n/a	2/28/2019	0.1	No	33	n/a	n/a	87.88	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-31	1	n/a	2/28/2019	0.1	No	33	n/a	n/a	87.88	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-32	1	n/a	2/28/2019	0.4	No	33	n/a	n/a	87.88	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
Sulfate, total (mg/L)	**AD-2**	**23**	**n/a**	**2/28/2019**	**129**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Sulfate, total (mg/L)	**AD-31**	**23**	**n/a**	**2/28/2019**	**74.8**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Sulfate, total (mg/L)	**AD-32**	**23**	**n/a**	**2/28/2019**	**121**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Total Dissolved Solids [TDS] (mg/L)	**AD-2**	**178.4**	**n/a**	**2/28/2019**	**384**	**Yes**	**32**	**113.7**	**36.26**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Total Dissolved Solids [TDS] (mg/L)	AD-31	178.4	n/a	2/28/2019	74	No	32	113.7	36.26	0	None	No	0.002505	Param Inter 1 of 2
Total Dissolved Solids [TDS] (mg/L)	**AD-32**	**178.4**	**n/a**	**2/28/2019**	**222**	**Yes**	**32**	**113.7**	**36.26**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**

Exceeds Limit: AD-2, AD-32

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=0.0252, Std. Dev.=0.012, n=33, 3.03% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9111, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

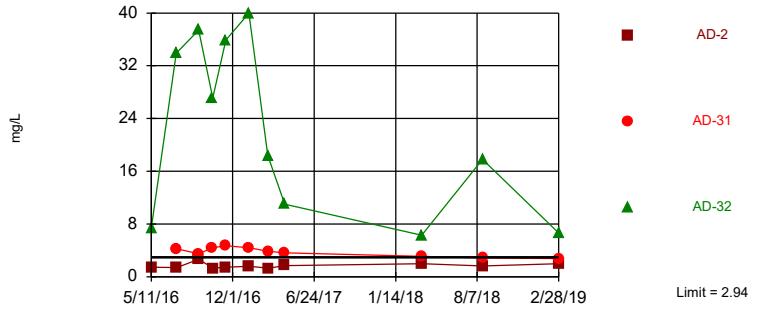
Constituent: Boron, total Analysis Run 7/5/2019 12:28 PM View: PL's Interwell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-32

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 33 background values. Annual per-constituent alpha = 0.009997. Individual comparison alpha = 0.001673 (1 of 2). Comparing 3 points to limit.

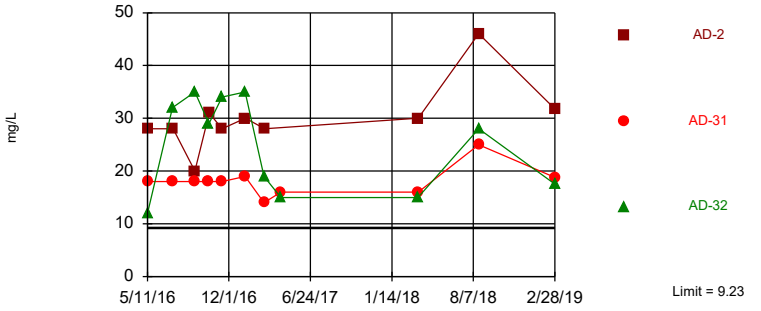
Constituent: Calcium, total Analysis Run 7/5/2019 12:28 PM View: PL's Interwell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-2, AD-31, AD-32

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=6.207, Std. Dev.=1.699, n=33. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9559, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

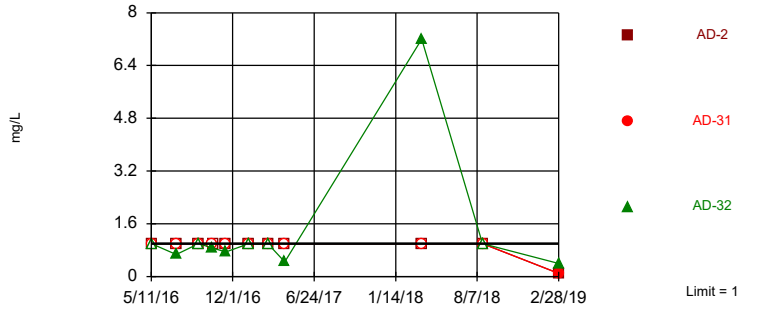
Constituent: Chloride, total Analysis Run 7/5/2019 12:28 PM View: PL's Interwell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Interwell Non-parametric



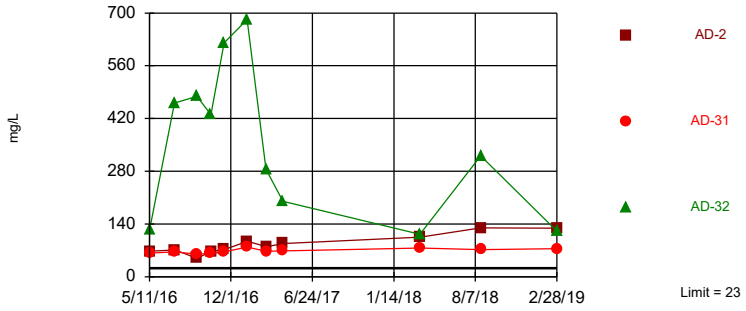
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 33 background values. 87.88% NDs. Annual per-constituent alpha = 0.009997. Individual comparison alpha = 0.001673 (1 of 2). Comparing 3 points to limit.

Constituent: Fluoride, total Analysis Run 7/5/2019 12:28 PM View: PL's Interwell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Exceeds Limit: AD-2, AD-31, AD-32

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 33 background values. Annual per-constituent alpha = 0.009997. Individual comparison alpha = 0.001673 (1 of 2). Comparing 3 points to limit.

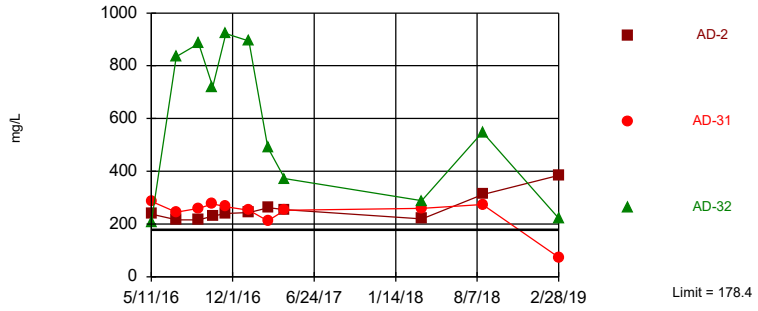
Constituent: Sulfate, total Analysis Run 7/5/2019 12:28 PM View: PL's Interwell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-2, AD-32

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=113.7, Std. Dev.=36.26, n=32. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9872, critical = 0.904. Kappa = 1.784 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 12:28 PM View: PL's Interwell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Intrawell Prediction Limit Summary - Significant Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 12:39 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH, field (SU)	**AD-31**	**4.903**	**2.687**	**2/28/2019**	**5**	**Yes**	**8**	**3.795**	**0.4507**	**0**	**None**	**No**	**0.001253**	Param 1 of 2

Intrawell Prediction Limit Summary - All Results

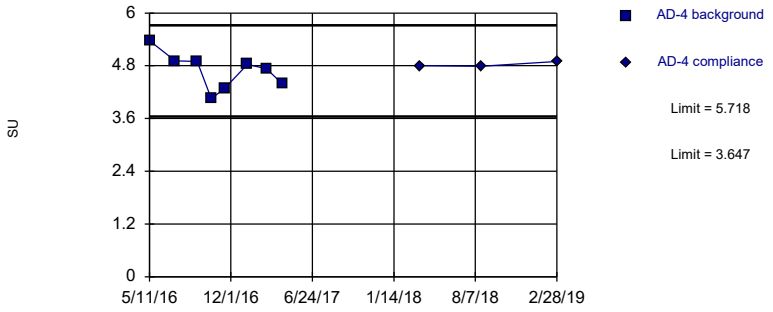
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 12:39 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH, field (SU)	AD-4	5.718	3.647	2/28/2019	4.9	No	8	4.683	0.4215	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-2	4.637	3.421	2/28/2019	3.45	No	8	4.029	0.2473	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	**AD-31**	**4.903**	**2.687**	**2/28/2019**	**5**	**Yes**	**8**	**3.795**	**0.4507**	**0**	**None**	**No**	**0.001253**	Param 1 of 2
pH, field (SU)	AD-32	4.549	2.259	2/28/2019	3.23	No	8	3.404	0.4657	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-18	5.063	3.75	2/28/2019	5.02	No	8	4.406	0.267	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-12	5.764	1.866	2/27/2019	5.17	No	8	3.815	0.7928	0	None	No	0.001253	Param 1 of 2

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.683, Std. Dev.=0.4215, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9603, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell

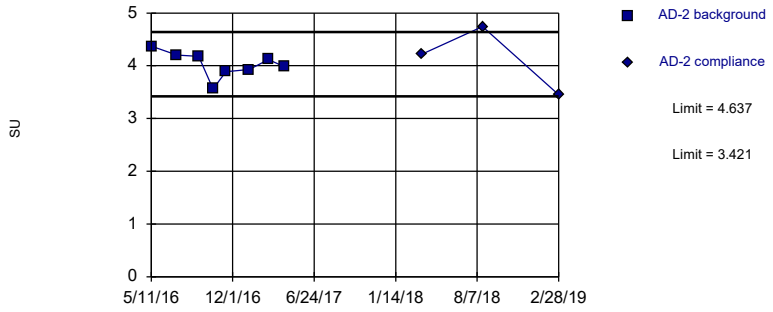
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.029, Std. Dev.=0.2473, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.956, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell

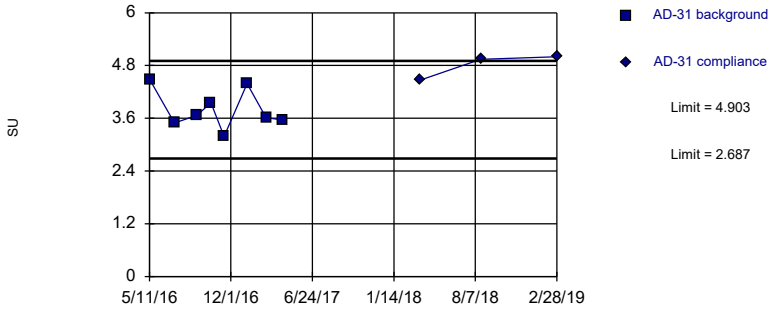
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.795, Std. Dev.=0.4507, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9179, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell

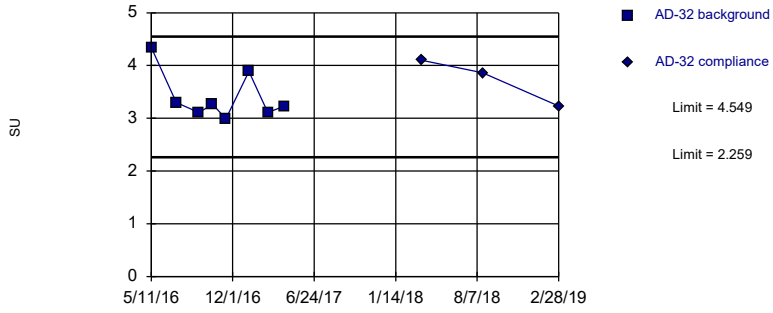
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.404, Std. Dev.=0.4657, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7949, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

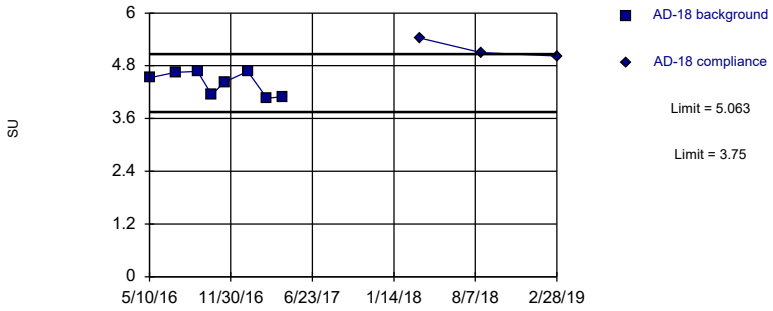
Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.406, Std. Dev.=0.267, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8312, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell

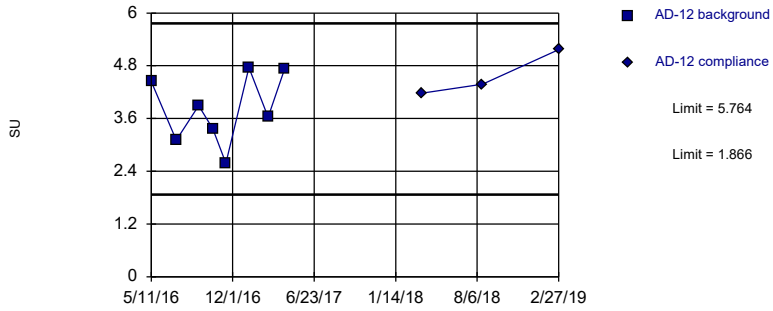
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.815, Std. Dev.=0.7928, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Trend Test Summary Table - Significant Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 1:08 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	**AD-2**	**0.3802**	**50**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Sulfate, total (mg/L)	**AD-2**	**25.54**	**41**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**

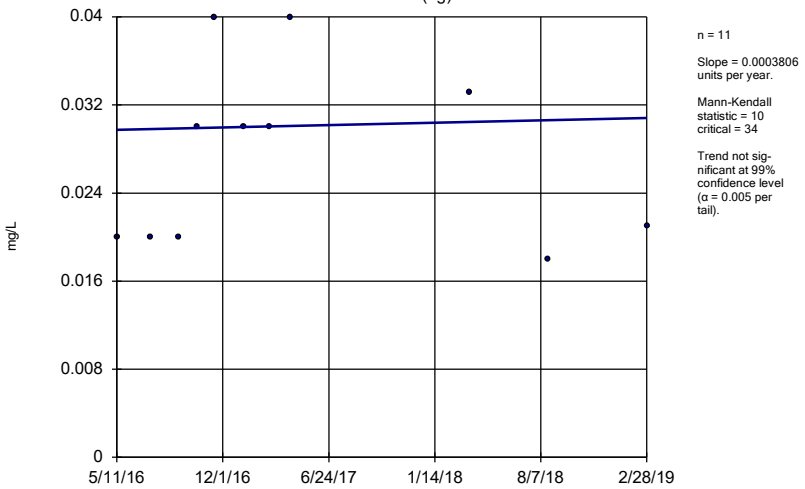
Trend Test Summary Table - All Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 1:08 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-4 (bg)	0.0003806	10	34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	**AD-2**	**0.3802**	**50**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Boron, total (mg/L)	AD-32	-1.705	-25	-34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-18 (bg)	0.0008764	17	34	No	11	9.091	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0	-4	-34	No	11	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-4 (bg)	-0.1181	-5	-34	No	11	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-32	-8.602	-19	-34	No	11	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-18 (bg)	-0.04371	-13	-34	No	11	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-12 (bg)	0.01357	5	34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-4 (bg)	0	-2	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-2	1.659	22	30	No	10	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-31	0	4	34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-32	-3.583	-11	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-18 (bg)	0	-7	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.03234	10	34	No	11	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-4 (bg)	-0.05639	-10	-34	No	11	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-31	0.441	19	34	No	11	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-18 (bg)	0.1747	12	34	No	11	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-12 (bg)	0.5174	19	34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-4 (bg)	0	4	34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	**AD-2**	**25.54**	**41**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Sulfate, total (mg/L)	AD-31	5.856	32	34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-32	-92.31	-15	-34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-18 (bg)	0	-7	-34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.5376	-15	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-4 (bg)	0	2	34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-2	48.67	34	34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-32	-176.2	-15	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-18 (bg)	-7.565	-16	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-18.79	-14	-30	No	10	0	n/a	n/a	0.01	NP

Sen's Slope Estimator

AD-4 (bg)



n = 11

Slope = 0.0003806 units per year.

Mann-Kendall statistic = 10 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

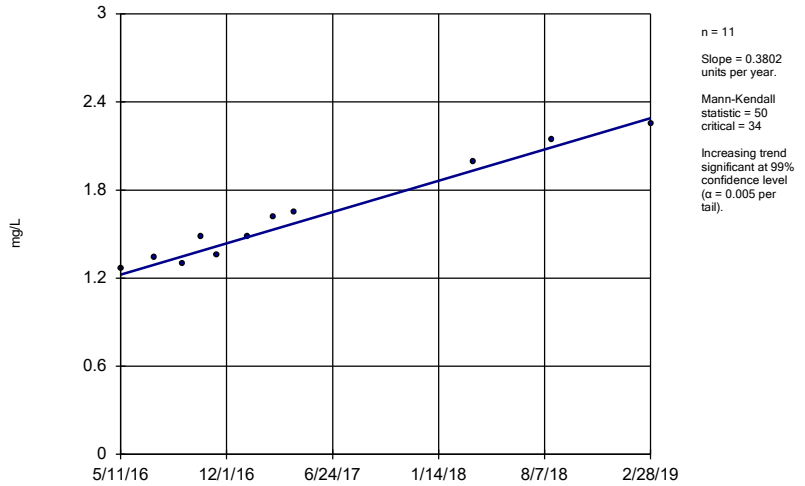
Constituent: Boron, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-2



n = 11

Slope = 0.3802 units per year.

Mann-Kendall statistic = 50 critical = 34

Increasing trend significant at 99% confidence level (α = 0.005 per tail).

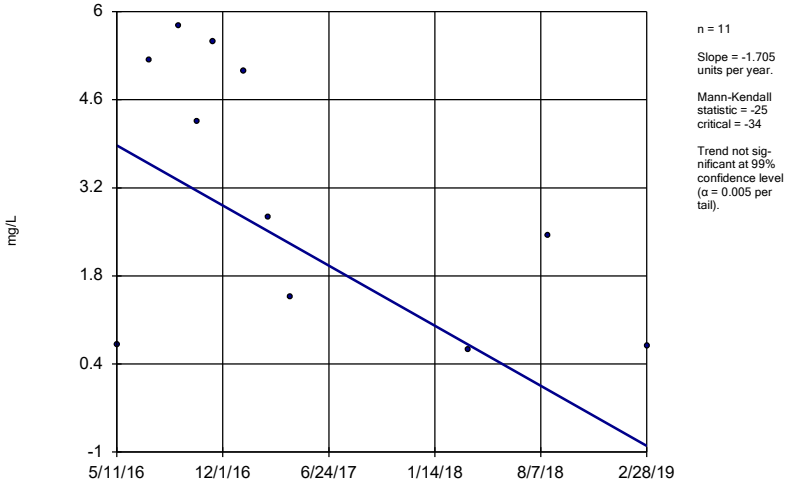
Constituent: Boron, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-32



n = 11

Slope = -1.705 units per year.

Mann-Kendall statistic = -25 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests

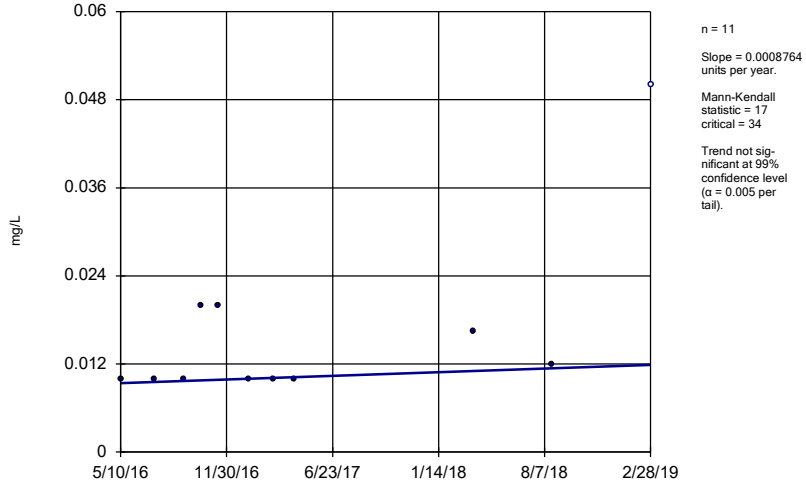
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = 0.0008764 units per year.

Mann-Kendall statistic = 17 critical = 34

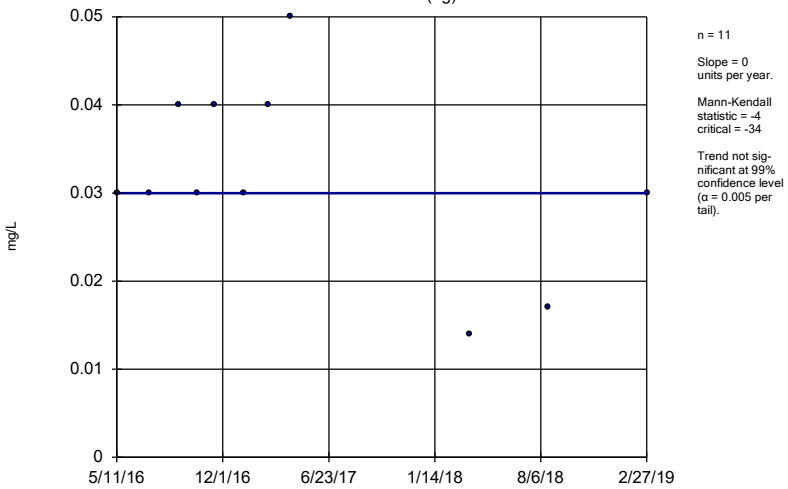
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -4 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

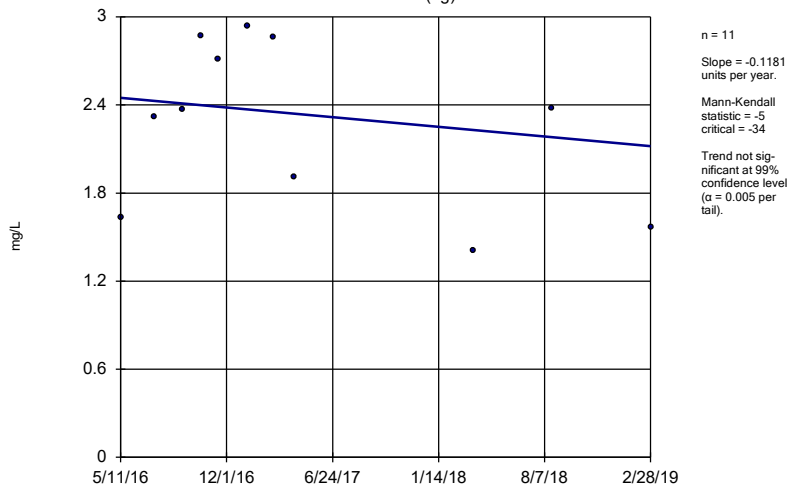
Constituent: Boron, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-4 (bg)



n = 11

Slope = -0.1181 units per year.

Mann-Kendall statistic = -5 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

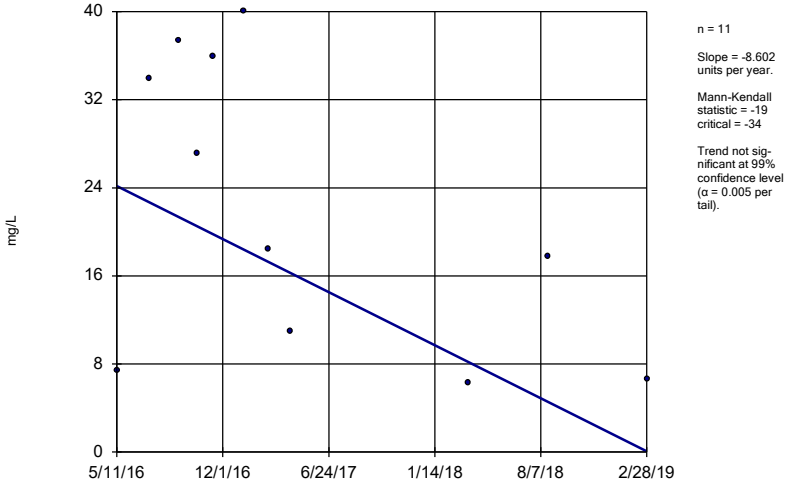
Constituent: Calcium, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-32



n = 11

Slope = -8.602 units per year.

Mann-Kendall statistic = -19 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

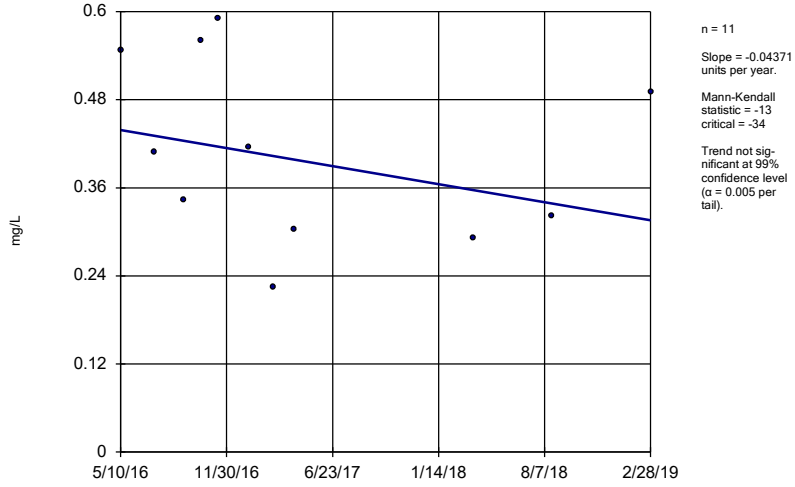
Constituent: Calcium, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = -0.04371 units per year.

Mann-Kendall statistic = -13 critical = -34

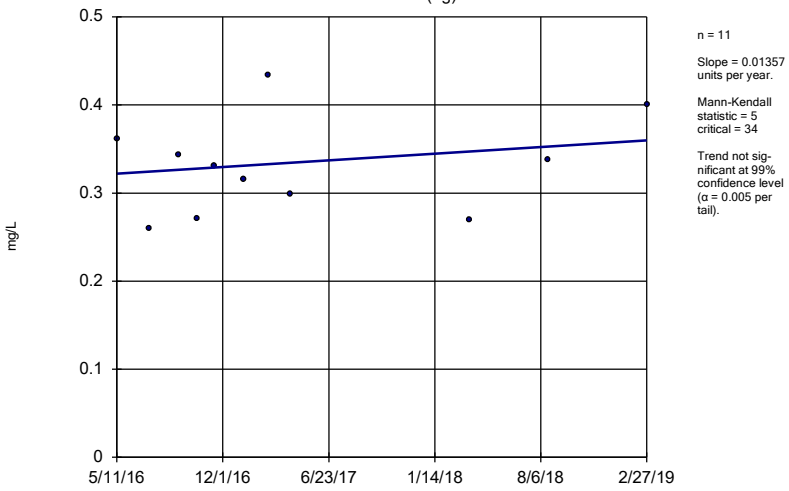
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Calcium, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.01357 units per year.

Mann-Kendall statistic = 5 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

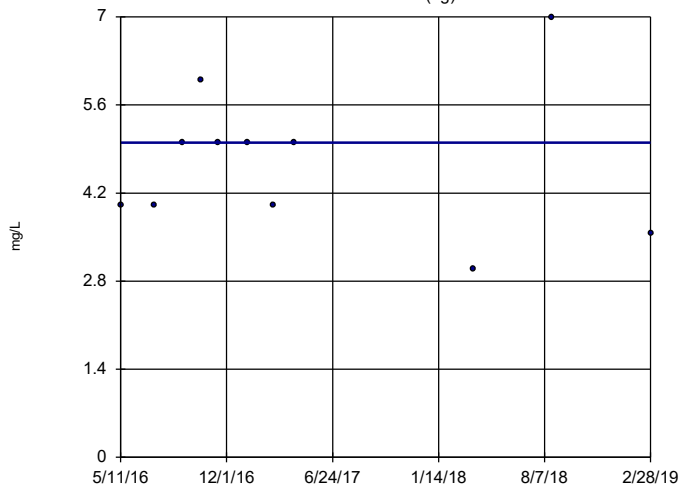
Constituent: Calcium, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-4 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -2 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

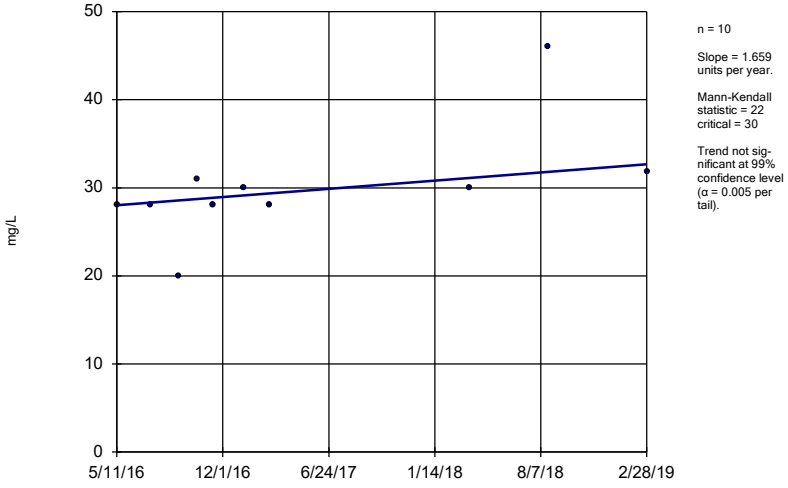
Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-2



n = 10

Slope = 1.659 units per year.

Mann-Kendall statistic = 22 critical = 30

Trend not significant at 99% confidence level (α = 0.005 per tail).

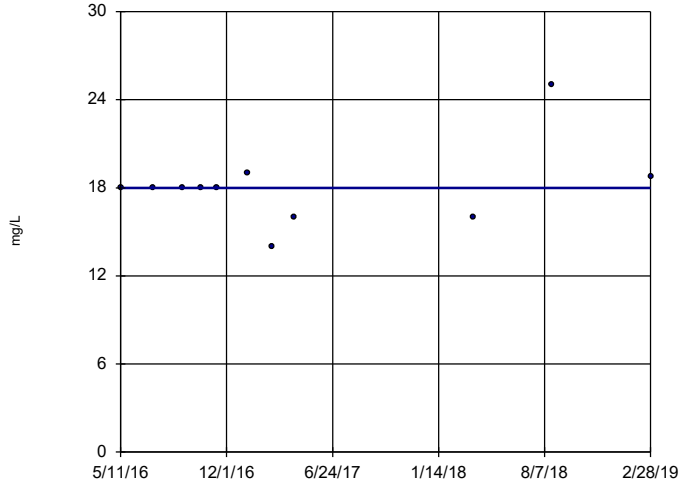
Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-31



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = 4 critical = 34

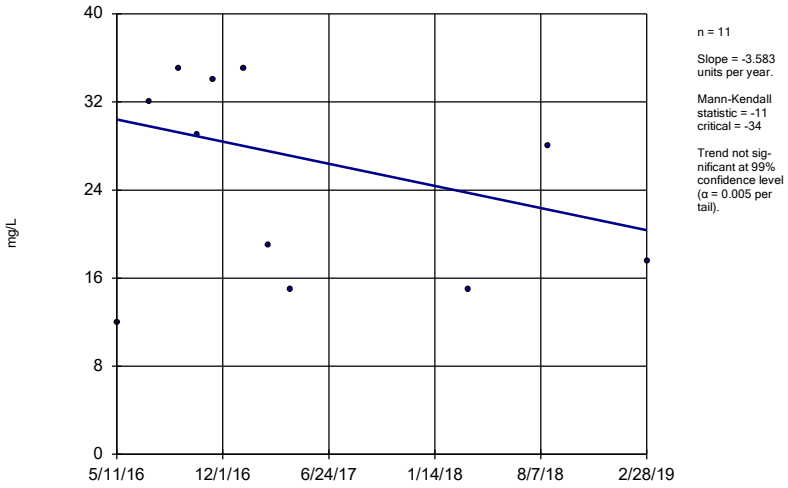
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-32



n = 11

Slope = -3.583 units per year.

Mann-Kendall statistic = -11 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

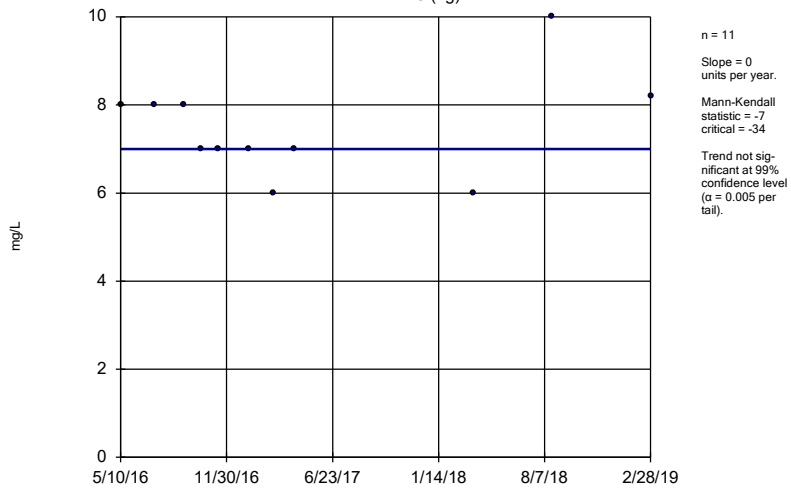
Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -7 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

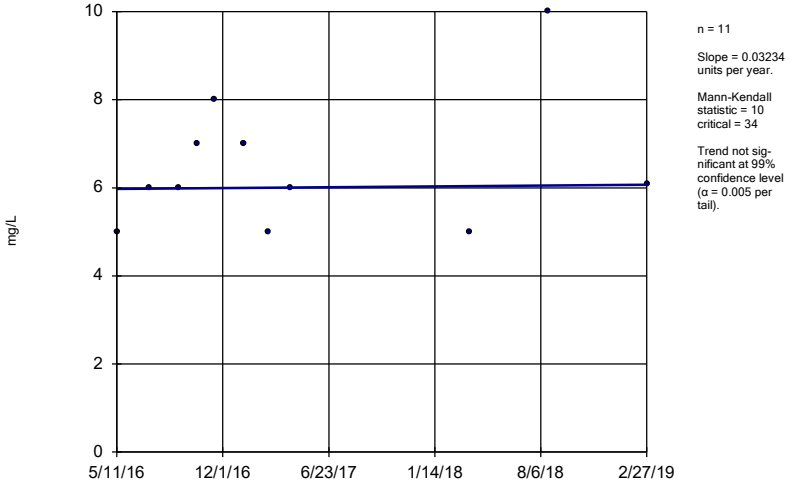
Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.03234 units per year.

Mann-Kendall statistic = 10 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

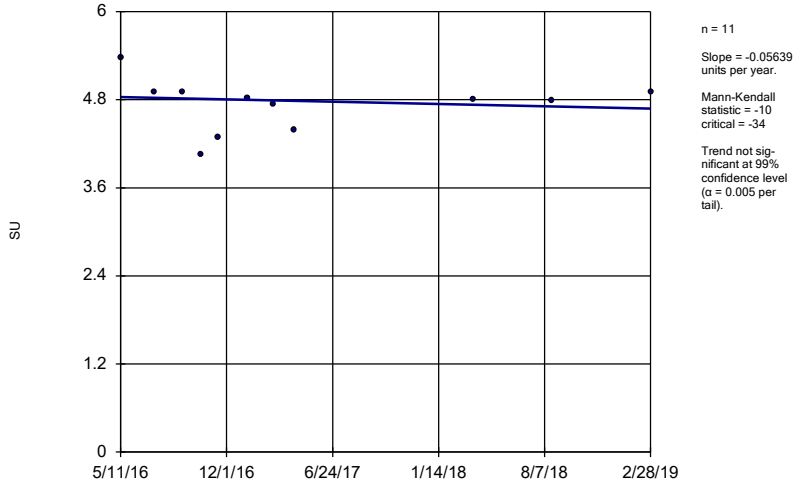
Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-4 (bg)



n = 11

Slope = -0.05639 units per year.

Mann-Kendall statistic = -10 critical = -34

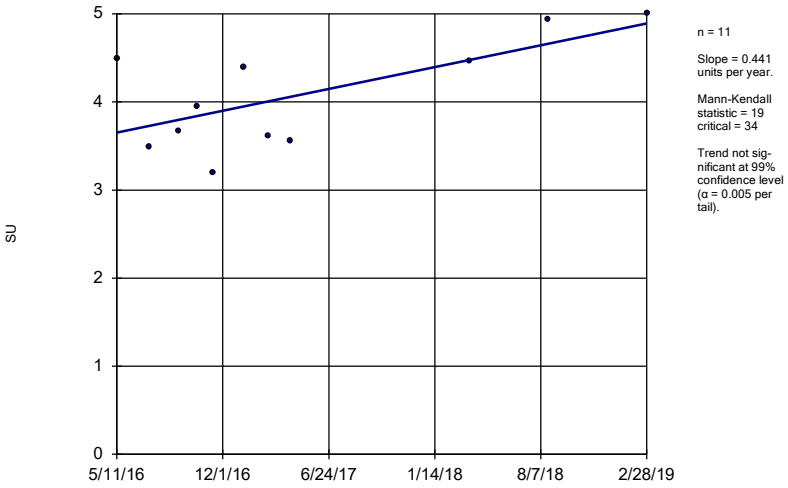
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-31



n = 11

Slope = 0.441 units per year.

Mann-Kendall statistic = 19 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

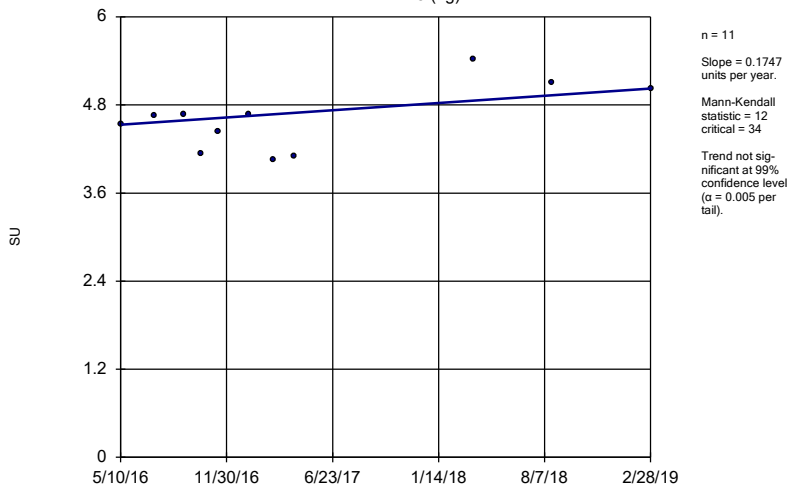
Constituent: pH, field Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = 0.1747 units per year.

Mann-Kendall statistic = 12 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

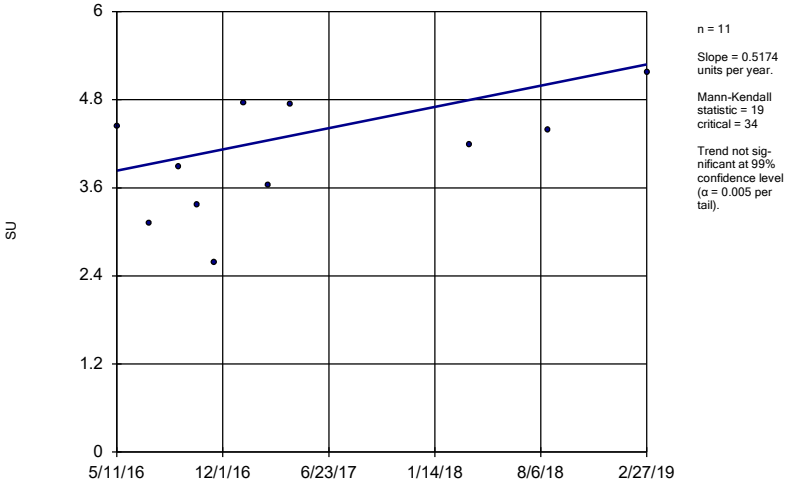
Constituent: pH, field Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.5174 units per year.

Mann-Kendall statistic = 19 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

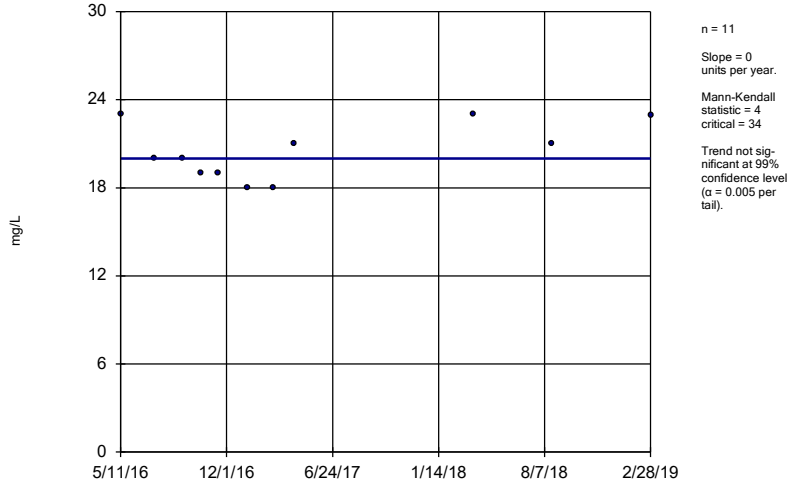
Constituent: pH, field Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-4 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = 4 critical = 34

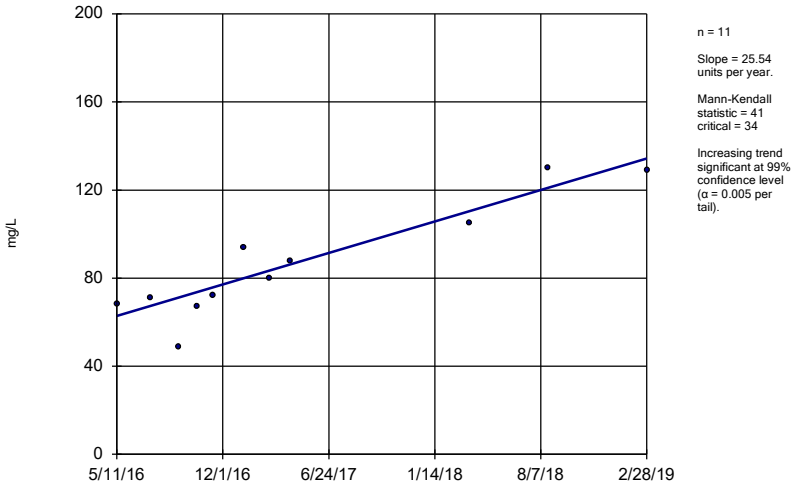
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-2



n = 11

Slope = 25.54 units per year.

Mann-Kendall statistic = 41 critical = 34

Increasing trend significant at 99% confidence level (α = 0.005 per tail).

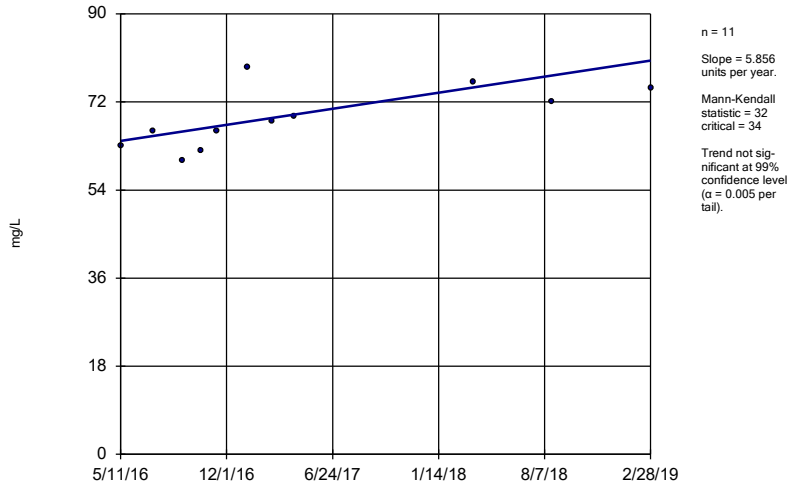
Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-31



n = 11

Slope = 5.856 units per year.

Mann-Kendall statistic = 32 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

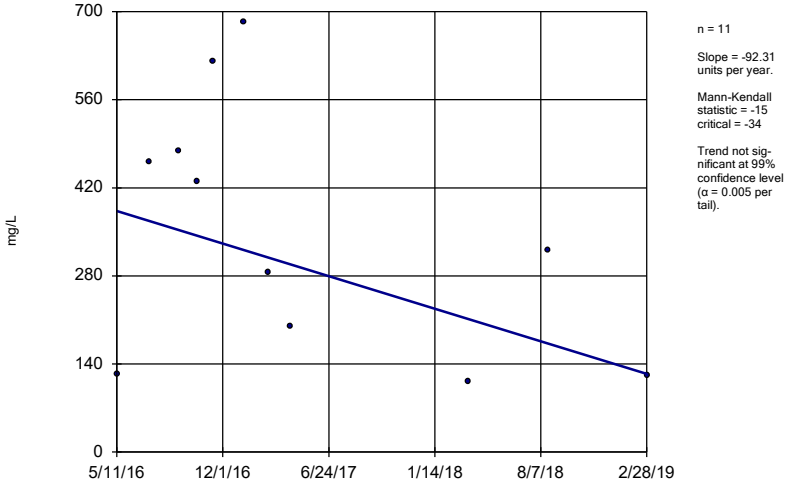
Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-32



n = 11

Slope = -92.31 units per year.

Mann-Kendall statistic = -15 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

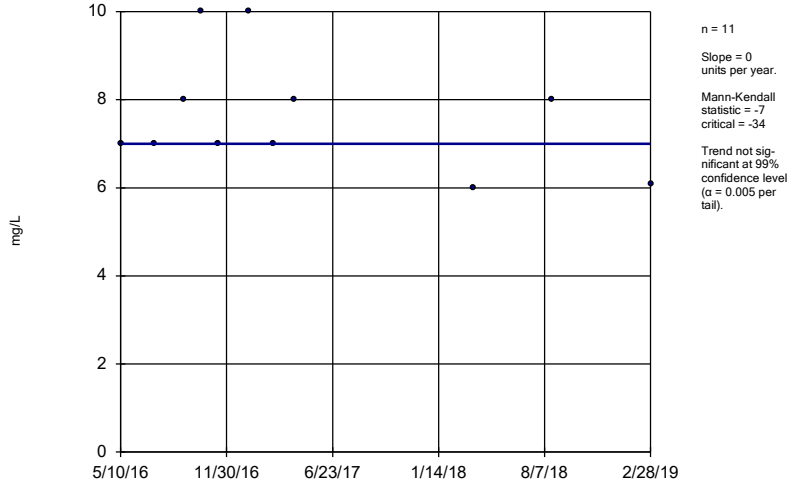
Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -7 critical = -34

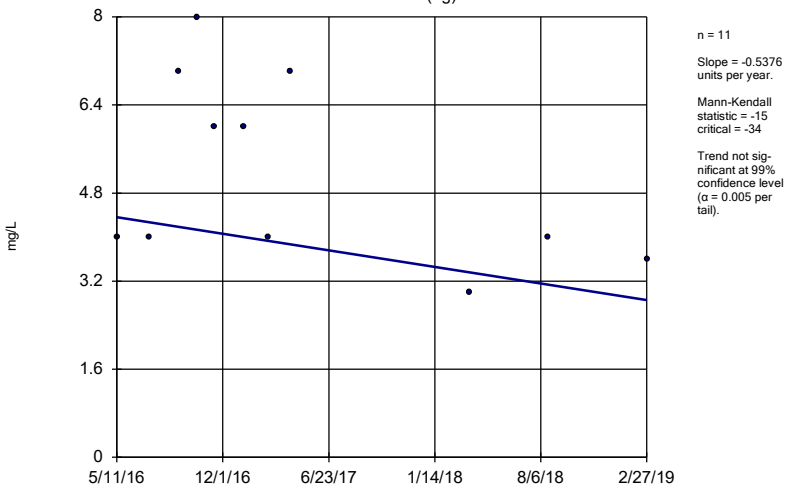
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = -0.5376 units per year.

Mann-Kendall statistic = -15 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

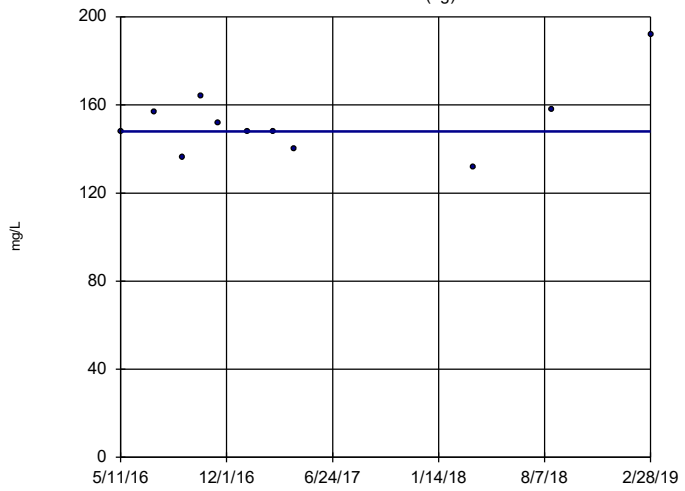
Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-4 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = 2 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

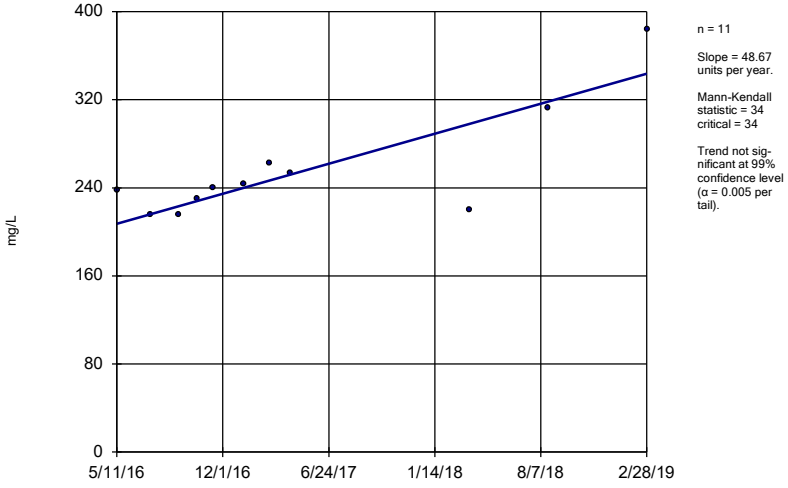
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-2



n = 11

Slope = 48.67 units per year.

Mann-Kendall statistic = 34 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

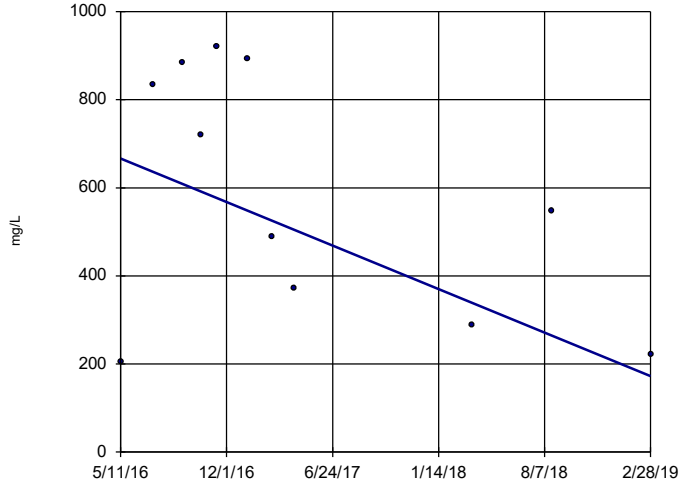
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-32



n = 11

Slope = -176.2 units per year.

Mann-Kendall statistic = -15 critical = -34

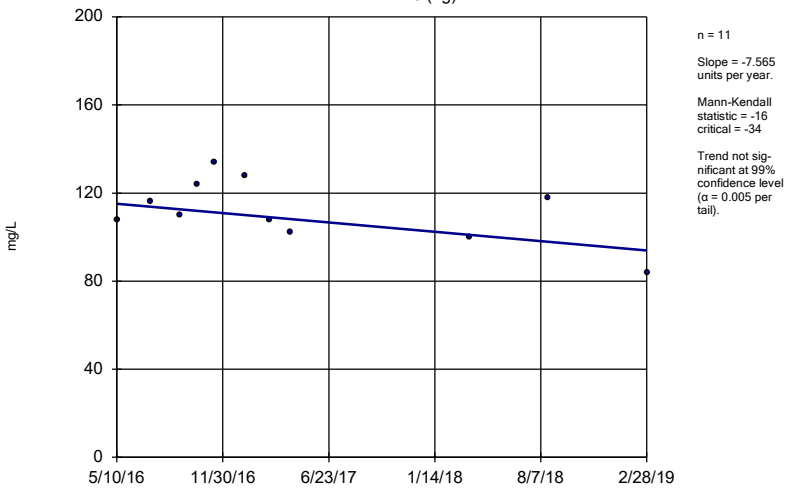
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = -7.565 units per year.

Mann-Kendall statistic = -16
critical = -34

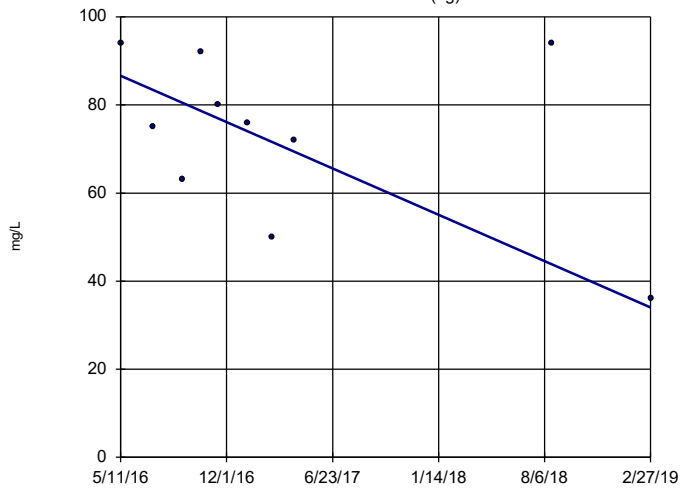
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 10

Slope = -18.79 units per year.

Mann-Kendall statistic = -14
critical = -30

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tolerance Limit Summary Table - Appendix IV Parameters

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 12:55 PM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.002	33	n/a	n/a	96.97	n/a	n/a	0.184	NP Inter(NDs)
Arsenic, total (mg/L)	n/a	0.011	33	n/a	n/a	72.73	n/a	n/a	0.184	NP Inter(normality)
Barium, total (mg/L)	n/a	0.183	33	n/a	n/a	0	n/a	n/a	0.184	NP Inter(normality)
Beryllium, total (mg/L)	n/a	0.00115	33	n/a	n/a	6.061	n/a	n/a	0.184	NP Inter(normality)
Cadmium, total (mg/L)	n/a	0.001	33	n/a	n/a	72.73	n/a	n/a	0.184	NP Inter(normality)
Chromium, total (mg/L)	n/a	0.007	33	n/a	n/a	15.15	n/a	n/a	0.184	NP Inter(Cohens/xform)
Cobalt, total (mg/L)	n/a	0.00939	33	n/a	n/a	0	n/a	n/a	0.184	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	n/a	3.455	33	1.012	0.3872	0	None	sqrt(x)	0.05	Inter
Fluoride, total (mg/L)	n/a	1	33	n/a	n/a	87.88	n/a	n/a	0.184	NP Inter(NDs)
Lead, total (mg/L)	n/a	0.002	33	n/a	n/a	84.85	n/a	n/a	0.184	NP Inter(NDs)
Lithium, total (mg/L)	n/a	0.05207	33	0.02139	0.01402	3.03	None	No	0.05	Inter
Mercury, total (mg/L)	n/a	0.000064	33	n/a	n/a	36.36	n/a	n/a	0.184	NP Inter(Cohens/xform)
Molybdenum, total (mg/L)	n/a	0.002	33	n/a	n/a	90.91	n/a	n/a	0.184	NP Inter(NDs)
Selenium, total (mg/L)	n/a	0.004	33	n/a	n/a	63.64	n/a	n/a	0.184	NP Inter(normality)
Thallium, total (mg/L)	n/a	0.001874	33	n/a	n/a	81.82	n/a	n/a	0.184	NP Inter(NDs)

Confidence Interval Summary Table - Significant Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 1:02 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-2**	**0.0136**	**0.01**	**0.0094**	**n/a**	**Yes**	**11**	**0**	**No**	**0.006**	**NP (normality)**
Cobalt, total (mg/L)	**AD-31**	**0.01192**	**0.009429**	**0.0094**	**n/a**	**Yes**	**10**	**0**	**sqrt(x)**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-32**	**0.0675**	**0.03328**	**0.0094**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Lithium, total (mg/L)	**AD-31**	**0.097**	**0.077**	**0.052**	**n/a**	**Yes**	**11**	**0**	**No**	**0.006**	**NP (normality)**
Lithium, total (mg/L)	**AD-32**	**0.1154**	**0.07511**	**0.052**	**n/a**	**Yes**	**10**	**0**	**x^2**	**0.01**	**Param.**

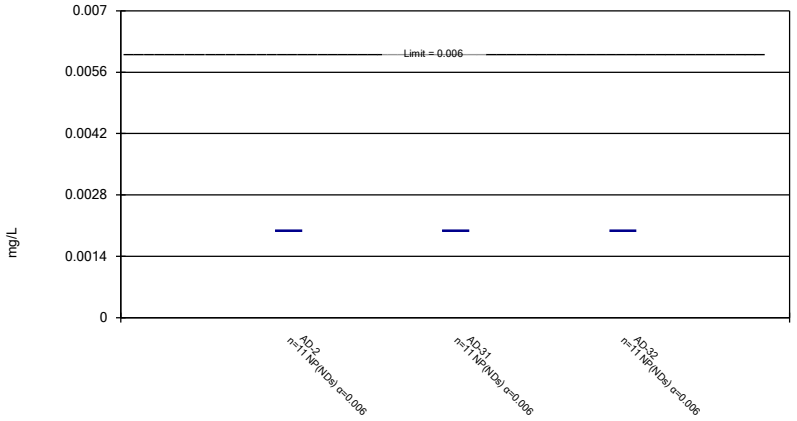
Confidence Interval Summary Table - All Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 1:02 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-2	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-31	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-32	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Arsenic, total (mg/L)	AD-2	0.002	0.00053	0.011	n/a	No	11	81.82	No	0.006	NP (NDs)
Arsenic, total (mg/L)	AD-31	0.006	0.002	0.011	n/a	No	10	20	No	0.011	NP (Cohens/xfrm)
Arsenic, total (mg/L)	AD-32	0.007737	0.002689	0.011	n/a	No	11	9.091	sqrt(x)	0.01	Param.
Barium, total (mg/L)	AD-2	0.03849	0.03229	2	n/a	No	11	0	x^3	0.01	Param.
Barium, total (mg/L)	AD-31	0.09365	0.04907	2	n/a	No	10	0	No	0.01	Param.
Barium, total (mg/L)	AD-32	0.04527	0.02662	2	n/a	No	11	0	No	0.01	Param.
Beryllium, total (mg/L)	AD-2	0.0004741	0.0003971	0.004	n/a	No	11	0	No	0.01	Param.
Beryllium, total (mg/L)	AD-31	0.002	0.0009983	0.004	n/a	No	11	0	No	0.006	NP (normality)
Beryllium, total (mg/L)	AD-32	0.007452	0.003677	0.004	n/a	No	11	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-2	0.001	0.00006	0.005	n/a	No	11	81.82	No	0.006	NP (NDs)
Cadmium, total (mg/L)	AD-31	0.001	0.0000944	0.005	n/a	No	11	54.55	No	0.006	NP (normality)
Cadmium, total (mg/L)	AD-32	0.0006616	0.0003662	0.005	n/a	No	11	0	No	0.01	Param.
Chromium, total (mg/L)	AD-2	0.004	0.0002438	0.1	n/a	No	11	45.45	No	0.006	NP (normality)
Chromium, total (mg/L)	AD-31	0.01835	0.004053	0.1	n/a	No	10	10	No	0.01	Param.
Chromium, total (mg/L)	AD-32	0.01144	0.002569	0.1	n/a	No	11	0	No	0.01	Param.
Cobalt, total (mg/L)	**AD-2**	**0.0136**	**0.01**	**0.0094**	**n/a**	**Yes**	**11**	**0**	**No**	**0.006**	**NP (normality)**
Cobalt, total (mg/L)	**AD-31**	**0.01192**	**0.009429**	**0.0094**	**n/a**	**Yes**	**10**	**0**	**sqrt(x)**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-32**	**0.0675**	**0.03328**	**0.0094**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Combined Radium 226 + 228 (pCi/L)	AD-2	1.886	0.9373	5	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-31	4.384	2.647	5	n/a	No	11	0	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-32	5.566	3.585	5	n/a	No	10	0	No	0.01	Param.
Fluoride, total (mg/L)	AD-2	1	1	4	n/a	No	11	90.91	No	0.006	NP (NDs)
Fluoride, total (mg/L)	AD-31	1	1	4	n/a	No	11	90.91	No	0.006	NP (NDs)
Fluoride, total (mg/L)	AD-32	1	0.4468	4	n/a	No	11	45.45	No	0.006	NP (normality)
Lead, total (mg/L)	AD-2	0.002	0.000355	0.015	n/a	No	11	81.82	No	0.006	NP (NDs)
Lead, total (mg/L)	AD-31	0.002	0.00154	0.015	n/a	No	10	70	No	0.011	NP (normality)
Lead, total (mg/L)	AD-32	0.002	0.002	0.015	n/a	No	11	90.91	No	0.006	NP (NDs)
Lithium, total (mg/L)	AD-2	0.05472	0.04503	0.052	n/a	No	11	9.091	x^4	0.01	Param.
Lithium, total (mg/L)	**AD-31**	**0.097**	**0.077**	**0.052**	**n/a**	**Yes**	**11**	**0**	**No**	**0.006**	**NP (normality)**
Lithium, total (mg/L)	**AD-32**	**0.1154**	**0.07511**	**0.052**	**n/a**	**Yes**	**10**	**0**	**x^2**	**0.01**	**Param.**
Mercury, total (mg/L)	AD-2	0.000147	0.00002779	0.002	n/a	No	11	0	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-31	0.0008212	0.0001268	0.002	n/a	No	10	0	sqrt(x)	0.01	Param.
Mercury, total (mg/L)	AD-32	0.008327	0.001765	0.002	n/a	No	11	0	No	0.01	Param.
Molybdenum, total (mg/L)	AD-2	0.002	0.0008627	0.1	n/a	No	11	81.82	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-31	0.002	0.0003161	0.1	n/a	No	11	63.64	No	0.006	NP (normality)
Molybdenum, total (mg/L)	AD-32	0.002	0.0007621	0.1	n/a	No	11	81.82	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-2	0.004	0.001231	0.05	n/a	No	11	45.45	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-31	0.004	0.001113	0.05	n/a	No	11	54.55	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-32	0.004	0.00218	0.05	n/a	No	10	50	No	0.011	NP (normality)
Thallium, total (mg/L)	AD-2	0.01	0.001264	0.002	n/a	No	11	81.82	No	0.006	NP (NDs)
Thallium, total (mg/L)	AD-31	0.01	0.001019	0.002	n/a	No	11	81.82	No	0.006	NP (NDs)
Thallium, total (mg/L)	AD-32	0.01	0.0009911	0.002	n/a	No	11	63.64	No	0.006	NP (normality)

Non-Parametric Confidence Interval

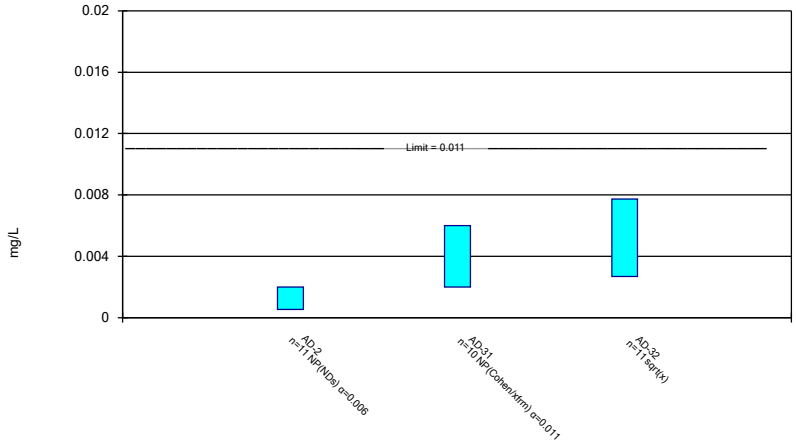
Compliance Limit is not exceeded.



Constituent: Antimony, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

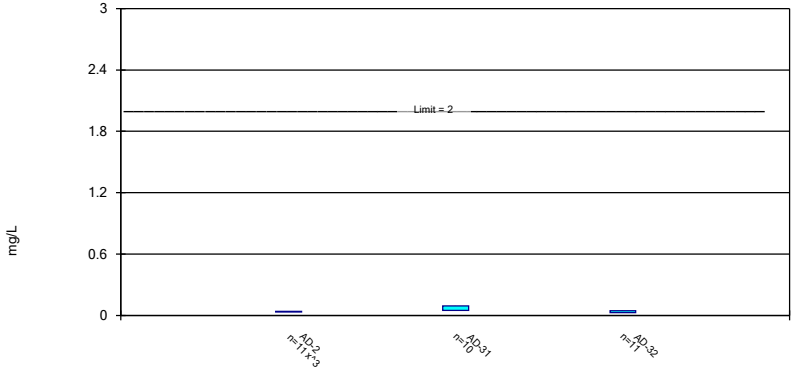
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Arsenic, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric Confidence Interval

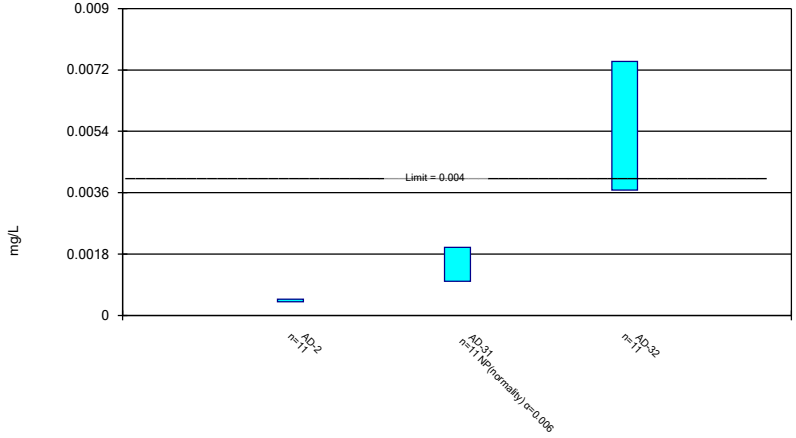
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Barium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

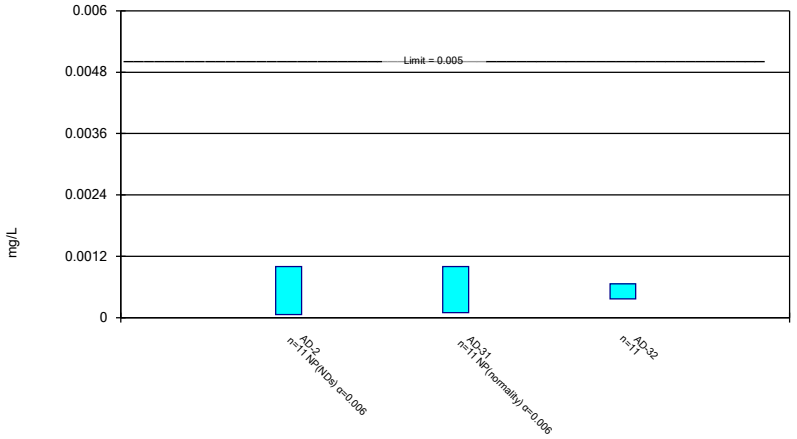
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Beryllium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

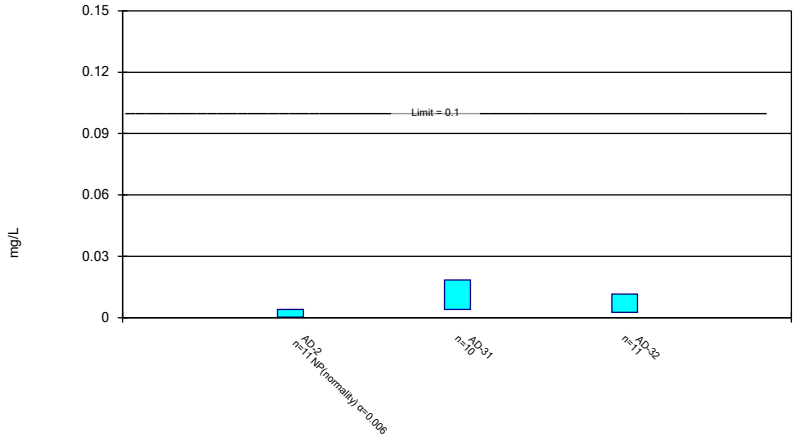


Constituent: Cadmium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

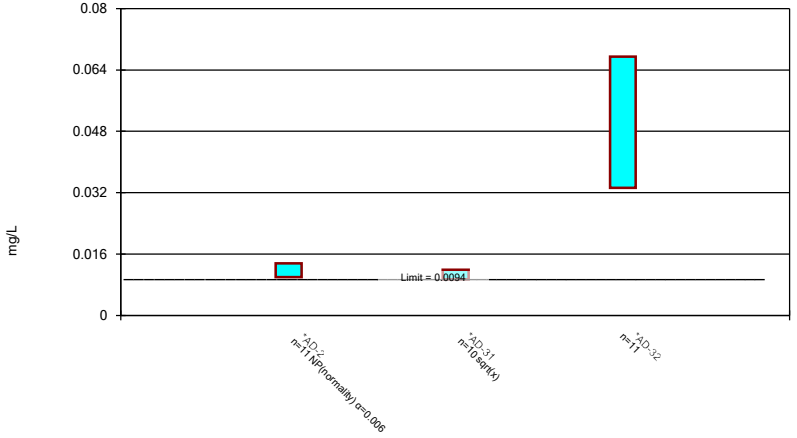


Constituent: Chromium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

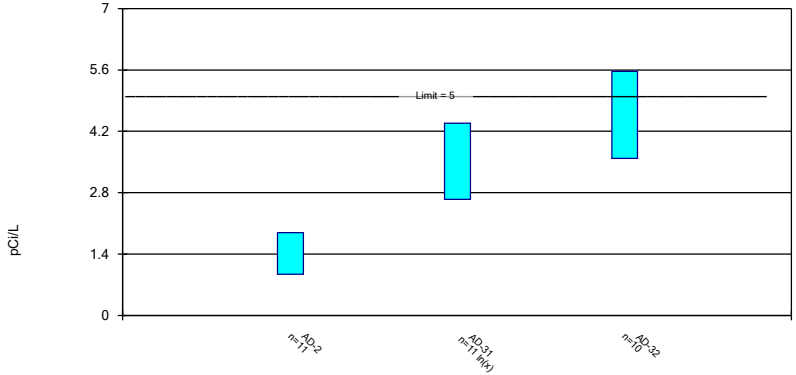


Constituent: Cobalt, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

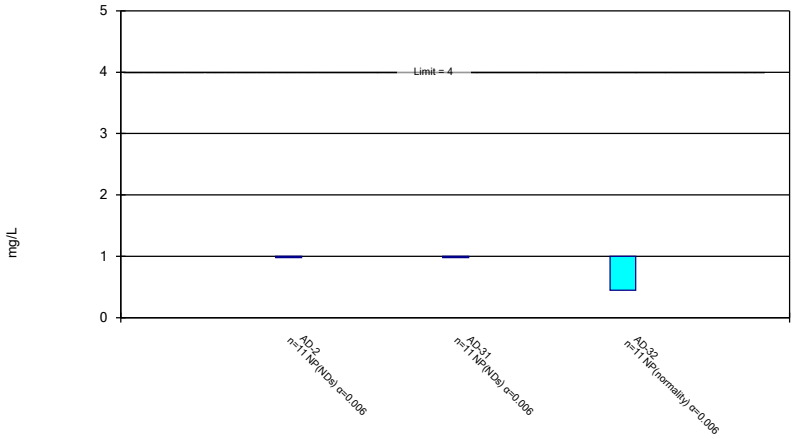
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - A
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

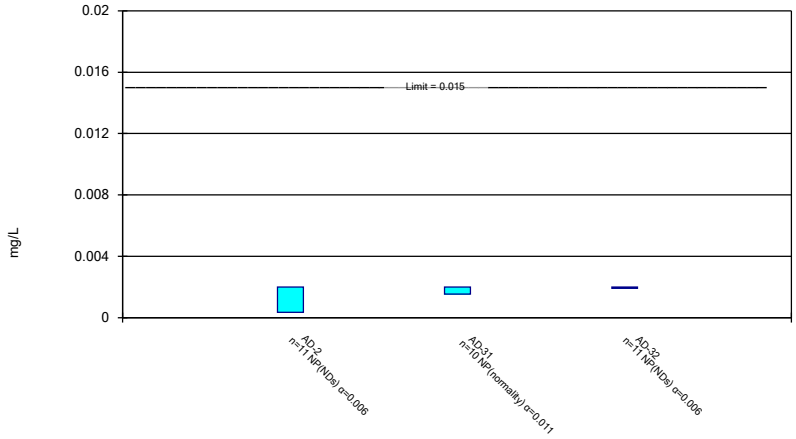


Constituent: Fluoride, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

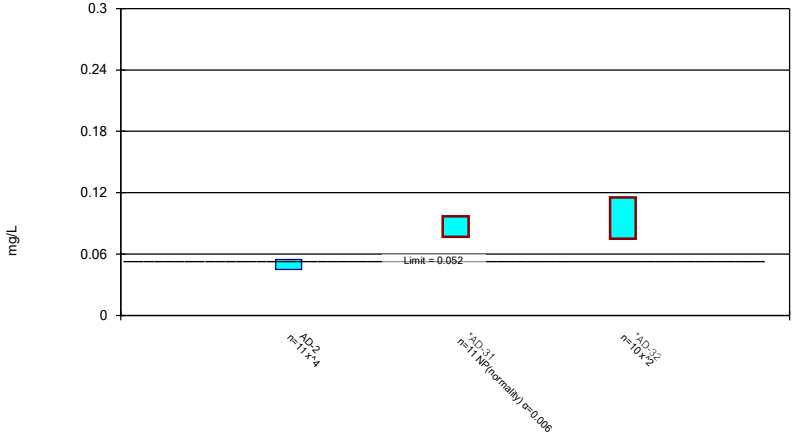


Constituent: Lead, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

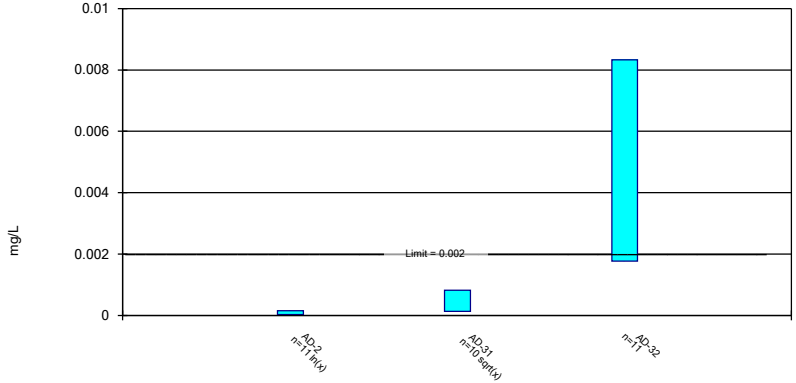


Constituent: Lithium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

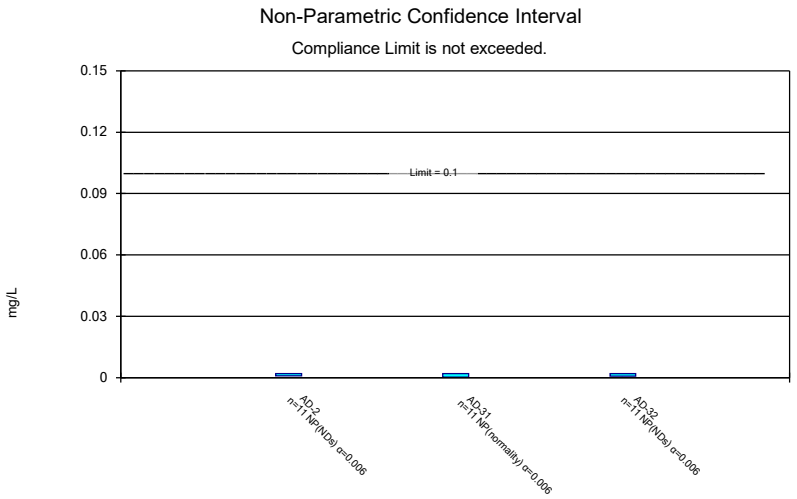
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

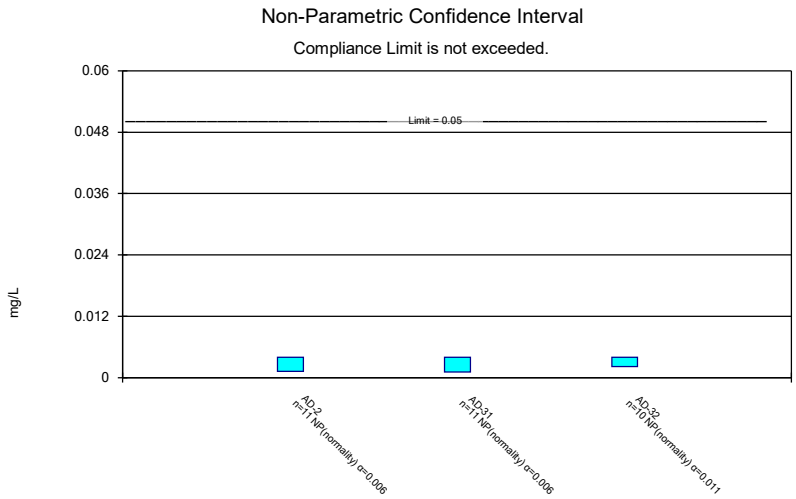


Constituent: Mercury, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP



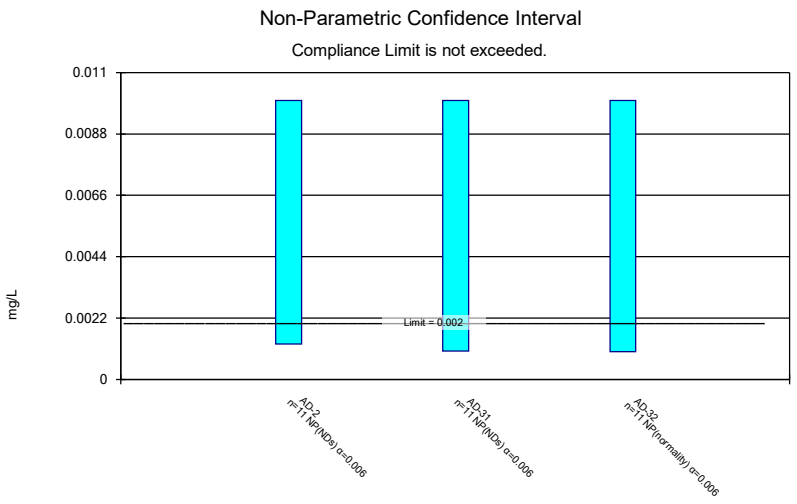
Constituent: Molybdenum, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Selenium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Thallium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

STATISTICAL ANALYSIS SUMMARY
EAST BOTTOM ASH POND
H.W. Pirkey Plant
Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

December 26, 2019

CHA8473

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
SU	Standard Units
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the East Bottom Ash Pond (EBAP), an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, calcium, chloride, total dissolved solids (TDS), and sulfate at the EBAP. An alternative source was not identified at the time, so the EBAP has been in assessment monitoring since. During the most recent assessment monitoring event, completed in July 2019, SSLs were identified for cobalt at wells AD-2, AD-31, and AD-32 and for lithium at wells AD-31 and AD-31. An alternative source demonstration (ASD) was successfully completed for cobalt and lithium (Geosyntec, 2019); thus, the unit remained in assessment monitoring. Two assessment monitoring events were conducted at the EBAP in May and August 2019, in accordance with 40 CFR 257.95. The results of these events are documented in this report.

Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. SSLs were identified for cobalt and lithium. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

EAST BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, two sets of samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) (May 2019) and 257.95(d)(1) (August 2019). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during these assessment monitoring events may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.23 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the EBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained during the May and August 2019 sampling events were screened for potential outliers. While possible outliers were identified for beryllium at wells AD-2 and AD-31 and for molybdenum at well AD-32, these values were not removed from the dataset as they were either non-detects or were similar to concentrations in adjacent wells.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring

events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for barium, beryllium, cobalt, and mercury due to apparent non-normal distributions, for antimony, arsenic, cadmium, fluoride, lead, molybdenum, selenium, and thallium due to a high non-detect frequency, and for chromium due to both an apparent non-normal distribution and a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey EBAP:

- LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.0100 mg/L) and AD-32 (0.0310 mg/L).
- LCLs for lithium exceeded the GWPS of 0.0616 mg/L at AD-31 (0.0859 mg/L) and AD-32 (0.0878 mg/L).

As a result, the Pirkey EBAP will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Establishment of Appendix III Prediction Limits

Upper prediction limits (UPL) were previously established for all Appendix III parameters following the background monitoring period (Geosyntec, 2018). Intrawell tests were used to evaluate potential SSIs for pH, whereas interwell tests were used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS. While interwell prediction limits have been updated periodically during the assessment monitoring period as sufficient data became available, this represents the first update to the background dataset for parameters evaluated using intrawell tests.

Mann-Whitney (Wilcoxon rank-sum) tests were performed to determine whether the newer data are affected by a release from the EBAP. Because the interwell Appendix III limits and the Appendix IV GWPSs are based on data from upgradient wells which we would not expect to have been impacted by a release, these tests were used for intrawell Appendix III tests only. Mann-Whitney tests were used to compare the medians of historical data (May 2016-April 2017) to the new compliance samples (August 2017- February 2019) for pH. Results were evaluated to determine if the medians of the two groups were similar at the 99% confidence level. Where no

significant difference was found, the new compliance data were added to the background dataset. Where a statistically significant difference was found between the medians of the two groups, the data were reviewed to evaluate the cause of the difference and to determine if adding newer data to the background dataset, replacing the background dataset with the newer data, or continuing to use the existing background dataset was most appropriate. If the differences appeared to have been caused by a release, then the previous background dataset continued to be used.

The complete Mann-Whitney test results and a summary of the significant findings can be found in Attachment B. A statistically significant difference was identified for pH in well AD-18. However, because this is an upgradient well and limited data are available, the background data were updated to include all data through February 2019.

After the revised background set was established, a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., "J-flagged" data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets (either transformed or untransformed) that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or non-parametric) and transformation (where applicable) for each background dataset are shown in Attachment B.

UPLs were updated using all the historical data through February 2019 to represent background values. LPLs were also updated for pH. The updated prediction limits are summarized in Table 3. Intrawell tests continued to be used to evaluate potential SSIs for pH, whereas interwell tests continued to be used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS. The intrawell UPLs were calculated for a one-of-two retesting procedure; i.e., if at least one sample in a series of two does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, where the initial result did not exceed the UPL, a second sample was not collected. The retesting procedures allowed achieving an acceptably high statistical power to detect changes at downgradient wells for constituents evaluated using intrawell prediction limits.

2.2.4 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations.

Data collected during the May and August 2019 assessment monitoring events from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 4. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0510 mg/L at AD-2 (2.17 mg/L and 2.16 mg/L) and AD-32 (0.555 mg/L and 1.77 mg/L).

- Calcium concentrations exceeded the interwell UPL of 2.94 mg/L at AD-2 (3.30 mg/L), AD-31 (3.29 mg/L), and AD-32 (5.35 mg/L and 13.3 mg/L).

- Chloride concentrations exceeded the interwell UPL of 9.16 mg/L at AD-2 (29.6 mg/L and 28.4 mg/L), AD-31 (18.7 mg/L and 21.6 mg/L), and AD-32 (18.6 mg/L and 24.9 mg/L).

- Sulfate concentrations exceeded the interwell UPL of 23.0 mg/L at AD-2 (137 mg/L and 128 mg/L), AD-31 (79.9 mg/L and 70.0 mg/L), and AD-32 (105 mg/L and 228 mg/L).

- TDS concentrations exceeded the interwell UPL of 178 mg/L at AD-2 (316 mg/L and 306 mg/L), AD-31 (240 mg/L and 250 mg/L), and AD-32 (292 mg/L and 448 mg/L).

While the prediction limits were calculated assuming a 1-of-2 testing procedure, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the UPL based on previous results. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey EBAP during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. While potential outliers for beryllium and lithium were identified in the May and August 2019 data, no values were removed from the dataset. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. SSLs were identified for cobalt and lithium. Appendix III parameters were compared to recalculated prediction limits, with exceedances identified for boron, calcium, chloride, sulfate, and TDS.

Based on this evaluation, the Pirkey EBAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H.W. Pirkey Plant. January 2017.

Geosyntec Consultants. 2018. Statistical Analysis Summary – East Bottom Ash Pond, H.W. Pirkey Plant, Hallsville, Texas. January 15, 2018.

Geosyntec Consultants. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, East Bottom Ash Pond. September.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - East Bottom Ash Pond

Geosyntec Consultants, Inc.

Component	Unit	AD-2		AD-4		AD-12		AD-18		AD-31		AD-32	
		5/22/2019	8/12/2019	5/23/2019	8/14/2019	5/21/2019	8/12/2019	5/23/2019	8/13/2019	5/23/2019	8/12/2019	5/21/2019	8/12/2019
Antimony	µg/L	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U
Arsenic	µg/L	2.00 U	0.350	2.00 U	0.170	2.00 U	0.0700 J	2.00 U	0.450	2.00 U	0.530	0.800 J	3.43
Barium	µg/L	25.6	22.8	61.7	73.5	21.7	23.8	131	100	37.9	35.0	35.6	38.5
Beryllium	µg/L	2.00 U	0.402	0.500 J	1.04	2.00 U	0.154	2.00 U	0.118	0.900 J	0.850	2.77	3.65
Boron	mg/L	2.17	2.16	0.0210	0.0500 U	0.0200	0.0500 U	0.0130	0.0500 U	0.0210	0.0500 U	0.555	1.77
Cadmium	µg/L	1.00 U	0.0600	1.00 U	0.0500 U	1.00 U	0.0500 U	1.00 U	0.0200 J	1.00 U	0.0600	0.300 J	0.400
Calcium	mg/L	2.19	3.30	1.71	1.97	0.300 J	0.278	0.684	0.647	3.29	2.86	5.35	13.3
Chloride	mg/L	29.6	28.4	3.31	6.22	6.30	7.24	8.82	8.49	18.7	21.6	18.6	24.9
Chromium	µg/L	4.00 U	0.292	1.00 J	0.0800 J	4.00 U	0.204	4.00 U	0.212	4.00 U	0.365	1.00 J	1.70
Cobalt	µg/L	15.5	13.0	7.86	6.52	1.15	1.30	1.47	1.25	10.3	8.69	23.5	33.7
Combined Radium	pCi/L	0.832	1.81	0.517	0.833	0.201	0.237	0.492	0.473	3.40	2.20	5.37	5.70
Fluoride	mg/L	0.100 J	0.100 J	0.150	0.120	0.0900	0.0600 J	0.0200 J	0.0100 J	0.130	0.160	0.310	0.670
Lead	µg/L	2.00 U	0.288	2.00 U	0.0600 J	2.00 U	0.0800 J	2.00 U	0.200 J	2.00 U	0.325	0.400 J	0.996
Lithium	mg/L	0.0542	0.0560	0.0516	0.0484	0.00576	0.00829	0.0209	0.0183	0.0928	0.0875	0.0897	0.0964
Mercury	mg/L	0.0000630	0.0000440	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.00000900 J	0.0000230 J	0.0000570	0.00103	0.00137	0.00413
Molybdenum	µg/L	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U
Selenium	µg/L	0.900 J	0.800	4.00 U	0.0400 J	4.00 U	0.200 J	4.00 U	0.0900 J	4.00 U	0.400	1.00 J	7.30
Total Dissolved Solids	mg/L	316	306	150	146	80.0	90.0	104	90.0	240	250	292	448
Sulfate	mg/L	137	128	24.6	21.7	4.00	2.60	10.6	6.60	79.9	70.0	105	228
Thallium	µg/L	0.500 U	0.100 J	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.200 J	0.200 J
pH	SU	4.04	4.55	4.97	5.49	4.09	4.94	5.20	5.22	5.14	4.06	3.21	4.01

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above the method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit

Table 2: Groundwater Protection Standards
Pirkey Plant - East Bottom Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL
Antimony, Total (mg/L)	0.006		0.0025
Arsenic, Total (mg/L)	0.01		0.011
Barium, Total (mg/L)	2		0.18
Beryllium, Total (mg/L)	0.004		0.0012
Cadmium, Total (mg/L)	0.005		0.0005
Chromium, Total (mg/L)	0.1		0.007
Cobalt, Total (mg/L)	n/a	0.006	0.0094
Combined Radium, Total (pCi/L)	5		3.33
Fluoride, Total (mg/L)	4		0.5
Lead, Total (mg/L)	0.015		0.0025
Lithium, Total (mg/L)	n/a	0.04	0.062
Mercury, Total (mg/L)	0.002		0.000064
Molybdenum, Total (mg/L)	n/a	0.1	0.020
Selenium, Total (mg/L)	0.05		0.0025
Thallium, Total (mg/L)	0.002		0.0019

Notes:
Grey cell indicates calculated UTL is higher than MCL or CCR Rule-specified value.
MCL = Maximum Contaminant Level
Calculated UTL (Upper Tolerance Limit) represents site-specific background values.
The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3: Revised Prediction Limits
Pirkey - East Bottom Ash Pond

Geosyntec Consultants, Inc.

Parameter	Unit	Description	AD-2	AD-31	AD-32
Boron	mg/L	Interwell Background Value (UPL)	0.0510		
Calcium	mg/L	Interwell Background Value (UPL)	2.94		
Chloride	mg/L	Interwell Background Value (UPL)	9.16		
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
pH	SU	Intrawell Background Value (UPL)	4.8	5.4	4.6
		Intrawell Background Value (LPL)	3.3	2.8	2.5
Sulfate	mg/L	Interwell Background Value (UPL)	23.0		
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	176		

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

Table 4: Appendix III Data Summary
Pirkey - East Bottom Ash Pond

Geosyntec Consultants, Inc.

Parameter	Unit	Description	AD-2		AD-31		AD-32	
			5/22/2019	8/12/2019	5/23/2019	8/12/2019	5/21/2019	8/12/2019
Boron	mg/L	Interwell Background Value (UPL)	0.0510					
		Detection Monitoring Result	**2.17**	**2.16**	0.0210	0.0200	**0.555**	**1.77**
Calcium	mg/L	Interwell Background Value (UPL)	2.94					
		Detection Monitoring Result	2.19	**3.30**	**3.29**	2.86	**5.35**	**13.3**
Chloride	mg/L	Interwell Background Value (UPL)	9.16					
		Detection Monitoring Result	**29.6**	**28.4**	**18.7**	**21.6**	**18.6**	**24.9**
Fluoride	mg/L	Interwell Background Value (UPL)	1.00					
		Detection Monitoring Result	0.100	0.100	0.130	0.160	0.310	0.670
pH	SU	Intrawell Background Value (UPL)	4.8		5.4		4.6	
		Intrawell Background Value (LPL)	3.3		2.8		2.5	
		Detection Monitoring Result	4.0	4.6	5.1	4.1	3.2	4.0
Sulfate	mg/L	Interwell Background Value (UPL)	23.0					
		Detection Monitoring Result	**137**	**128**	**79.9**	**70.0**	**105**	**228**
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	176					
		Detection Monitoring Result	**316**	**306**	**240**	**250**	**292**	**448**

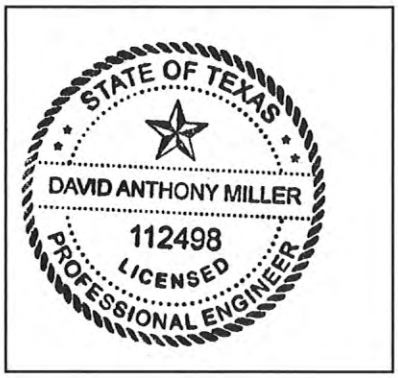
Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.



DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

112498	TEXAS	01.03.20
License Number	Licensing State	Date

ATTACHMENT B
Statistical Analysis Output

GROUNDWATER STATS CONSULTING

December 9, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey EBAP - Assessment Monitoring Event & Background Update 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the evaluation of groundwater data and the background update for American Electric Power Company's Pirkey EBAP. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling at each of the wells below began at Pirkey EBAP for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following: upgradient wells AD-4, AD-12, and AD-18; and downgradient wells AD-2, AD-31, and AD-32.

Data were sent electronically, and the statistical analysis was reviewed by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC. The analysis was conducted according to the Statistical Analysis Plan and initial screening evaluation prepared in November 2017 by GSC and approved by Dr. Kirk Cameron.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and

- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Values in background which have been flagged as outliers may be seen in a lighter font and disconnected symbol on the graphs. During the August 2018 event, a value of 0.015 mg/L was reported for selenium at well AD-32. That value was flagged as an outlier since the reported value during the February 2019 event was significantly lower (0.003 mg/L) and similar to historical concentrations.

Background data at all wells were initially evaluated during the background screening conducted in December 2017 for the following: 1) outliers; 2) trends; 3) most appropriate statistical method for Appendix III parameters based on site characteristics of groundwater data upgradient of the facility; and 4) eligibility of downgradient wells when intrawell statistical methods are recommended. A summary of that screening is provided below. Data are evaluated in this report for inclusion of more recent data into background to update the prediction limits. Power curves were provided during the initial background screening to demonstrate that the selected statistical methods for Appendix III parameters comply with the USEPA Unified Guidance recommendations as discussed below.

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for pH.
2) Interwell prediction limits, combined with a 1-of-2 resample plan for boron, calcium, chloride, fluoride, sulfate and TDS.

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, simple substitution of one-half the reporting limit may be utilized in the statistical analysis. The reporting limit

utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory.

- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric prediction limits are used on data containing greater than 50% nondetects.

Summary of Background Screening Conducted in December 2017

Outlier Evaluation

Time series plots are used to identify suspected outliers, or extreme values that would result in limits that are not conservative from a regulatory perspective, in proposed background data. Suspected outliers at all wells for Appendix III and Appendix IV parameters were formally tested using Tukey's box plot method and, when identified, flagged in the computer database with "o" and deselected prior to construction of statistical limits. The reports were submitted with the background screening.

Tukey's outlier test noted several outliers which were flagged in the database. Any values flagged as outliers are plotted in a lighter font on the time series graph. While the test identified a couple low outliers for chloride, lead and lithium in downgradient wells, these values were not flagged because they were similar in concentration to surrounding wells. It was noted that the first background sample in well AD-31 for several constituents was higher than all subsequent samples. This could be representative of well drilling processes, or an indication of sampling or analytical error. Therefore, these values were flagged as outliers since they do not appear to represent the population of groundwater at this well. In some cases, the test could not identify suspect outliers due to the upper and lower quartiles being equal. When extreme values were present in background, however, they were flagged as outliers, such as fluoride in upgradient well AD-12. A substitution of the most recent reporting limit was applied when varying detection limits existed in data.

No true seasonal patterns were observed on the time series plots for any of the detected data; therefore, no deseasonalizing adjustments were made to the data. When seasonal patterns are observed, data may be deseasonalized so that the resulting limits will correctly account for the seasonality as a predictable pattern rather than random variation or a release.

While trends may be visual, a quantification of the trend and its significance is needed. The Sen's Slope/Mann Kendall trend test was used to evaluate all data at each well to identify statistically significant increasing or decreasing trends. In the absence of suspected contamination, significant trending data are typically not included as part of the background data used for construction of prediction limits. This step serves to eliminate the trend and, thus, reduce variation in background. When statistically significant decreasing trends are present, earlier data are evaluated to determine whether earlier concentration levels are significantly different than current reported concentrations and will be deselected as necessary. When the historical records of data are truncated for the reasons above, a summary report will be provided to show the date ranges used in construction of the statistical limits.

The results of the trend analyses were submitted with the background screening report and showed a couple statistically significant increasing and decreasing trends. These trends were relatively low in magnitude when compared to average concentrations; therefore, no adjustments were made to the data sets.

Appendix III – Determination of Spatial Variation

The Analysis of Variance (ANOVA) was used to statistically evaluate differences in average concentrations among upgradient wells, which assists in identifying the most appropriate statistical approach. Interwell tests, which compare downgradient well data to statistical limits constructed from pooled upgradient well data, are appropriate when average concentrations are similar across upgradient wells. Intrawell tests, which compare compliance data from a single well to screened historical data within the same well, are appropriate when upgradient wells exhibit spatial variation; when statistical limits constructed from upgradient wells would not be conservative from a regulatory perspective; and when downgradient water quality is unimpacted compared to upgradient water quality for the same parameter.

The ANOVA identified no variation for fluoride, making this constituent suitable for interwell analyses. Variation was identified in groundwater upgradient of the site for all other Appendix III parameters. Therefore, these data were further evaluated as described for the appropriateness of intrawell testing to accommodate the groundwater quality. A summary table of the ANOVA results is included with the reports.

Appendix III - Statistical Limits

Intrawell limits constructed from carefully screened background data from within each well serve to provide statistical limits that are conservative (i.e. lower) from a regulatory perspective, and that will rapidly identify a change in more recent compliance data from within a given well. This statistical method removes the element of variation from across wells and eliminates the chance of mistaking natural spatial variation for a release from the facility. Prior to performing intrawell prediction limits, several steps are required to reasonably demonstrate downgradient water quality does not have existing impacts from the practices of the facility.

Exploratory data analysis was used as a general comparison of concentrations in downgradient wells for all Appendix III parameters recommended for intrawell analyses to concentrations reported in upgradient wells. Upper tolerance limits are used in conjunction with confidence intervals to determine whether the estimated averages in downgradient wells are higher than observed levels upgradient of the facility. The upper tolerance limits were constructed to represent the extreme upper range of possible background levels at the site.

In cases where downgradient average concentrations are higher than observed concentrations upgradient for a given constituent, an independent study and hydrogeological investigation would be required to identify local geochemical conditions and expected groundwater quality for the region to justify an intrawell approach. Such an assessment is beyond the scope of services provided by Groundwater Stats Consulting. When there is not an obvious explanation for observed concentration differences in downgradient wells relative to reported concentrations in upgradient wells, interwell prediction limits will initially be selected for the statistical method until further evidence shows that concentrations are due to natural variation rather than a result of the facility.

Parametric tolerance limits were constructed with a target of 99% confidence and 95% coverage using pooled upgradient well data for each of the Appendix III parameters recommended for intrawell analyses. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. As more data are collected, the background population is better represented and the confidence and coverage levels increase.

Confidence intervals were constructed on downgradient wells for each of the Appendix III parameters, using the tolerance limits discussed above, to determine intrawell eligibility for parameters exhibiting spatial variation. When the entire confidence interval is above a background standard for a given parameter, interwell methods are initially

recommended as the statistical method. Therefore, only parameters with confidence intervals which did not exceed background standards are eligible for intrawell prediction limits.

Confidence intervals for the above parameters were found to be within their respective background limit for pH, while the confidence intervals for all other Appendix III parameters evaluated were above the background standards for parameters exhibiting spatial variation. Therefore, intrawell methods were recommended for pH, and interwell methods were recommended for all other Appendix III parameters. As mentioned earlier, if a demonstration supports natural variation in groundwater, intrawell methods will be considered for all parameters.

All available data through April 2017 at each well were used to establish intrawell background limits based on a 1-of-2 resample plan that will be used for future comparisons. Interwell prediction limits, combined with a 1-of-2 resample plan, were constructed from upgradient wells for the Appendix III parameters discussed above. Downgradient measurements will be compared to these background limits during each subsequent semi-annual sampling event.

Natural systems continuously evolve due to physical changes made to the environment. Examples include capping a landfill, paving areas near a well, or lining a drainage channel to prevent erosion. Periodic updating of background statistical limits will be necessary to accommodate these types of changes In the interwell case, newer data will be carefully screened during each event for new outliers or extreme trending data. In the intrawell case, data for all wells and constituents are re-evaluated when a minimum of 4 new data points from each well are available to determine whether earlier concentrations are representative of present-day groundwater quality. In some cases, the earlier portion of data are deselected prior to construction of limits in order to provide sensitive limits that will rapidly detect changes in groundwater quality. Even though the data are excluded from the calculation, the values will continue to be reported and shown in tables and graphs.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of an additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered to be a false positive result and, therefore, no further action is necessary.

Background Update Summary – November 2019

Prior to updating background data sets, all Appendix III and data through February 2019 were re-evaluated using Tukey's outlier test and visual screening (Figure C). Tukey's Outlier test identified an outlier for fluoride in well AD-32 which was flagged in the database. Additionally, the reported nondetect value of <5.0 mg/L for TDS in upgradient well AD-12 was flagged as it is not consistent with remaining measurements within this well. As mentioned above, flagged data are displayed in a lighter font and as a disconnected symbol on the time series reports, as well as in a lighter font on the accompanying data pages. An updated summary of Tukey's test results and flagged outliers follows this letter.

The Mann-Whitney (Wilcoxon Rank Sum) test was used to compare the medians of historical data through April 2017 to the new compliance samples at each well through February 2019 to evaluate whether the groups are significantly different at the 99% confidence level. When no differences are noted, background data may be updated with more recent compliance data (Figure D). Typically, when the test concludes that the medians of the two groups are significantly different, particularly in the downgradient wells, the background are not updated to include the newer data but will be reconsidered in the future.

A statistically significant difference was identified for pH in well AD-18. However, because this is an upgradient well and limited data are available, the background data were updated to include all data through February 2019. These data will be re-evaluated during the next background update. If earlier measurements no longer represent present-day conditions, the earlier portion of the record will be deselected prior to construction of statistical limits. A summary of these results follows this letter and the test results are included with the Mann Whitney test section at the end of this report.

Intrawell prediction limits using all historical data through February 2019 combined with a 1-of-2 resample plan, were constructed for pH and a summary of the updated limits follows this letter (Figure E). Future compliance observations at each well will be compared to these background limits during each subsequent semi-annual sampling event.

The Sen's Slope/Mann Kendall trend test was used to evaluate data at upgradient wells for boron, calcium, chloride, fluoride, sulfate and TDS, which are tested using interwell prediction limits, to identify statistically significant increasing or decreasing trends. The results of the trend analyses showed all data are consistent over time with no statistically significant increasing or decreasing trends (Figure F).

Interwell prediction limits, combined with a 1-of-2 resample plan, were updated using all available data from upgradient wells for the same time period for the parameters listed above (Figure G). Interwell prediction limits pool upgradient well data to establish a background limit for an individual constituent. A summary table of the updated limits may be found following this letter in the Prediction Limit Summary Tables.

Evaluation of Appendix IV Parameters

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure H). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. The test identified a few outliers such as: beryllium in wells AD-2 and AD-31 and molybdenum in well AD-32 (which were reported nondetects). The value identified for beryllium in well AD-2 was not flagged due to the low concentrations within this well and all values being similar to neighboring wells, indicating natural variability. The nondetect values were not flagged as outliers for molybdenum in well AD-32, but it was noted these limits are higher than historical limits and have been reported at these levels for two events. A nondetect adjustment may be required depending on what the future reporting limit is set at for nondetects. Additionally, several other values that were not identified by Tukey's test (often due to the natural log transformation) were flagged as they were significantly different from the other reported measurements within the same well. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure I).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, CCR-Rule specified levels or ACL as discussed above (Figure J). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. When a GWPS is exceeded, if an Alternate Source Demonstration cannot be made, corrective action would be initiated. The following confidence interval exceedances were noted: cobalt in wells AD-2 and AD-32, and lithium in wells AD-31 and AD-32. A summary of the confidence interval results follows this letter.

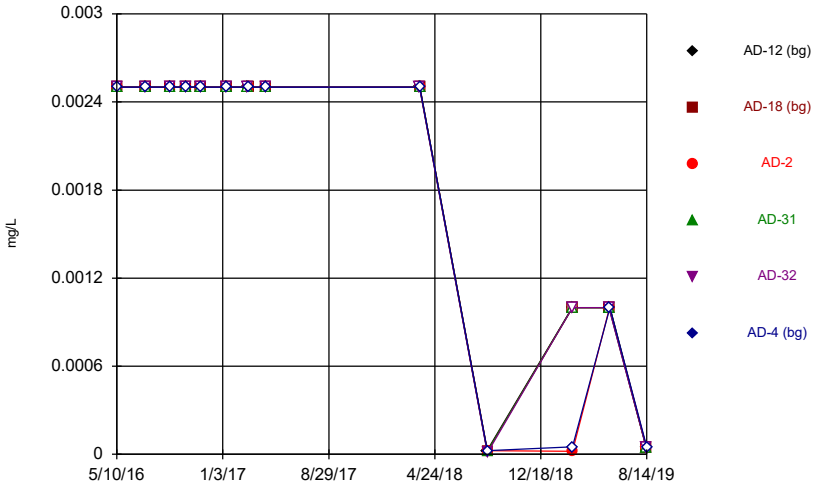
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey EBAP. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

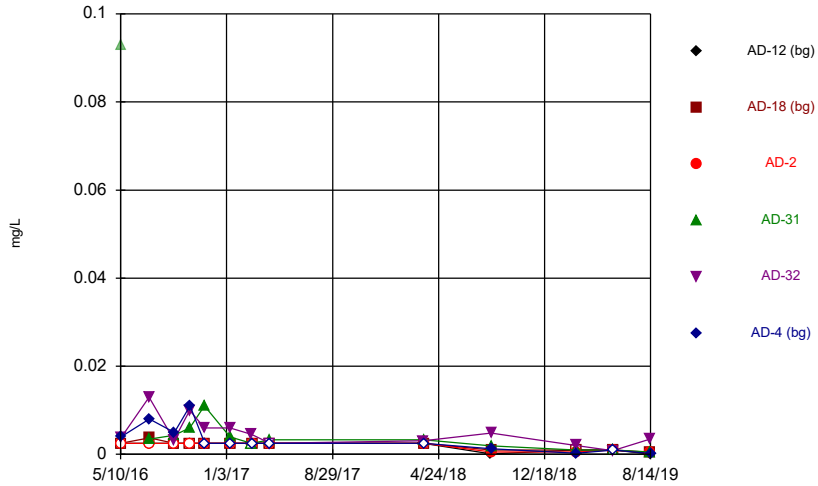
Time Series



Constituent: Antimony, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

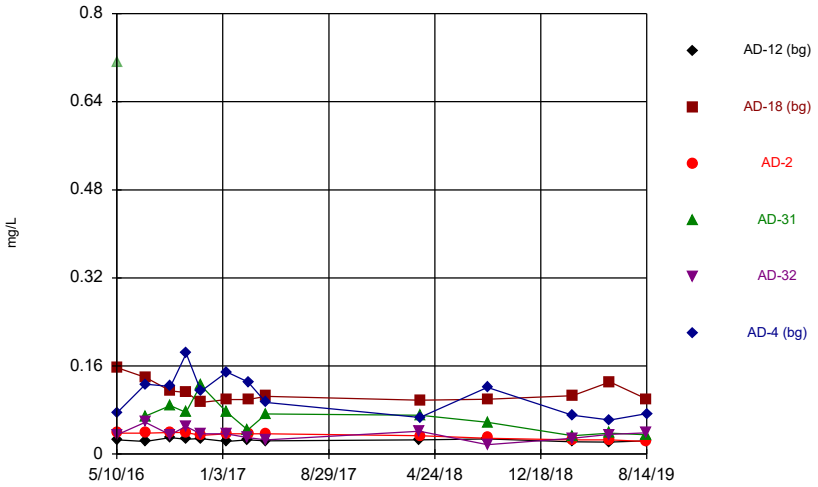
Time Series



Constituent: Arsenic, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

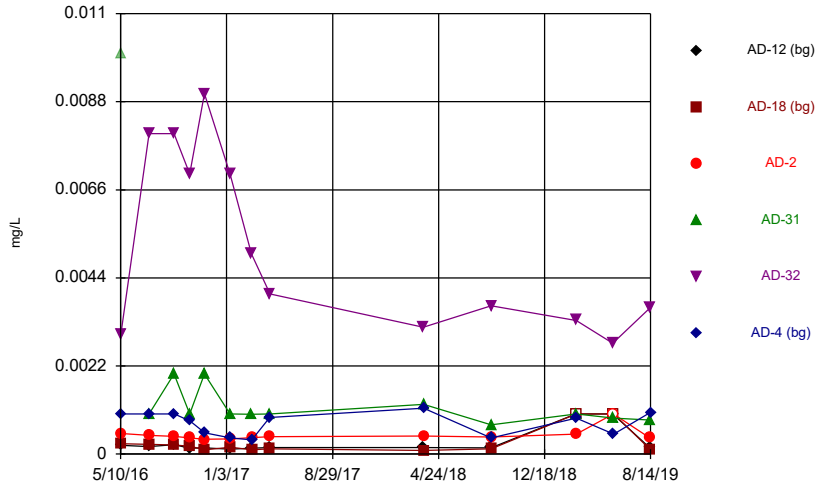
Time Series



Constituent: Barium, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

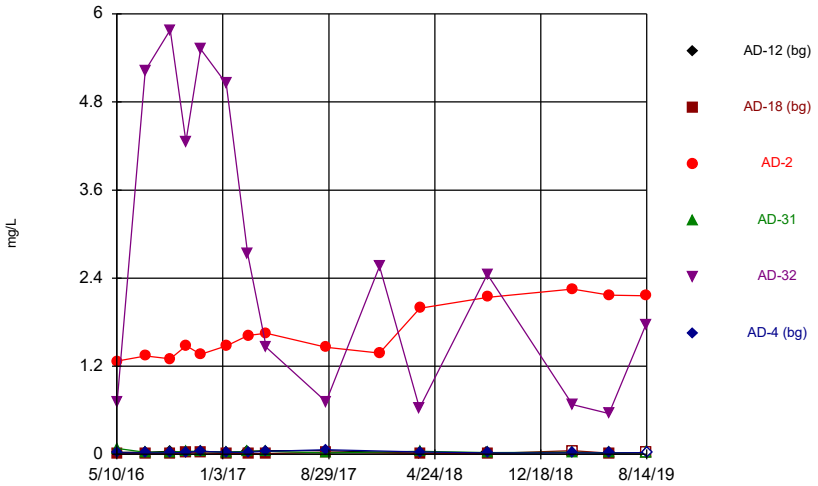
Time Series



Constituent: Beryllium, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

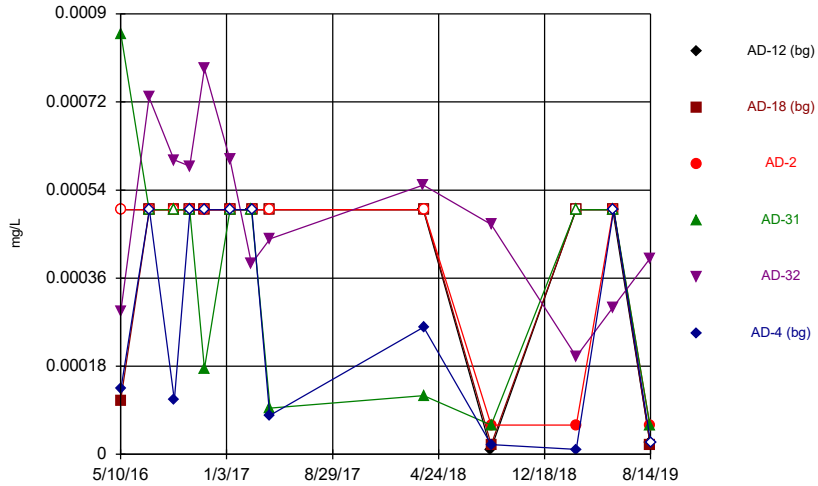
Time Series



Constituent: Boron, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

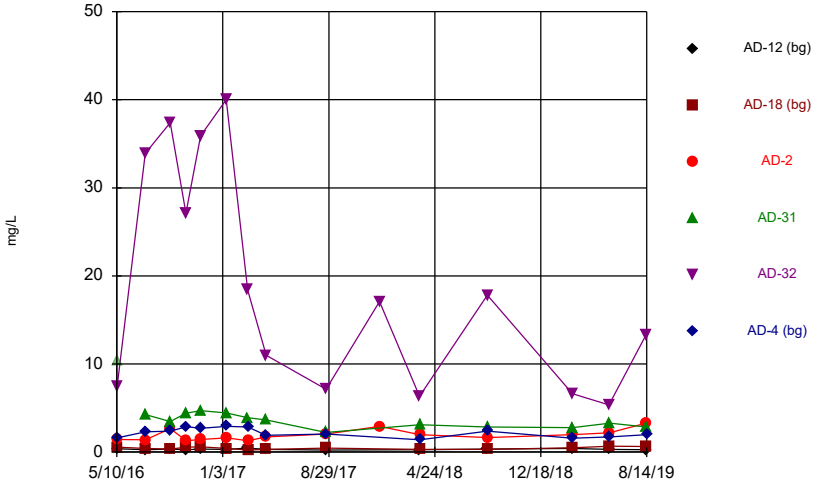
Time Series



Constituent: Cadmium, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

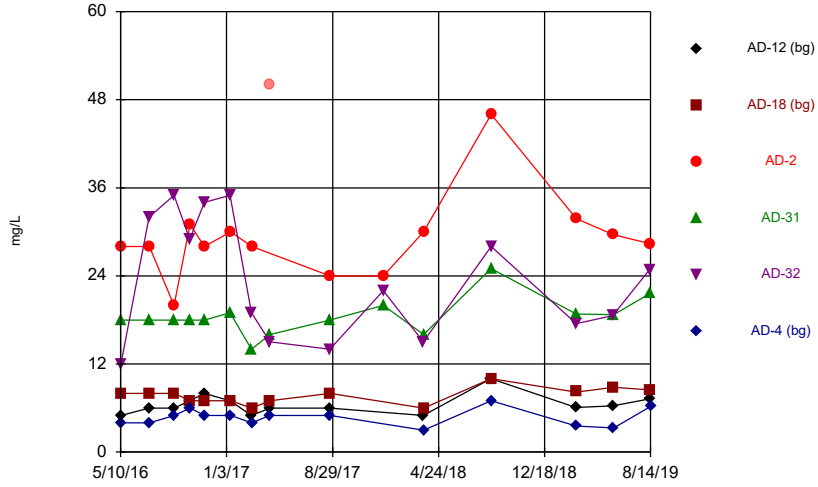
Time Series



Constituent: Calcium, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

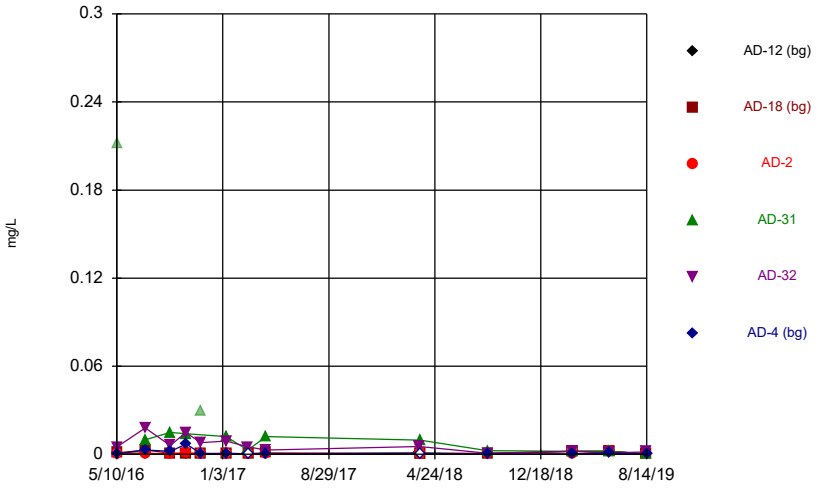
Time Series



Constituent: Chloride, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

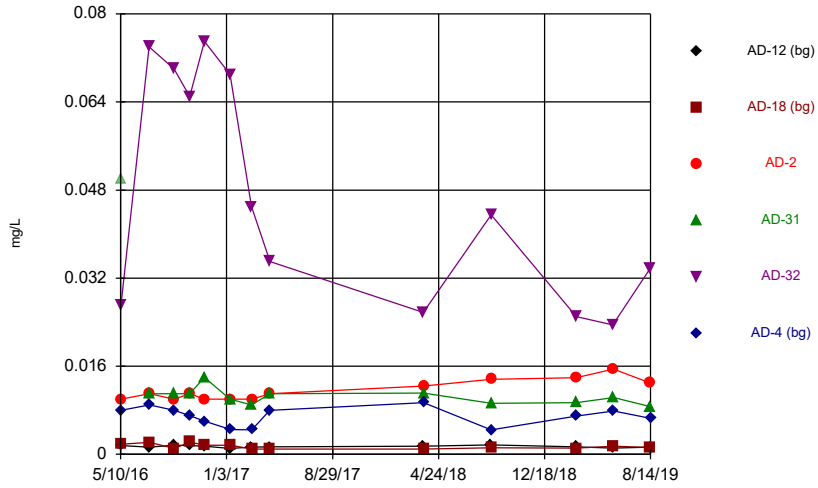
Time Series



Constituent: Chromium, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

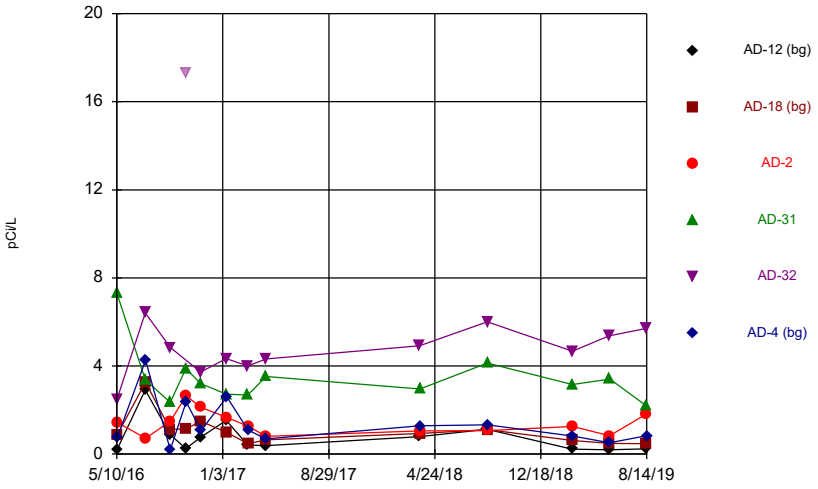
Time Series



Constituent: Cobalt, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

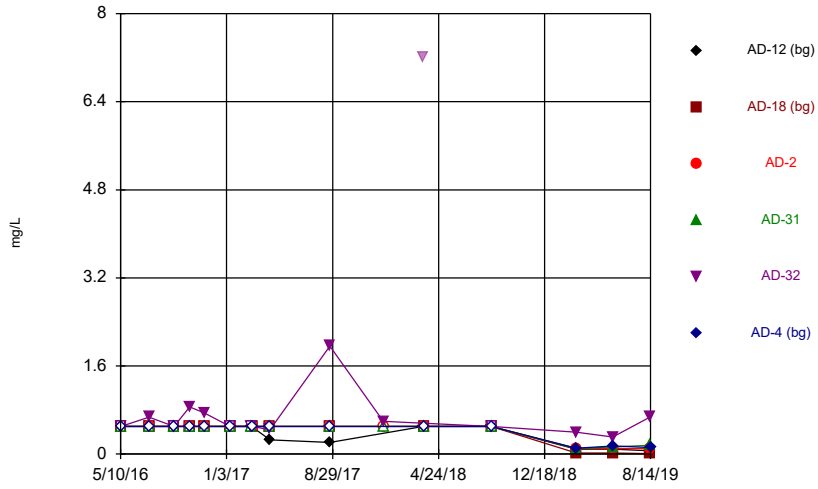
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

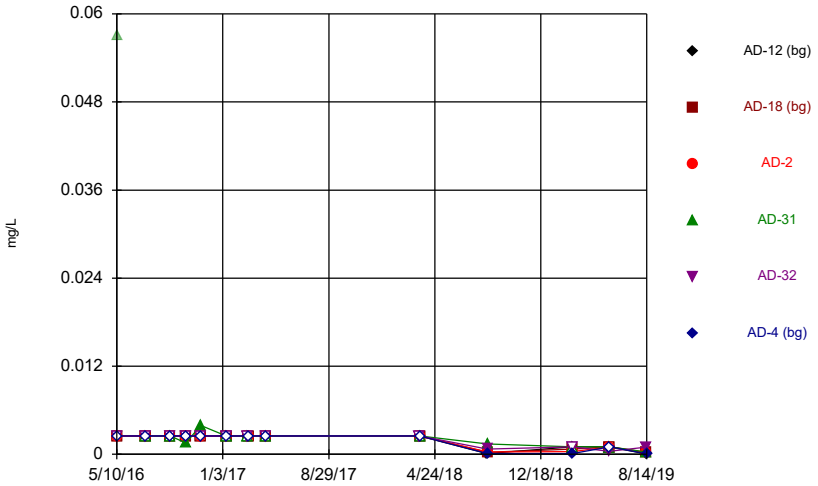
Time Series



Constituent: Fluoride, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

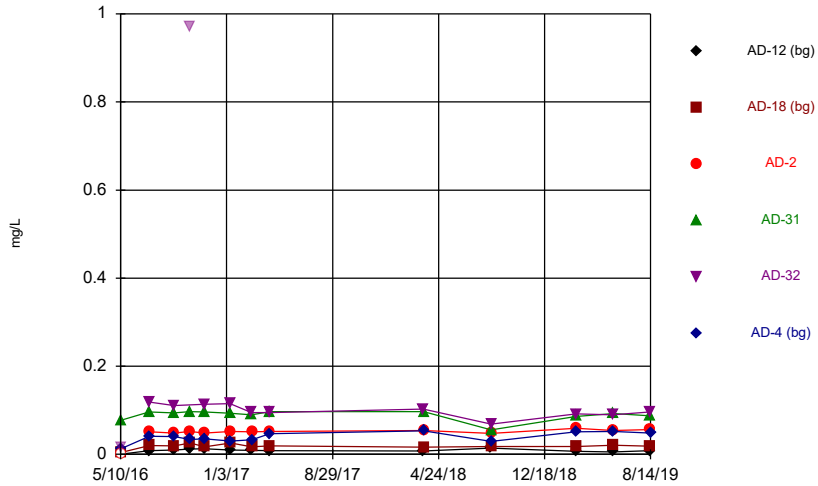
Time Series



Constituent: Lead, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

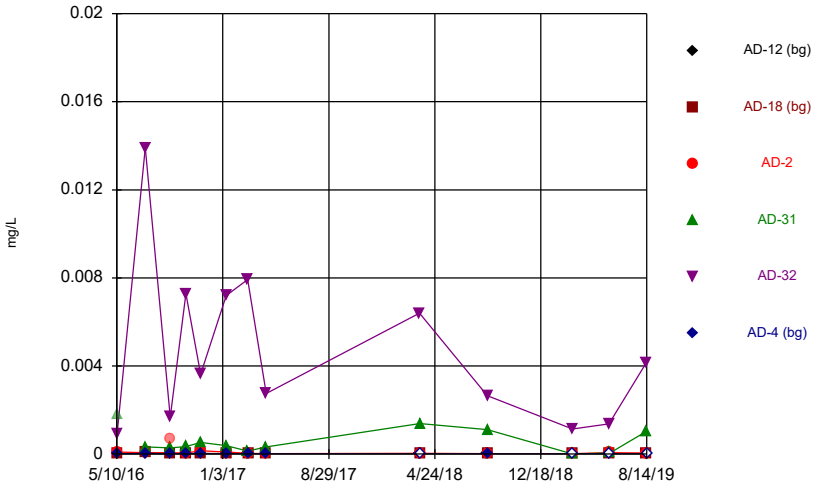
Time Series



Constituent: Lithium, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

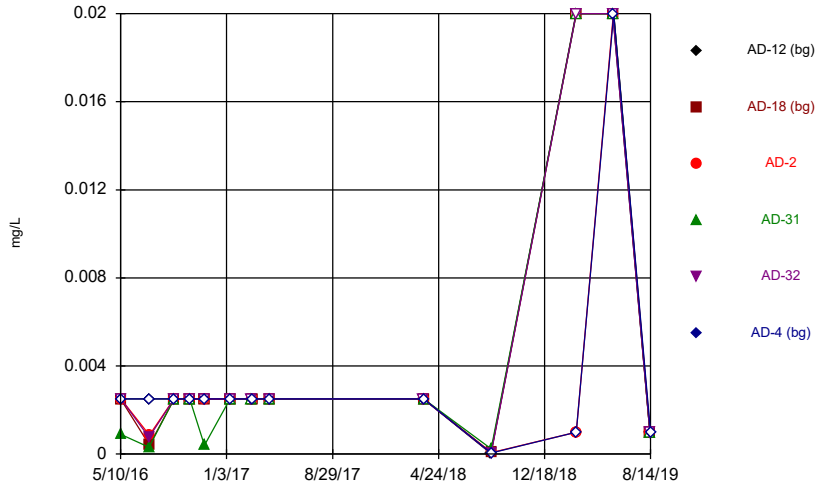
Time Series



Constituent: Mercury, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

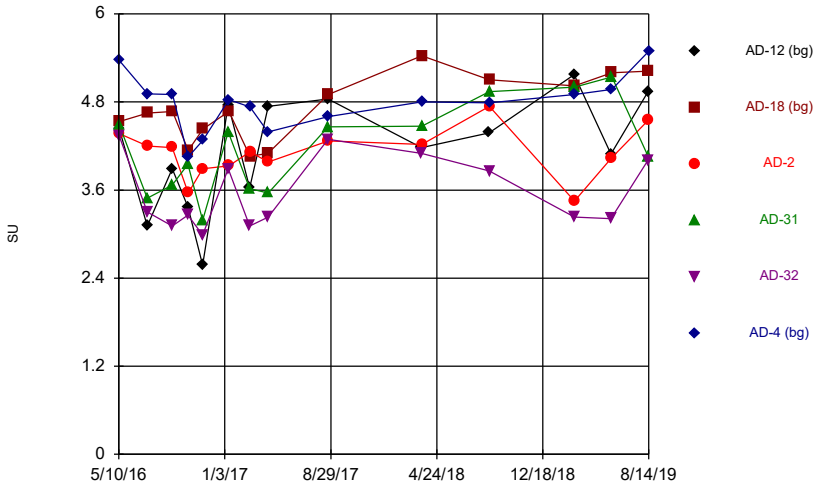
Time Series



Constituent: Molybdenum, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

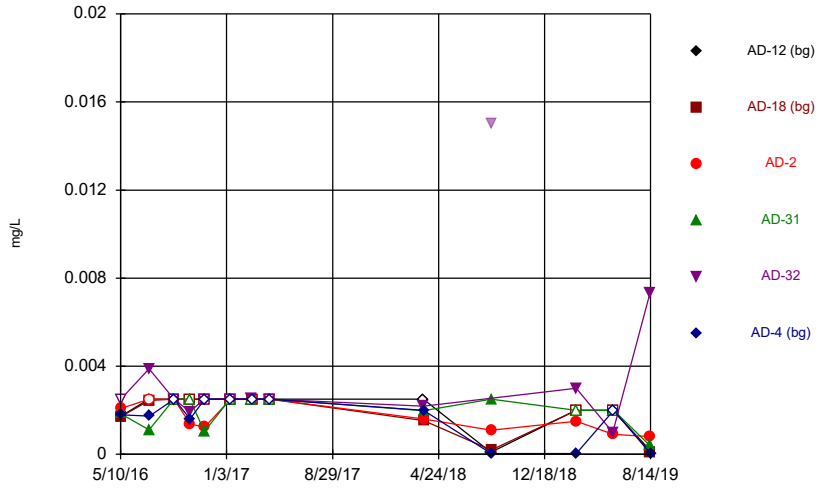
Time Series



Constituent: pH, field Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

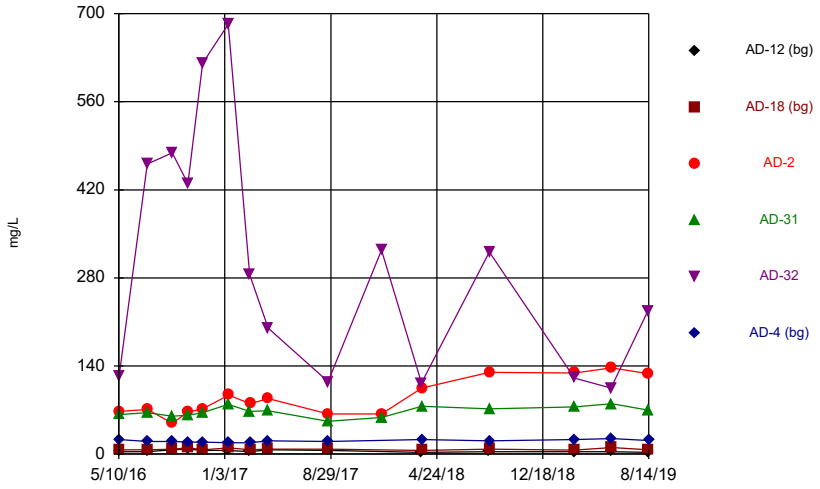
Time Series



Constituent: Selenium, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

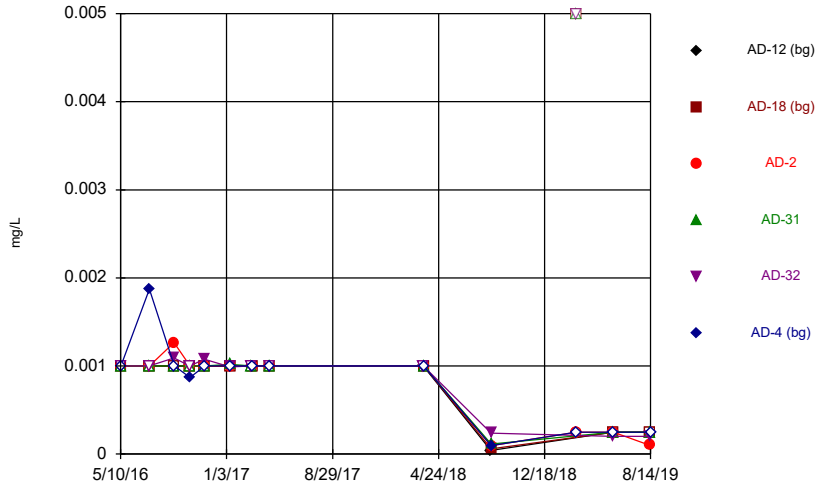
Time Series



Constituent: Sulfate, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

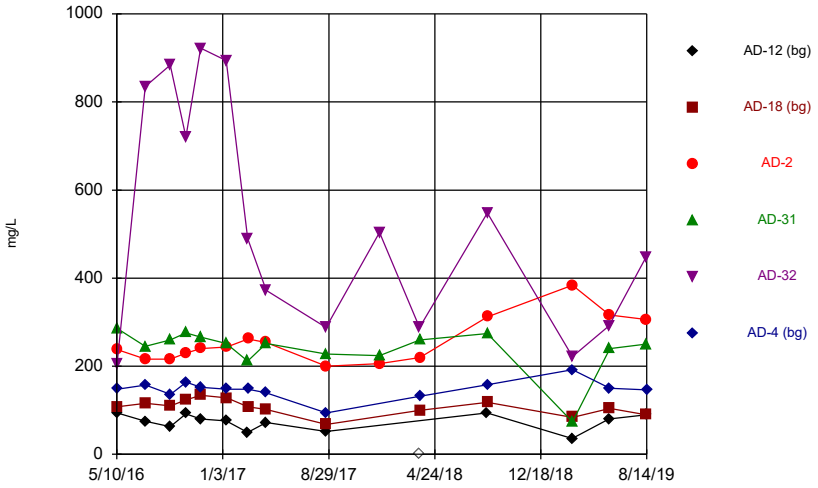
Time Series



Constituent: Thallium, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

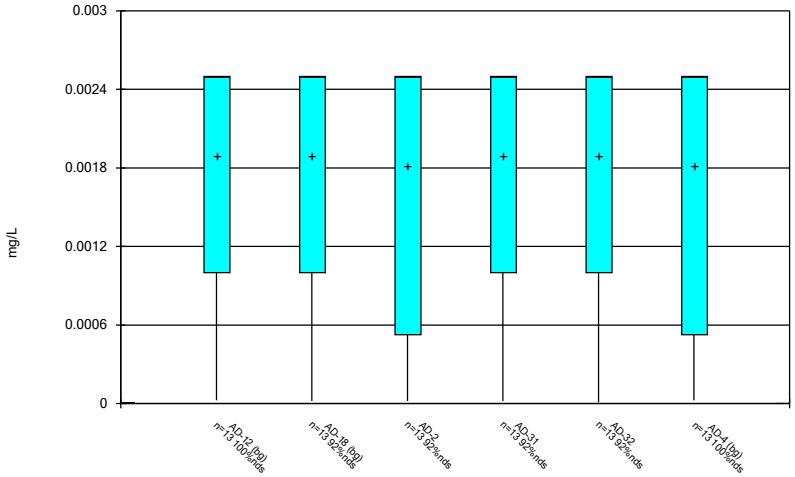
Time Series



Constituent: Total Dissolved Solids [TDS] Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

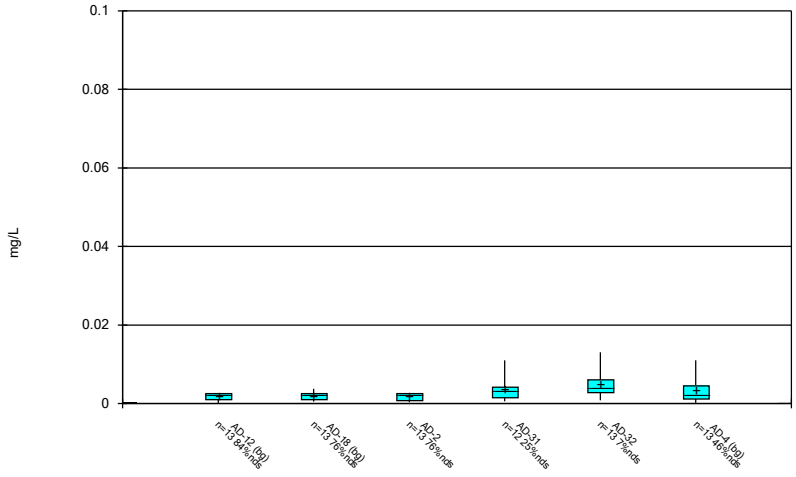
Box & Whiskers Plot



Constituent: Antimony, total Analysis Run 11/25/2019 11:36 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

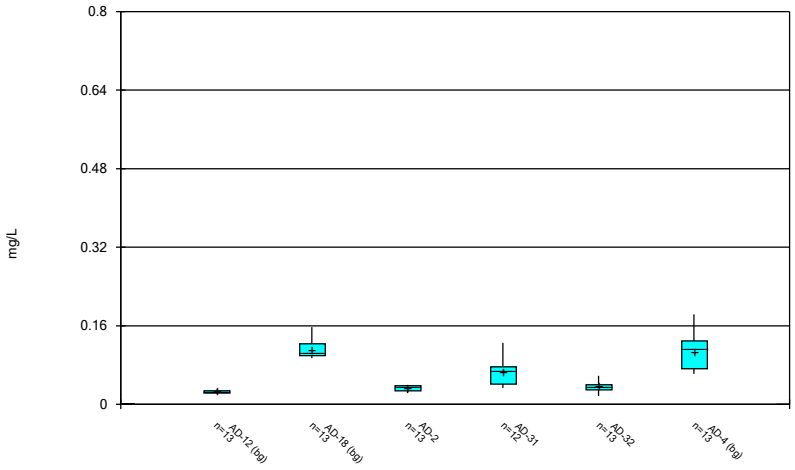
Box & Whiskers Plot



Constituent: Arsenic, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

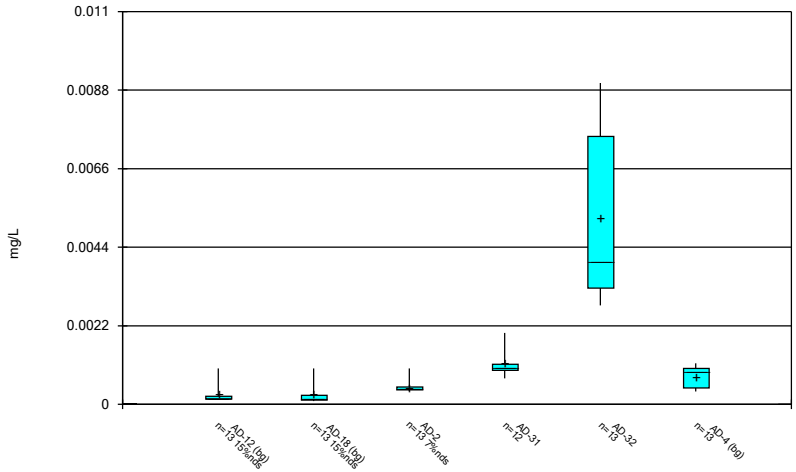
Box & Whiskers Plot



Constituent: Barium, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

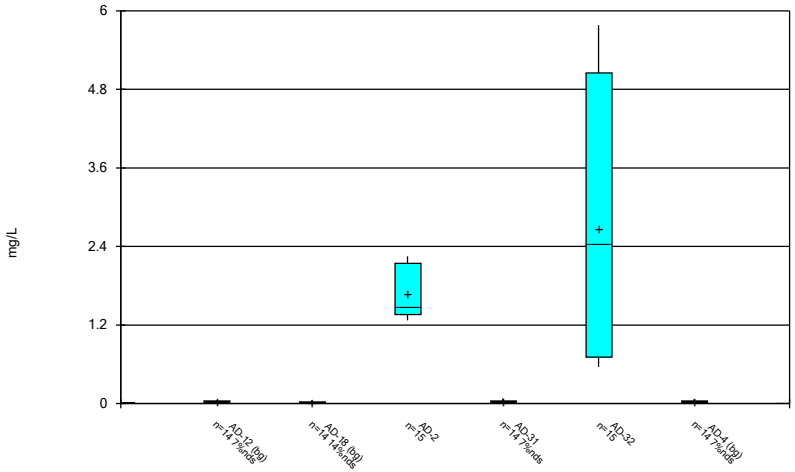
Box & Whiskers Plot



Constituent: Beryllium, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

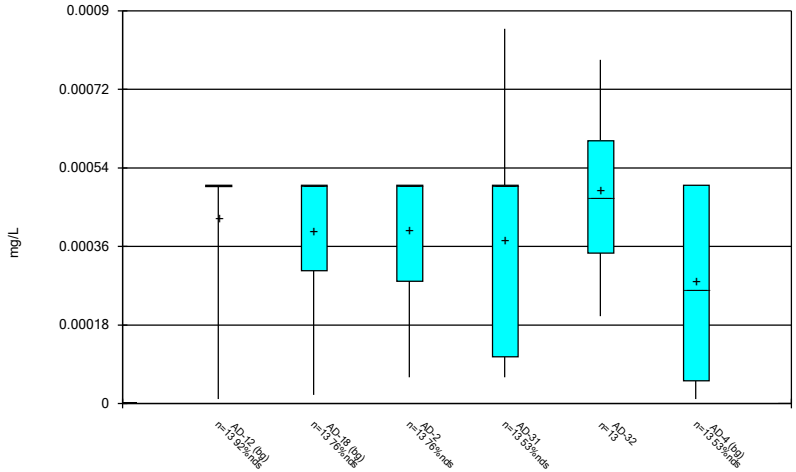
Box & Whiskers Plot



Constituent: Boron, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

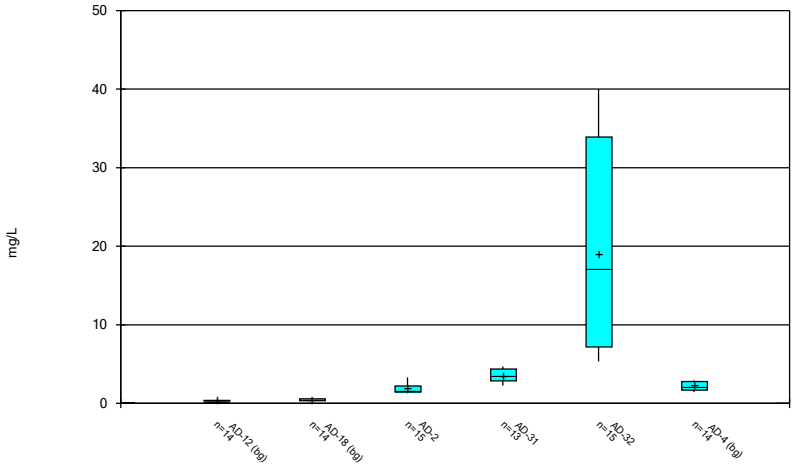
Box & Whiskers Plot



Constituent: Cadmium, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

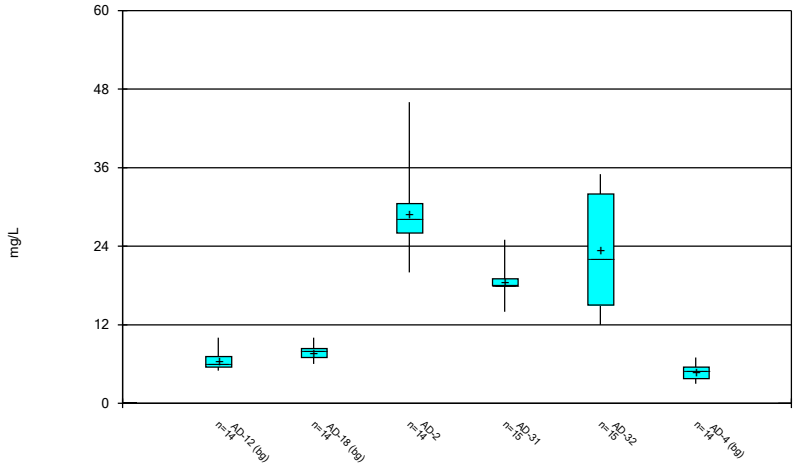
Box & Whiskers Plot



Constituent: Calcium, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

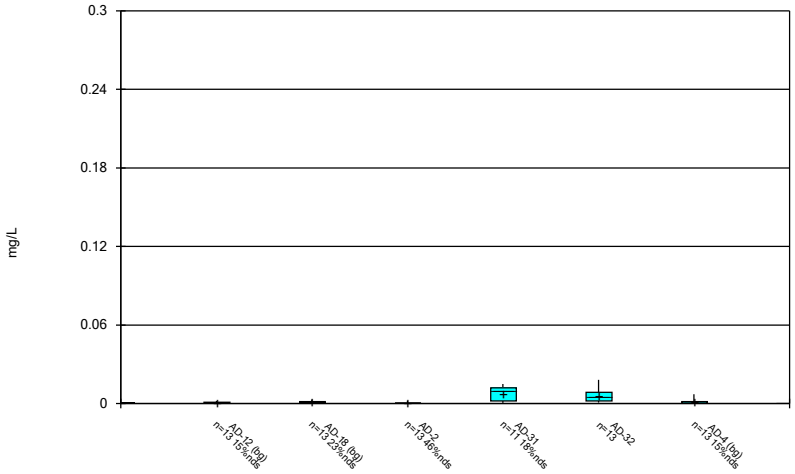
Box & Whiskers Plot



Constituent: Chloride, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

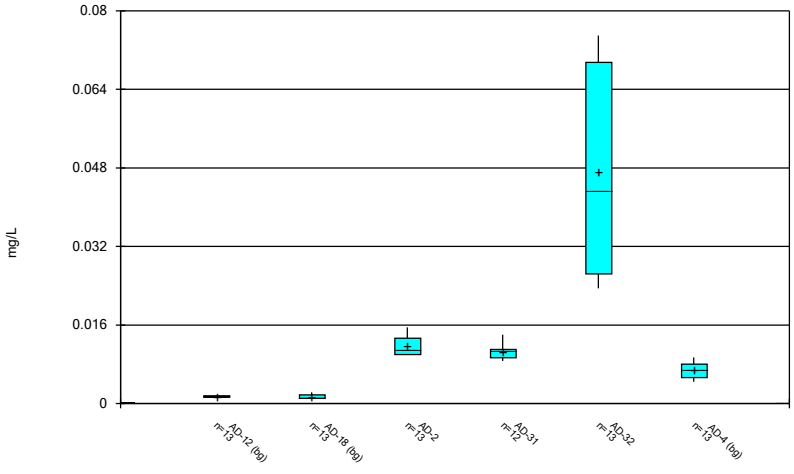
Box & Whiskers Plot



Constituent: Chromium, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

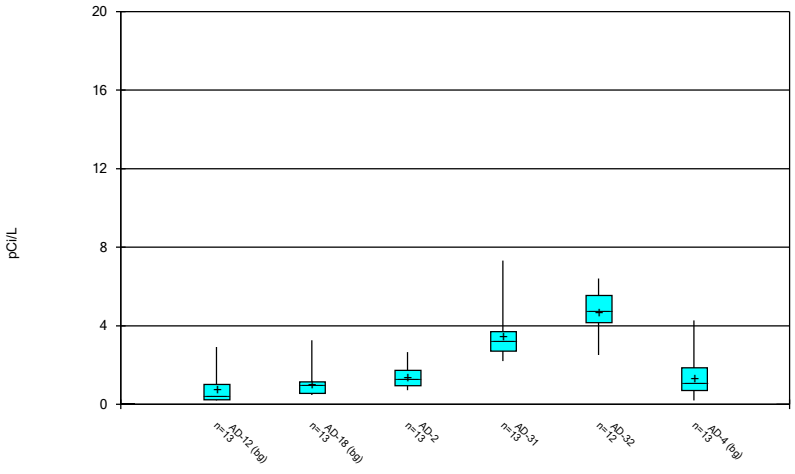
Box & Whiskers Plot



Constituent: Cobalt, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

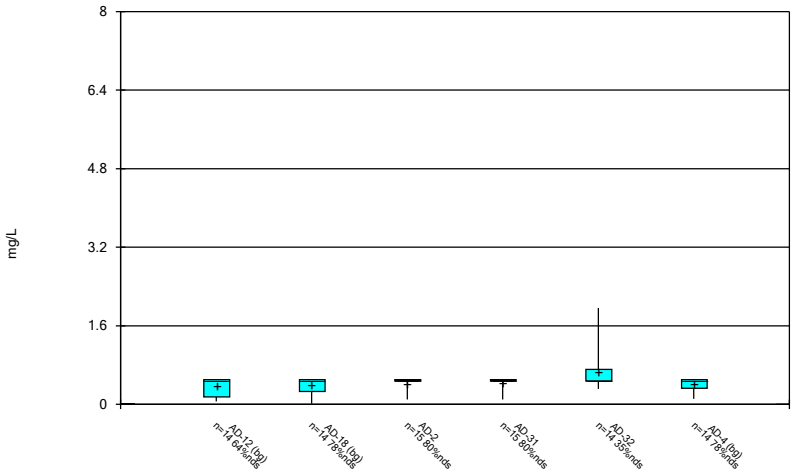
Box & Whiskers Plot



Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

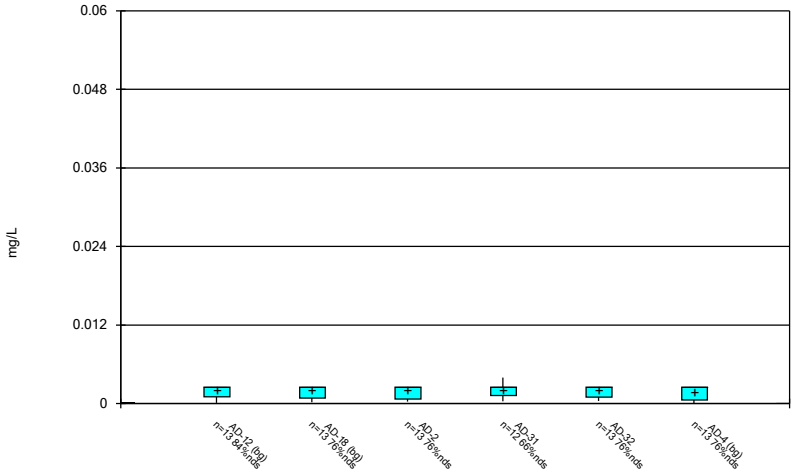
Box & Whiskers Plot



Constituent: Fluoride, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

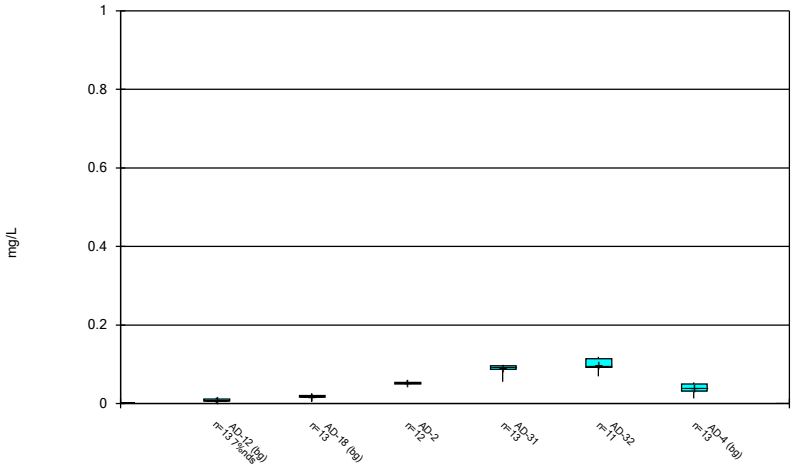
Box & Whiskers Plot



Constituent: Lead, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

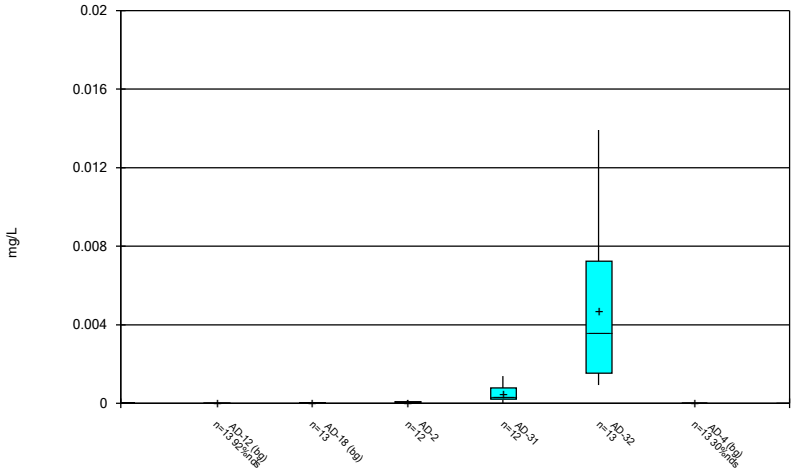
Box & Whiskers Plot



Constituent: Lithium, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

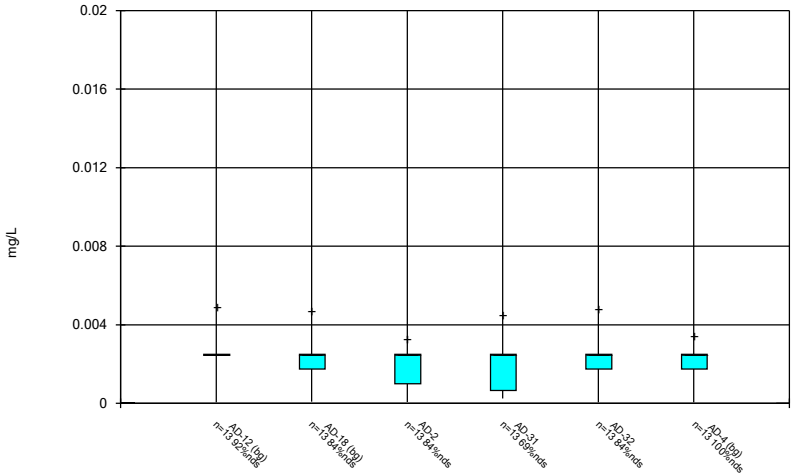
Box & Whiskers Plot



Constituent: Mercury, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

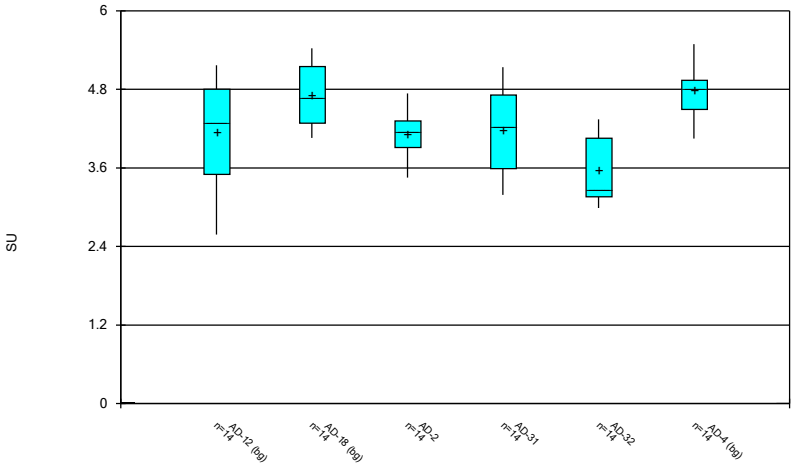
Box & Whiskers Plot



Constituent: Molybdenum, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

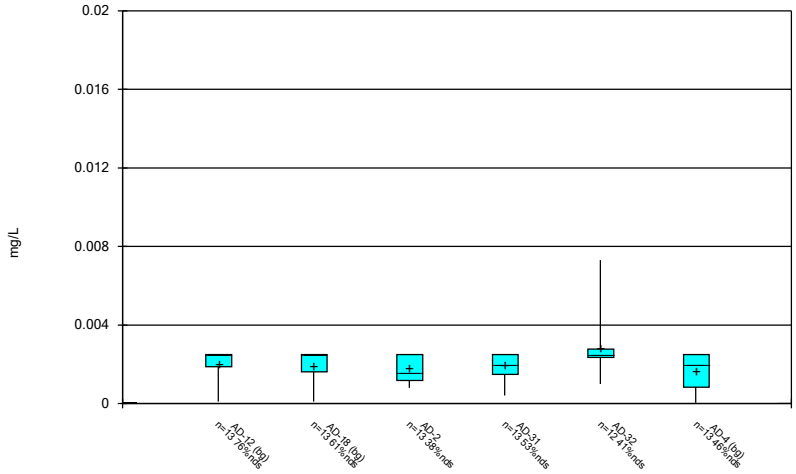
Box & Whiskers Plot



Constituent: pH, field Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

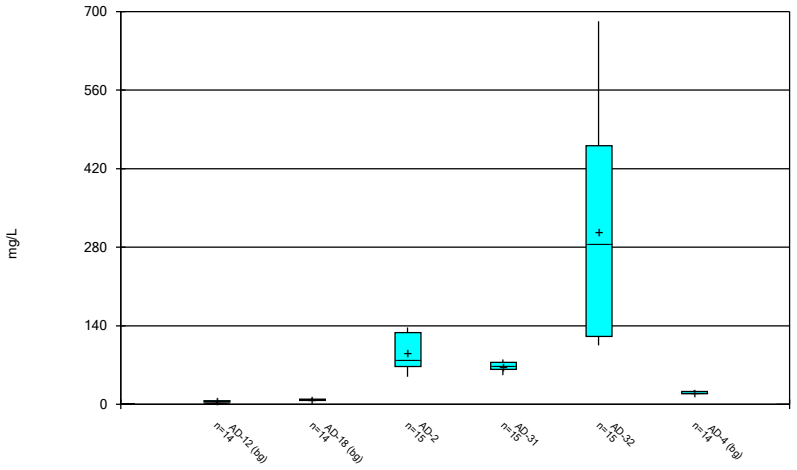
Box & Whiskers Plot



Constituent: Selenium, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

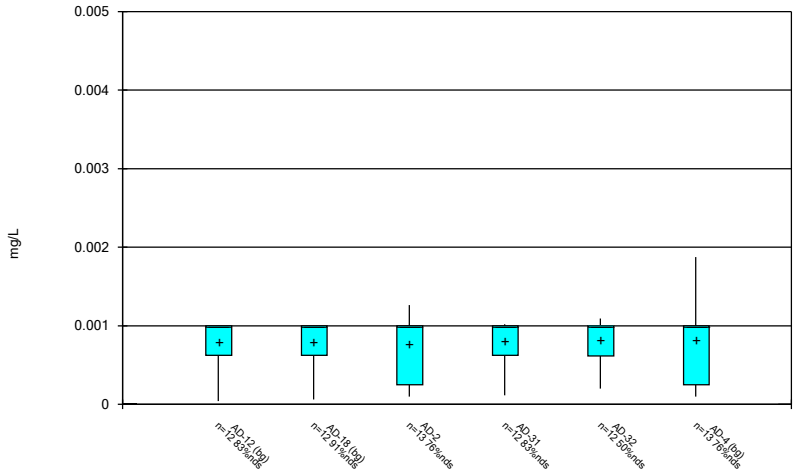
Box & Whiskers Plot



Constituent: Sulfate, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

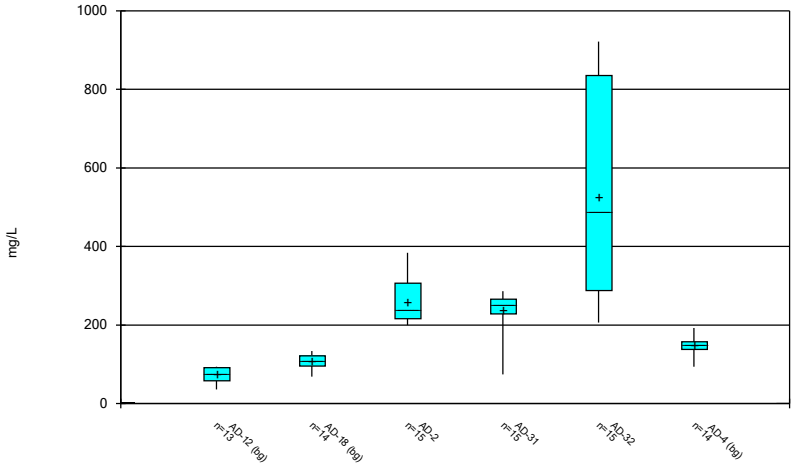
Sanitas™ v.9.6.23 . EPA

Box & Whiskers Plot



Constituent: Thallium, total Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



Constituent: Total Dissolved Solids [TDS] Analysis Run 11/25/2019 11:37 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Outlier Summary

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 11:50 AM

	AD-31 Arsenic, total (mg/L)	AD-31 Barium, total (mg/L)	AD-31 Beryllium, total (mg/L)	AD-31 Calcium, total (mg/L)	AD-2 Chloride, total (mg/L)	AD-31 Chromium, total (mg/L)	AD-31 Cobalt, total (mg/L)	AD-32 Combined Radium 226 + 228 (pCi/L)	AD-32 Fluoride, total (mg/L)	AD-31 Lead, total (mg/L)
5/11/2016	0.093 (o)	0.712 (o)	0.01 (o)	10.4 (o)		0.212 (o)	0.05 (o)			0.057 (o)
9/7/2016										
10/12/2016								17.32 (o)		
11/14/2016						0.03 (o)				
4/11/2017					50 (o)					
3/21/2018									7.2 (o)	
8/21/2018										
2/27/2019										
2/28/2019										

	AD-2 Lithium, total (mg/L)	AD-32 Lithium, total (mg/L)	AD-2 Mercury, total (mg/L)	AD-31 Mercury, total (mg/L)	AD-32 Selenium, total (mg/L)	AD-12 Thallium, total (mg/L)	AD-18 Thallium, total (mg/L)	AD-31 Thallium, total (mg/L)	AD-32 Thallium, total (mg/L)	AD-12 Total Dissolved Solids [TDS] (mg/L)
5/11/2016	<0.001 (o)	0.016 (o)		0.001797 (o)						
9/7/2016			0.000675 (o)							
10/12/2016		0.972 (o)								
11/14/2016										
4/11/2017										
3/21/2018										<5 (o)
8/21/2018					0.015 (o)					
2/27/2019						<0.01 (o)				
2/28/2019							<0.01 (o)	<0.01 (o)	<0.01 (o)	

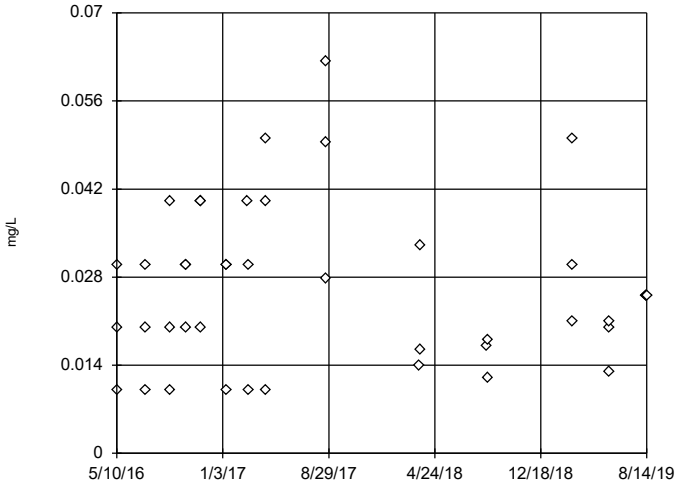
Interwell Outlier Analysis - All Results (No Significant)

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 10:07 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Boron, total (mg/L)	AD-12,AD-...	No	n/a	n/a w/com...	NP	NaN	42	0.02619	0.01281	x^(1/3)	ShapiroWilk
Calcium, total (mg/L)	AD-12,AD-...	No	n/a	n/a w/com...	NP	NaN	42	0.9856	0.9174	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-12,AD-...	No	n/a	n/a w/com...	NP	NaN	42	6.291	1.698	sqrt(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-12,AD-...	No	n/a	n/a w/com...	NP	NaN	42	0.7652	0.4008	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-12,AD-...	No	n/a	n/a w/com...	NP	NaN	42	11.18	7.187	ln(x)	ShapiroWilk
Total Dissolved Solids [TDS] (m...	AD-12,AD-...	No	n/a	n/a w/com...	NP	NaN	41	110.1	35.78	normal	ShapiroWilk

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4



n = 42

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1226, low cutoff = 0.0004167, based on IQR multiplier of 3.

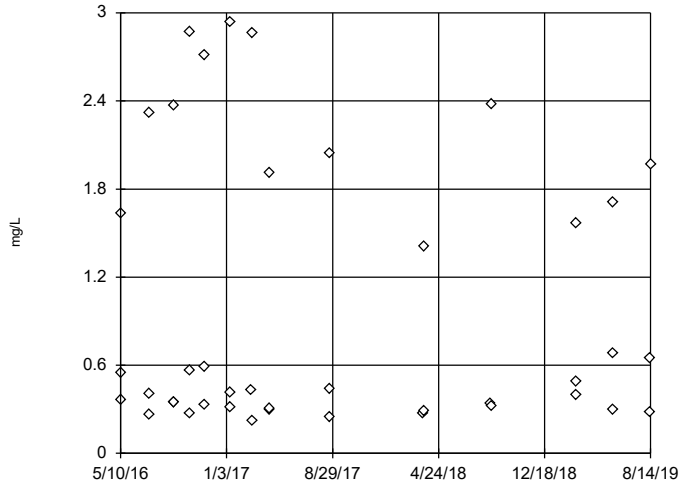
Constituent: Boron, total Analysis Run 11/25/2019 10:05 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4



n = 42

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 360, low cutoff = 0.001554, based on IQR multiplier of 3.

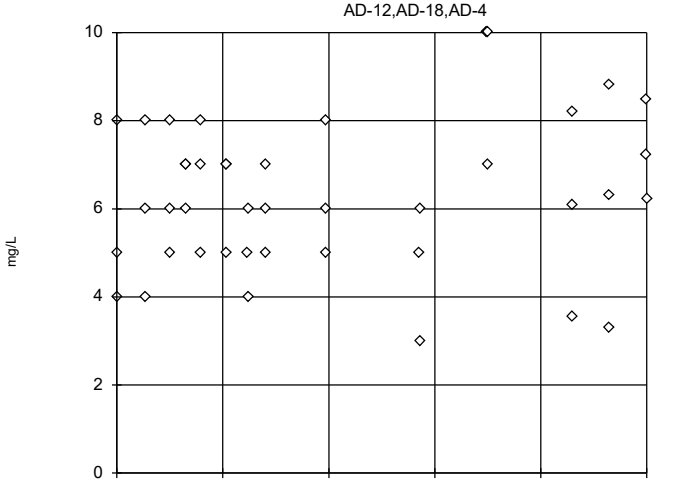
Constituent: Calcium, total Analysis Run 11/25/2019 10:05 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4



n = 42

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 18.75, low cutoff = 0.4429, based on IQR multiplier of 3.

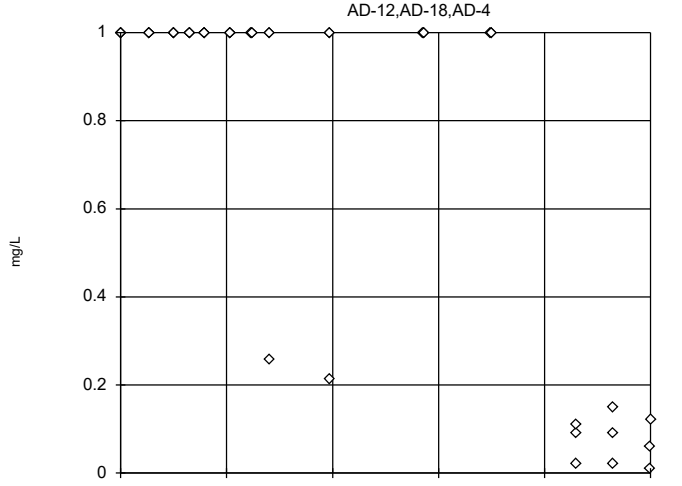
Constituent: Chloride, total Analysis Run 11/25/2019 10:05 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4



n = 42

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

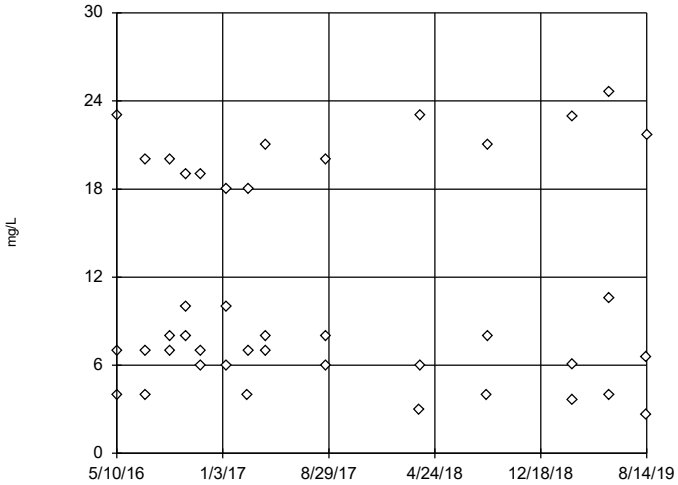
High cutoff = 78.31, low cutoff = 0.002985, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/25/2019 10:06 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4



n = 42

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

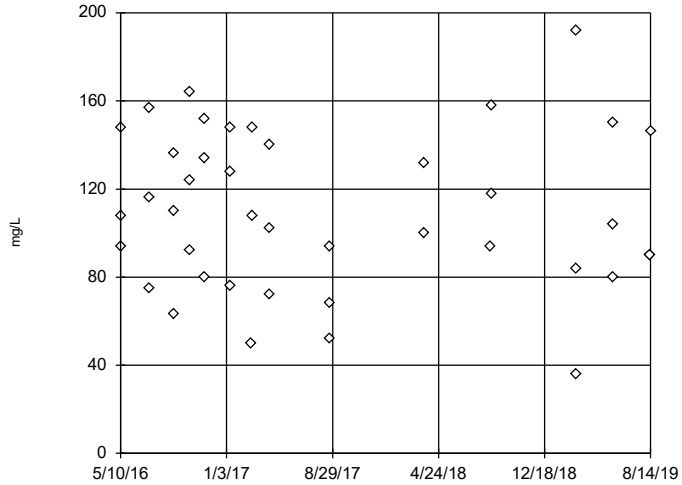
High cutoff = 668.5, low cutoff = 0.175, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/25/2019 10:06 AM View: Interwell AIII
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4



n = 41

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 326, low cutoff = -101, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/25/2019 10:06 AM View: Interwell AIII
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Intrawell Outlier Analysis - All Results (No Significant)

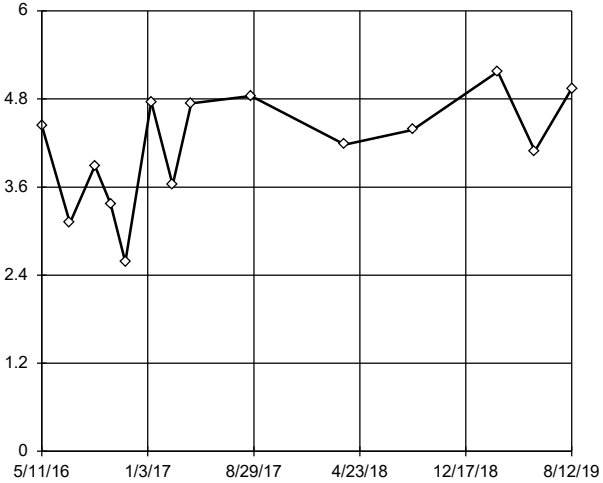
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 10:08 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
pH, field (SU)	AD-12 (bg)	No	n/a	n/a	NP	NaN	14	4.151	0.7593	x^3	ShapiroWilk
pH, field (SU)	AD-18 (bg)	No	n/a	n/a	NP	NaN	14	4.723	0.4418	x^2	ShapiroWilk
pH, field (SU)	AD-2	No	n/a	n/a	NP	NaN	14	4.107	0.3452	x^2	ShapiroWilk
pH, field (SU)	AD-31	No	n/a	n/a	NP	NaN	14	4.174	0.6174	x^(1/3)	ShapiroWilk
pH, field (SU)	AD-32	No	n/a	n/a	NP	NaN	14	3.566	0.4853	ln(x)	ShapiroWilk
pH, field (SU)	AD-4 (bg)	No	n/a	n/a	NP	NaN	14	4.786	0.3829	normal	ShapiroWilk

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-12 (bg)



n = 14

No outliers found. Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

High cutoff = 6.792, low cutoff = -5.425, based on IQR multiplier of 3.

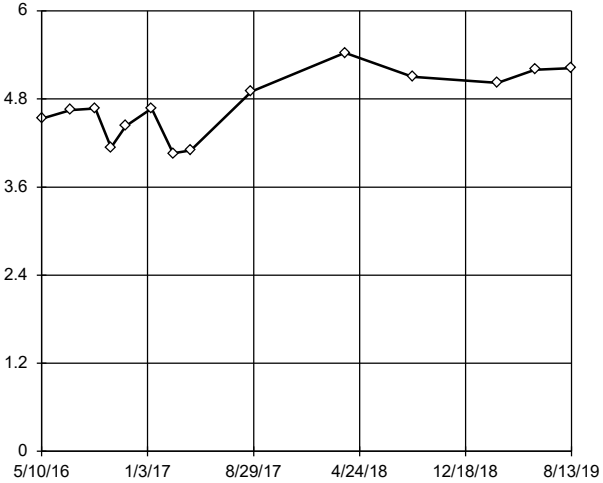
Constituent: pH, field Analysis Run 11/25/2019 10:08 AM View: Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-18 (bg)



n = 14

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 7.138, low cutoff = -2.459, based on IQR multiplier of 3.

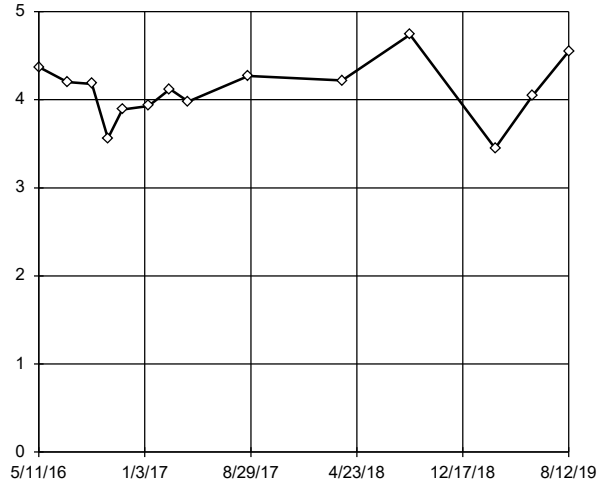
Constituent: pH, field Analysis Run 11/25/2019 10:08 AM View: Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 14

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 5.366, low cutoff = 2.271, based on IQR multiplier of 3.

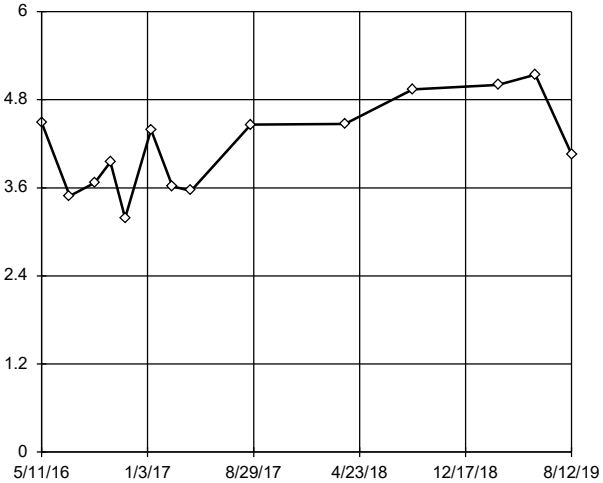
Constituent: pH, field Analysis Run 11/25/2019 10:08 AM View: Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 14

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

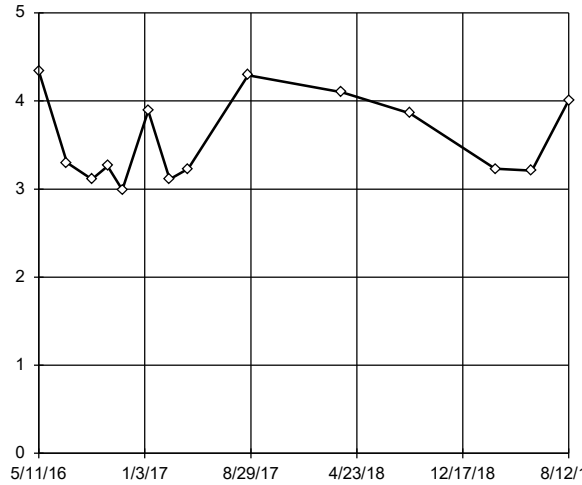
High cutoff = 9.423, low cutoff = 1.315, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/25/2019 10:08 AM View: Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening

AD-32



n = 14

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

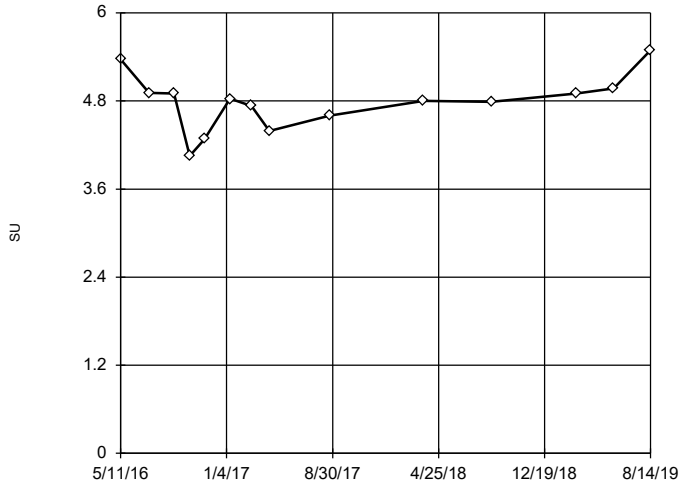
High cutoff = 8.57, low cutoff = 1.495, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/25/2019 10:08 AM View: Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-4 (bg)



n = 14

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 6.275, low cutoff = 3.16, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/25/2019 10:08 AM View: Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Downgradient Appendix IV Outlier Analysis - Significant Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 10:18 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Beryllium, total (mg/L)	**AD-2**	**Yes**	**0.001**	**5/22/2019**	**NP**	**NaN**	**13**	**0.000...**	**0.0001631**	**ln(x)**	**ShapiroWilk**
Beryllium, total (mg/L)	**AD-31**	**Yes**	**0.01**	**5/11/2016**	**NP**	**NaN**	**13**	**0.001824**	**0.002489**	**ln(x)**	**ShapiroWilk**
Fluoride, total (mg/L)	**AD-32**	**Yes**	**7.2**	**3/21/2018**	**NP**	**NaN**	**15**	**1.257**	**1.69**	**ln(x)**	**ShapiroWilk**
Molybdenum, total (mg/L)	**AD-32**	**Yes**	**0.00004,0...**	**8/21/2018...**	**NP**	**NaN**	**13**	**0.009446**	**0.01368**	**x^(1/3)**	**ShapiroWilk**

Downgradient Appendix IV Outlier Analysis - All Results

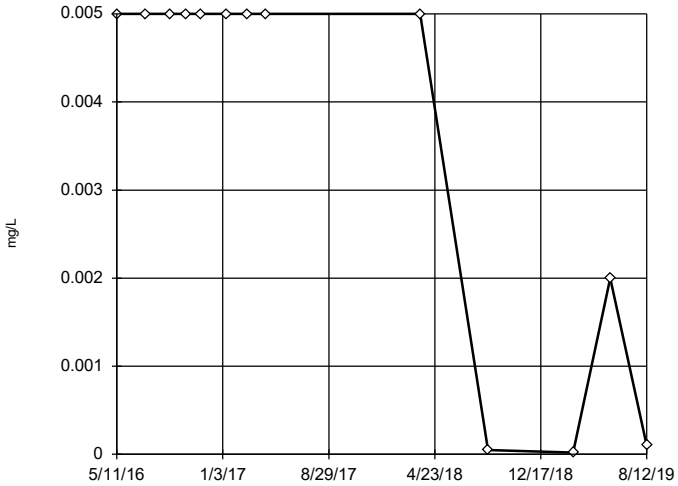
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 10:18 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.003628	0.002196	sqrt(x)	ShapiroWilk
Antimony, total (mg/L)	AD-31	n/a	n/a	n/a	NP	NaN	13	0.003778	0.001988	unknown	ShapiroWilk
Antimony, total (mg/L)	AD-32	n/a	n/a	n/a	NP	NaN	13	0.003778	0.001989	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.003723	0.002031	x^(1/3)	ShapiroWilk
Arsenic, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	12	0.003897	0.002691	x^(1/3)	ShapiroWilk
Arsenic, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.005052	0.003274	x^(1/3)	ShapiroWilk
Barium, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.03352	0.0057	x^6	ShapiroWilk
Barium, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	12	0.06554	0.02637	x^(1/3)	ShapiroWilk
Barium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.03612	0.01024	sqrt(x)	ShapiroWilk
Beryllium, total (mg/L)	**AD-2**	**Yes**	**0.001**	**5/22/2019**	**NP**	**NaN**	**13**	**0.000...**	**0.0001631**	**ln(x)**	**ShapiroWilk**
Beryllium, total (mg/L)	**AD-31**	**Yes**	**0.01**	**5/11/2016**	**NP**	**NaN**	**13**	**0.001824**	**0.002489**	**ln(x)**	**ShapiroWilk**
Beryllium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.005202	0.002256	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.000...	0.0004122	sqrt(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	13	0.000...	0.0004484	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.000...	0.0001743	normal	ShapiroWilk
Chromium, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.000...	0.0009898	ln(x)	ShapiroWilk
Chromium, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	12	0.009698	0.008089	x^(1/3)	ShapiroWilk
Chromium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.006133	0.005302	x^(1/3)	ShapiroWilk
Cobalt, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.01165	0.001847	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	12	0.01048	0.001419	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.04704	0.02056	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-2	No	n/a	n/a	NP	NaN	13	1.398	0.5579	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-31	No	n/a	n/a	NP	NaN	13	3.454	1.289	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-32	No	n/a	n/a	NP	NaN	12	4.735	1.074	x^2	ShapiroWilk
Fluoride, total (mg/L)	AD-2	n/a	n/a	n/a	NP	NaN	15	0.82	0.3726	unknown	ShapiroWilk
Fluoride, total (mg/L)	AD-31	n/a	n/a	n/a	NP	NaN	15	0.826	0.3604	unknown	ShapiroWilk
Fluoride, total (mg/L)	**AD-32**	**Yes**	**7.2**	**3/21/2018**	**NP**	**NaN**	**15**	**1.257**	**1.69**	**ln(x)**	**ShapiroWilk**
Lead, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.003691	0.002086	sqrt(x)	ShapiroWilk
Lead, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	12	0.003434	0.00182	sqrt(x)	ShapiroWilk
Lead, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.003778	0.001939	ln(x)	ShapiroWilk
Lithium, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.04812	0.01467	x^6	ShapiroWilk
Lithium, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	13	0.0892	0.01162	x^6	ShapiroWilk
Lithium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	12	0.09291	0.02791	x^4	ShapiroWilk
Mercury, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.000...	0.0001745	ln(x)	ShapiroWilk
Mercury, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	12	0.000...	0.0004424	x^(1/3)	ShapiroWilk
Mercury, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.004692	0.003739	ln(x)	ShapiroWilk
Molybdenum, total (mg/L)	AD-2	n/a	n/a	n/a	NP	NaN	13	0.006533	0.01022	unknown	ShapiroWilk
Molybdenum, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	13	0.008758	0.01402	ln(x)	ShapiroWilk
Molybdenum, total (mg/L)	**AD-32**	**Yes**	**0.00004,0...**	**8/21/2018...**	**NP**	**NaN**	**13**	**0.009446**	**0.01368**	**x^(1/3)**	**ShapiroWilk**
Selenium, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.002739	0.001887	ln(x)	ShapiroWilk
Selenium, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	13	0.003221	0.001784	sqrt(x)	ShapiroWilk
Selenium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	12	0.003903	0.001797	sqrt(x)	ShapiroWilk
Thallium, total (mg/L)	AD-2	n/a	n/a	n/a	NP	NaN	13	0.00142	0.0008116	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	13	0.002164	0.002461	ln(x)	ShapiroWilk
Thallium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.001985	0.002521	ln(x)	ShapiroWilk

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.0403, low cutoff = -0.01055, based on IQR multiplier of 3.

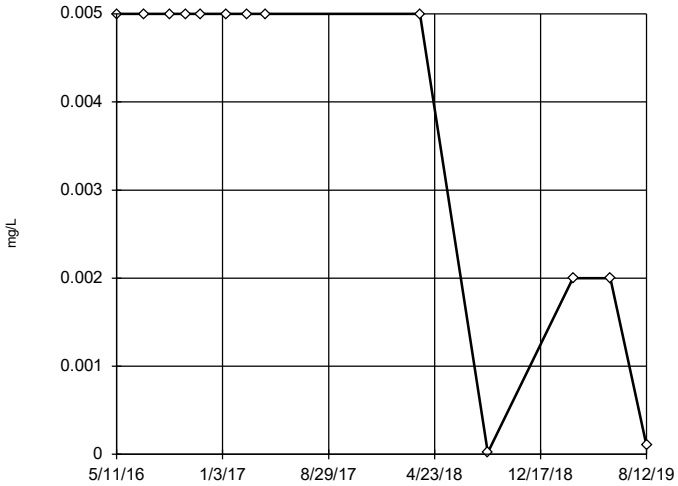
Constituent: Antimony, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

The results were invalidated, because both the lower and upper quartiles represent reporting limits.

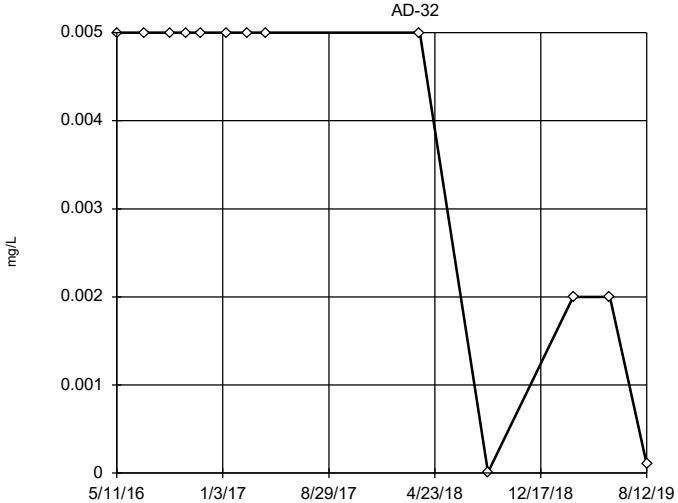
Constituent: Antimony, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

The results were invalidated, because both the lower and upper quartiles represent reporting limits.

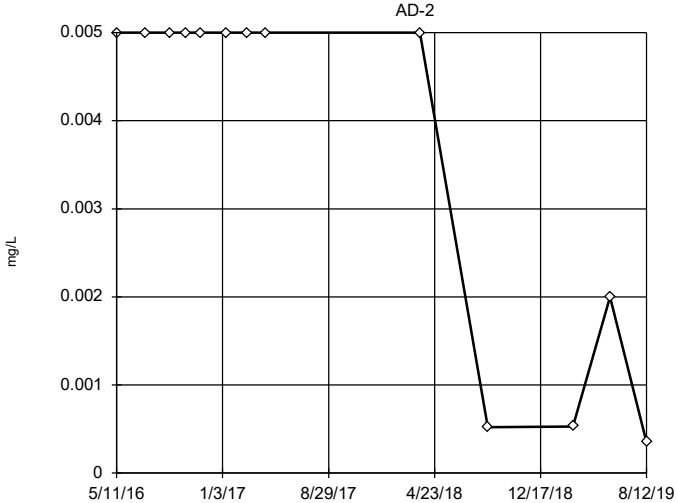
Constituent: Antimony, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

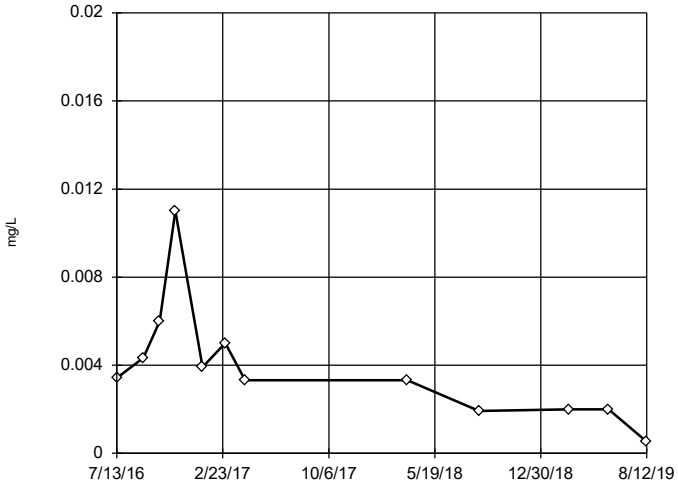
High cutoff = 0.05215, low cutoff = -0.0009749, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening

AD-31



n = 12

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.02445, low cutoff = 2.2e-8, based on IQR multiplier of 3.

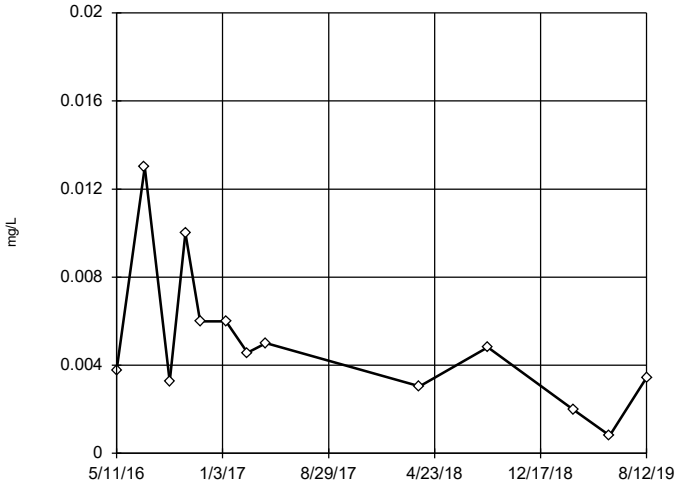
Constituent: Arsenic, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.02362, low cutoff = 0.00007109, based on IQR multiplier of 3.

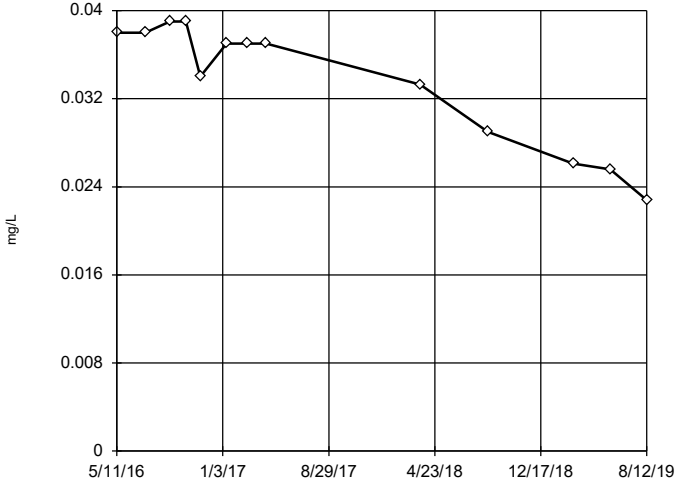
Constituent: Arsenic, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.04693, low cutoff = -0.04395, based on IQR multiplier of 3.

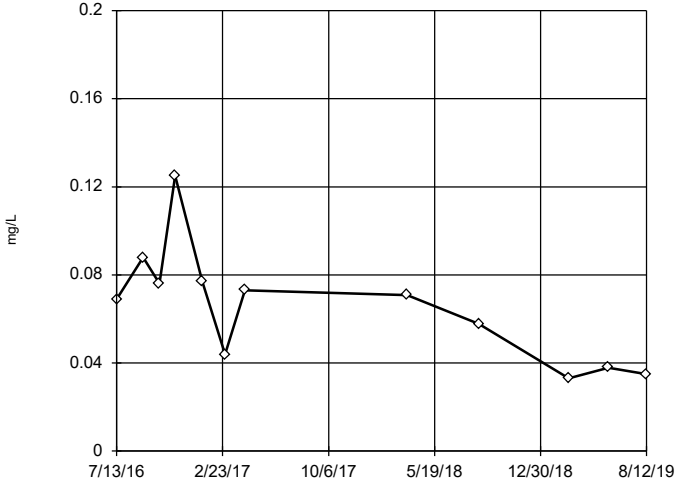
Constituent: Barium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 12

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

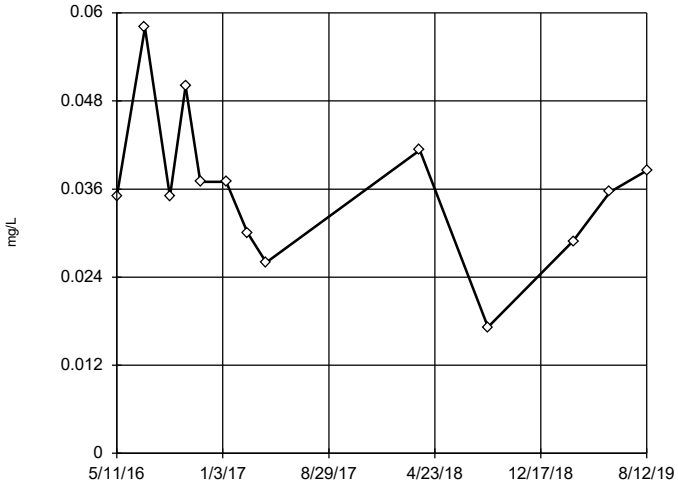
High cutoff = 0.2936, low cutoff = 0.001136, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

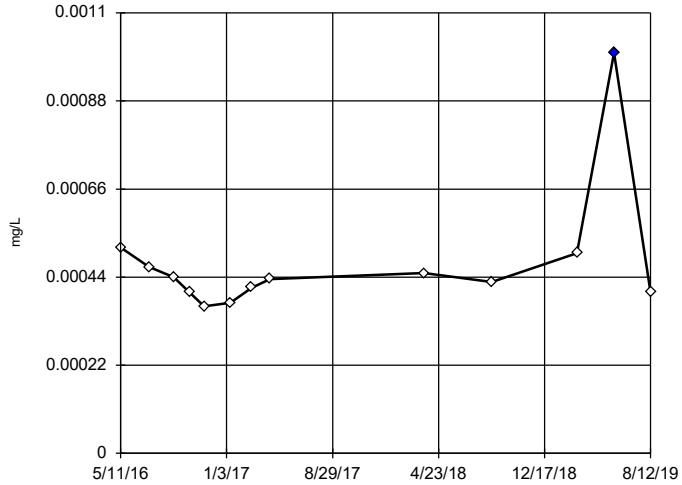
High cutoff = 0.0807, low cutoff = 0.007613, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

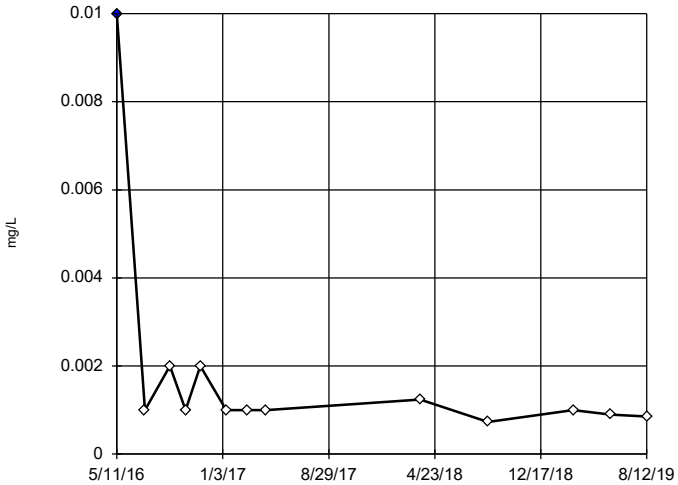
High cutoff = 0.0008336, low cutoff = 0.0002325, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 13

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

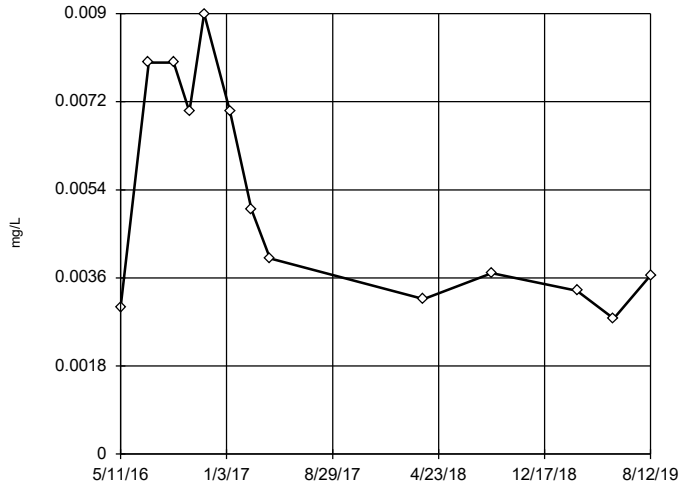
High cutoff = 0.007222, low cutoff = 0.0002067, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

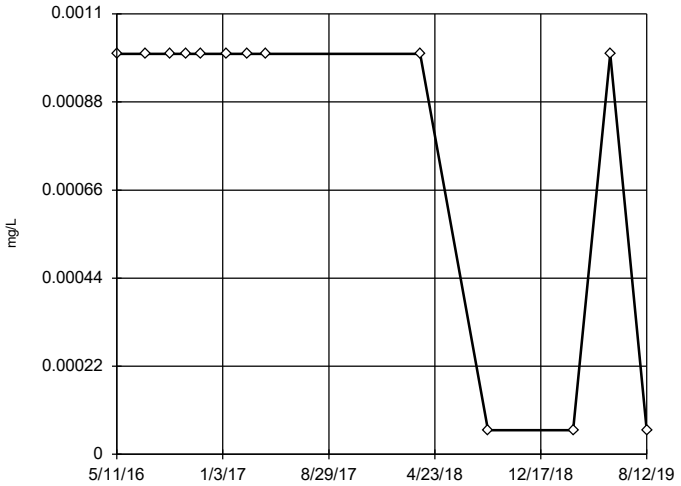
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.09103, low cutoff = 0.0002675, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.004548, low cutoff = -0.0002602, based on IQR multiplier of 3.

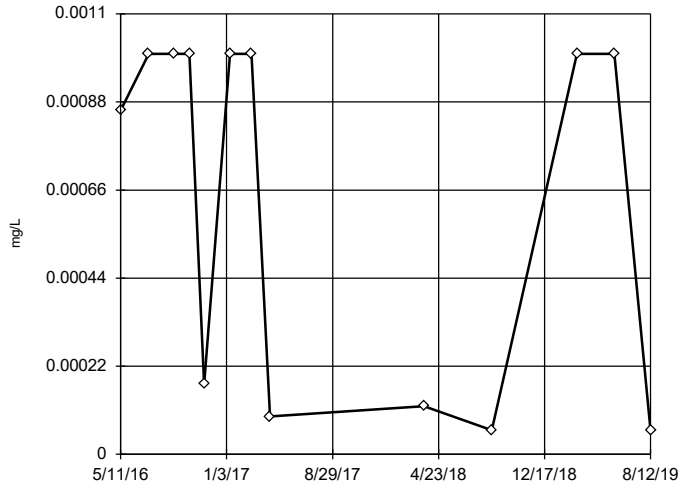
Constituent: Cadmium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.8294, low cutoff = 1.3e-7, based on IQR multiplier of 3.

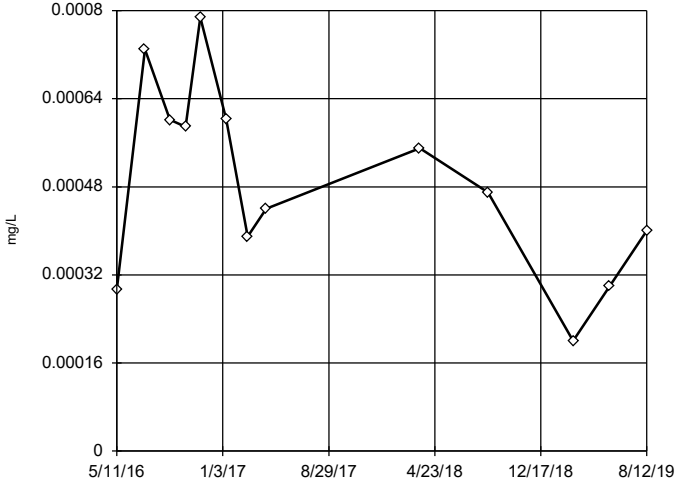
Constituent: Cadmium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.001373, low cutoff = -0.0004266, based on IQR multiplier of 3.

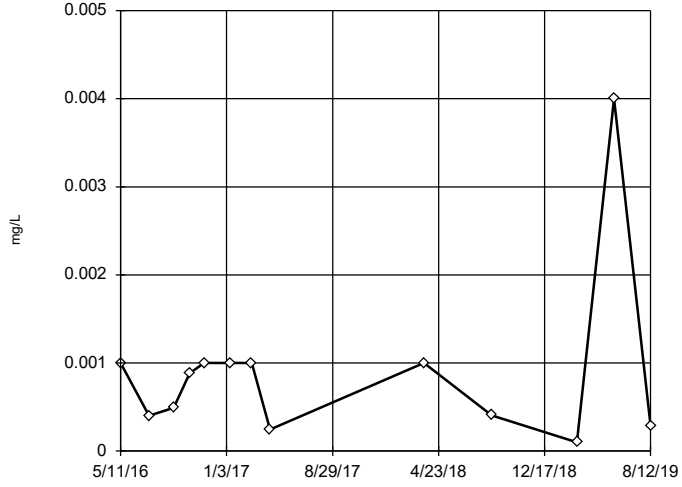
Constituent: Cadmium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

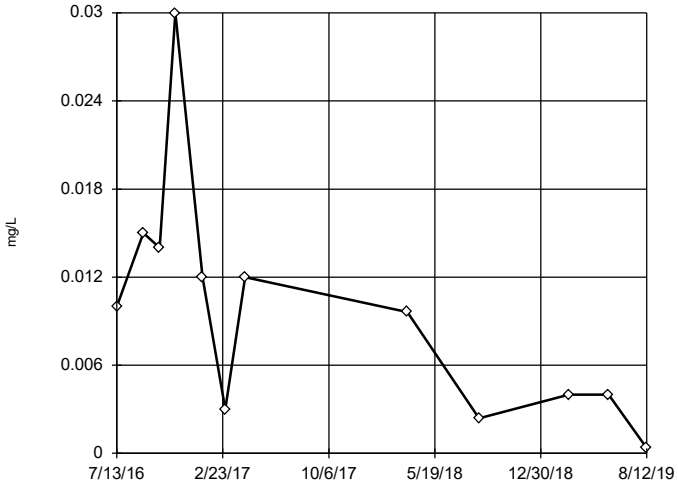
High cutoff = 0.02487, low cutoff = 0.00001377, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening

AD-31



n = 12

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

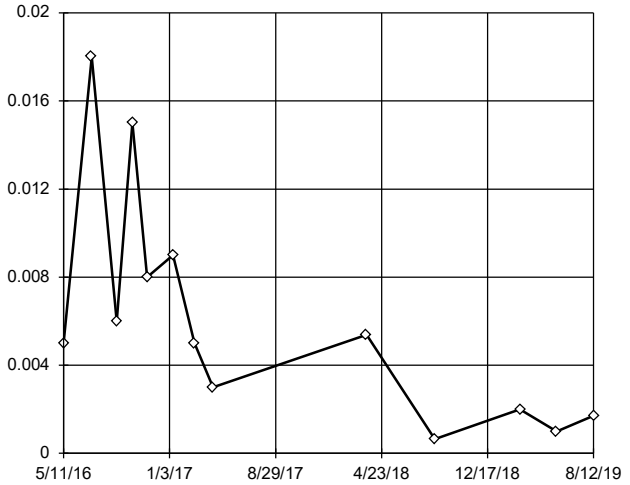
High cutoff = 0.1144, low cutoff = -0.0009705, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

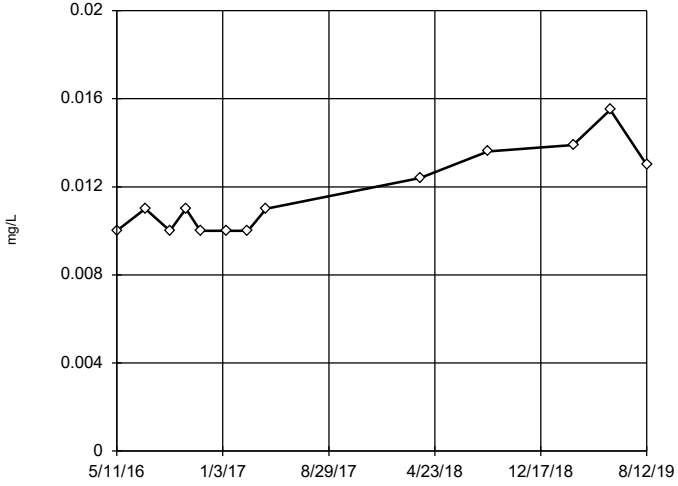
High cutoff = 0.08992, low cutoff = -0.001786, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

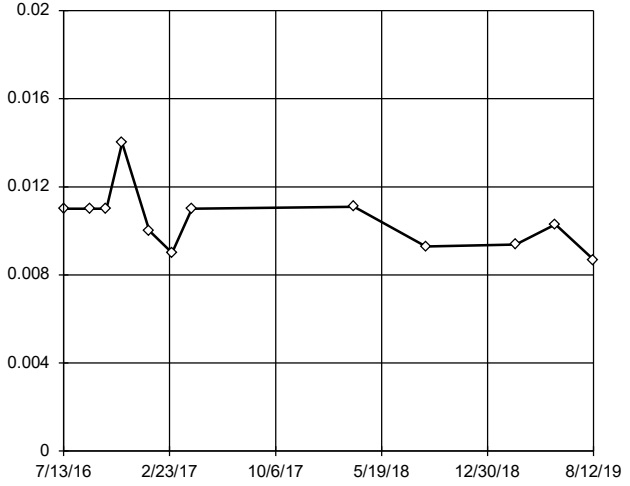
High cutoff = 0.03126, low cutoff = 0.004254, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 12

No outliers found. Tukey's method selected by user.

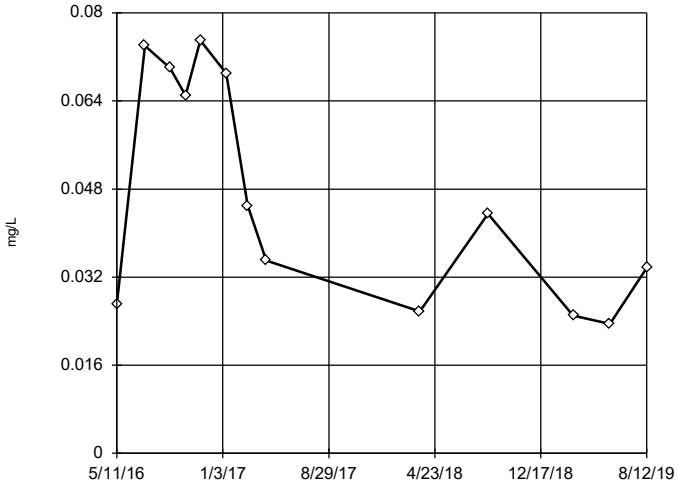
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.018, low cutoff = 0.005705, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

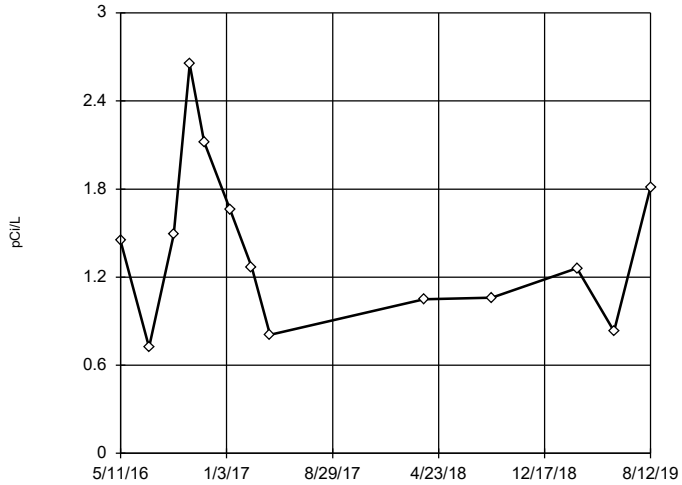
High cutoff = 1.269, low cutoff = 0.001446, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

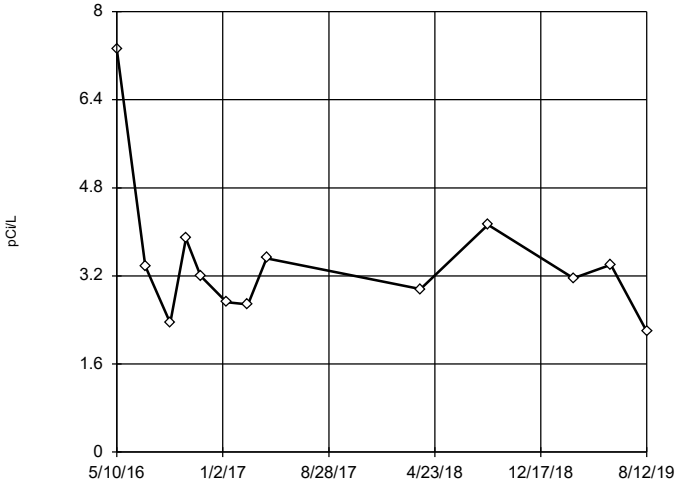
High cutoff = 11.03, low cutoff = 0.1468, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

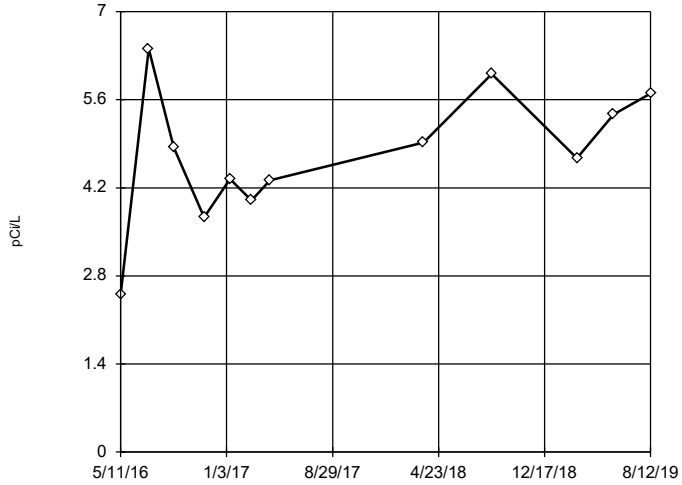
High cutoff = 9.436, low cutoff = 1.059, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 12

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

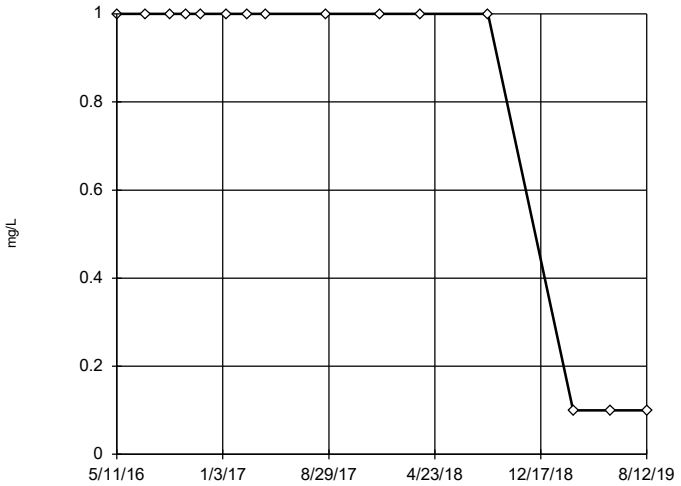
High cutoff = 8.405, low cutoff = -4.759, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 15

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

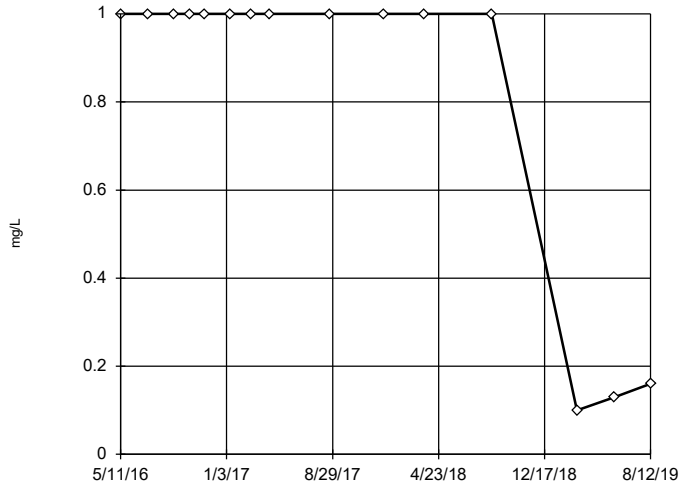
Constituent: Fluoride, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 15

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

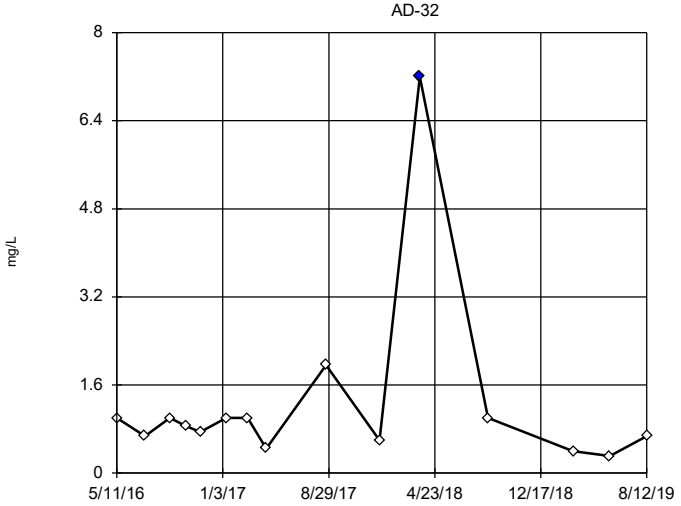
Constituent: Fluoride, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 15

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 4.791, low cutoff = 0.1238, based on IQR multiplier of 3.

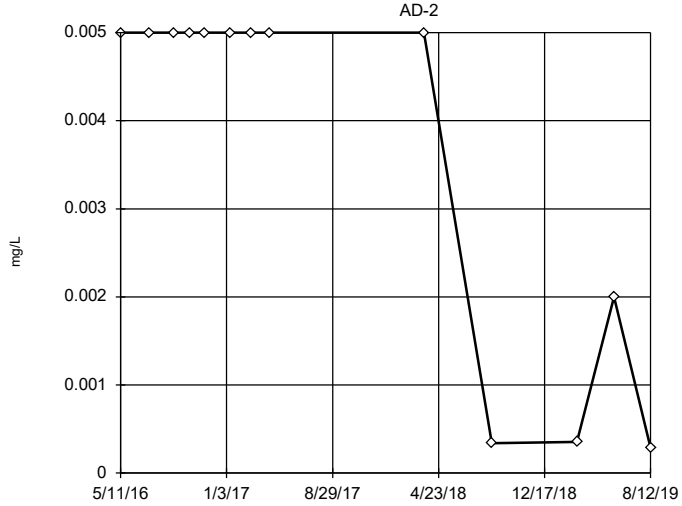
Constituent: Fluoride, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

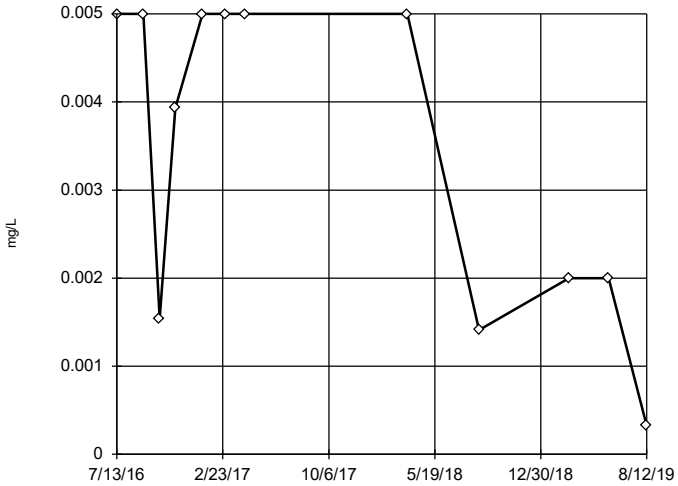
High cutoff = 0.03516, low cutoff = -0.007226, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening

AD-31



n = 12

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

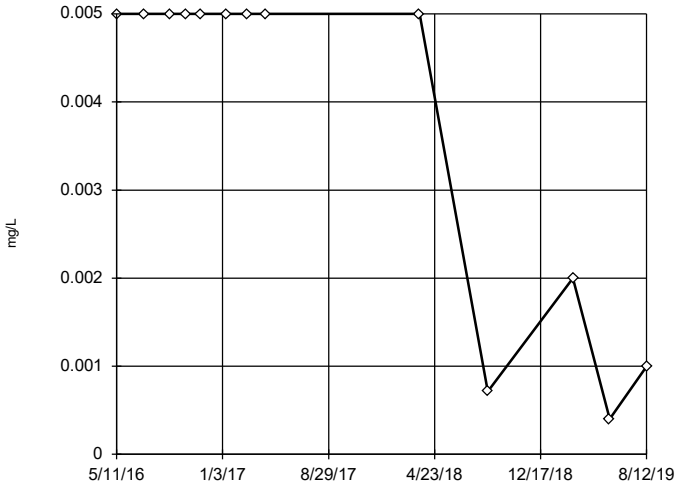
High cutoff = 0.02462, low cutoff = -0.001953, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

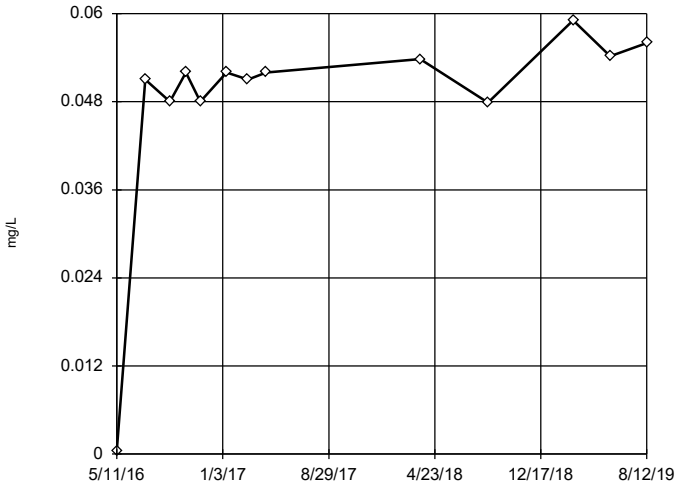
High cutoff = 0.2223, low cutoff = 0.00003174, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

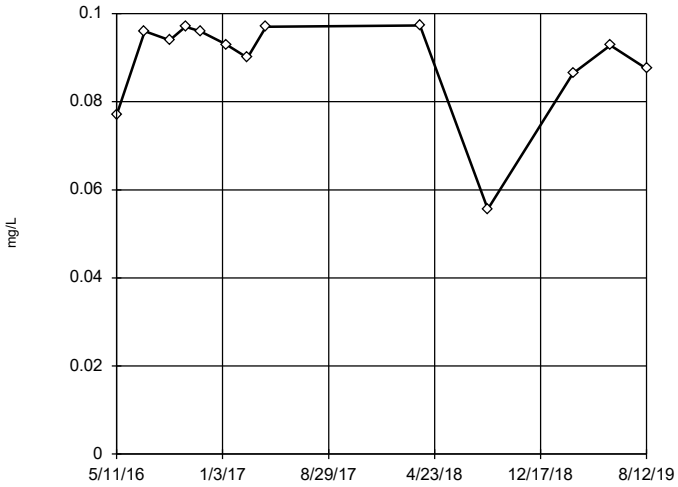
High cutoff = 0.063, low cutoff = -0.05425, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 13

No outliers found. Tukey's method selected by user.

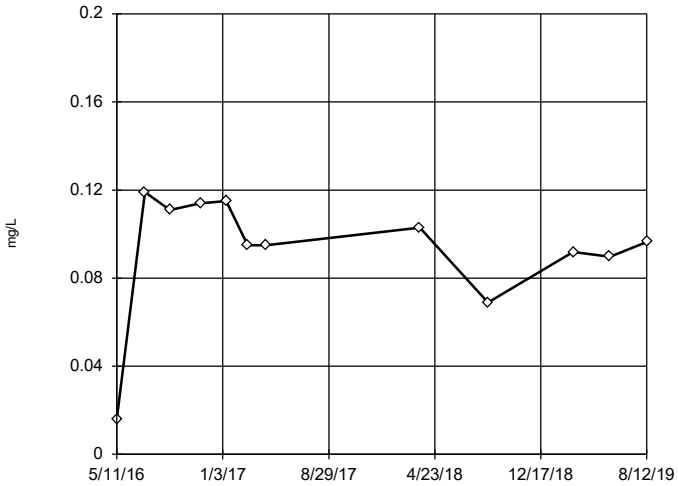
Data were x^6 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1116, low cutoff = -0.09409, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening

AD-32



n = 12

No outliers found. Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1446, low cutoff = -0.1202, based on IQR multiplier of 3.

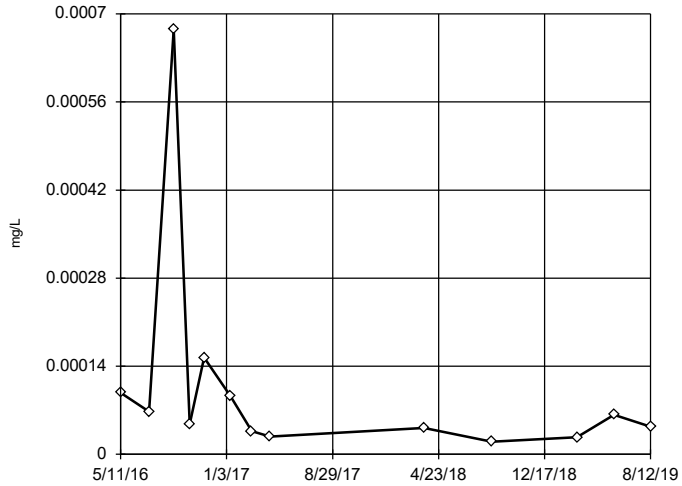
Constituent: Lithium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.002491, low cutoff = 0.000001234, based on IQR multiplier of 3.

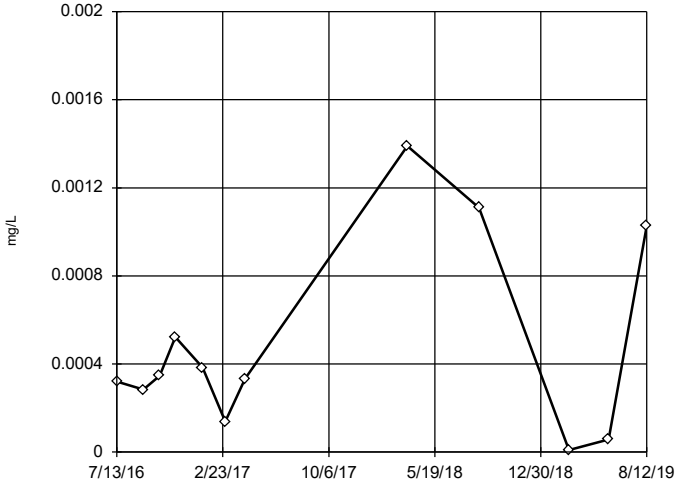
Constituent: Mercury, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 12

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.006519, low cutoff = -0.00005221, based on IQR multiplier of 3.

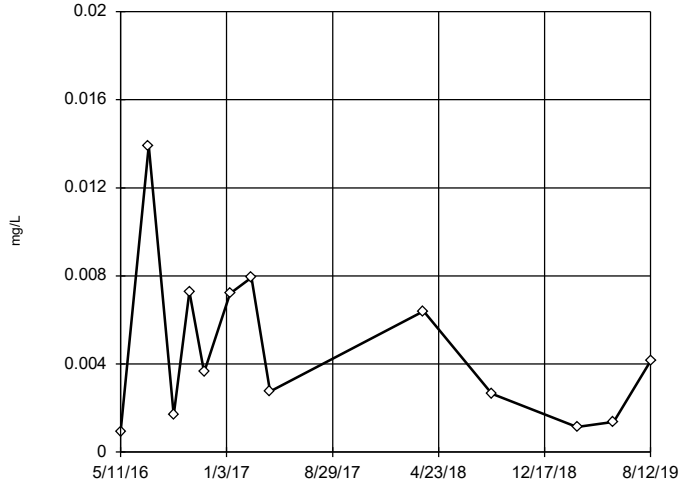
Constituent: Mercury, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

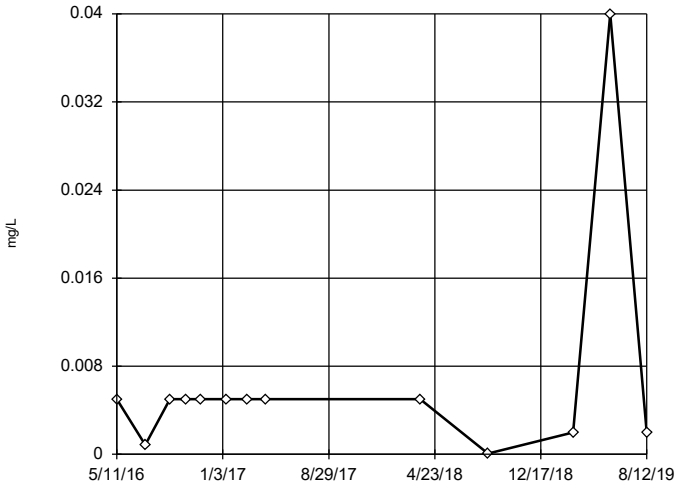
High cutoff = 0.7875, low cutoff = 0.00001396, based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening

AD-2



n = 13

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

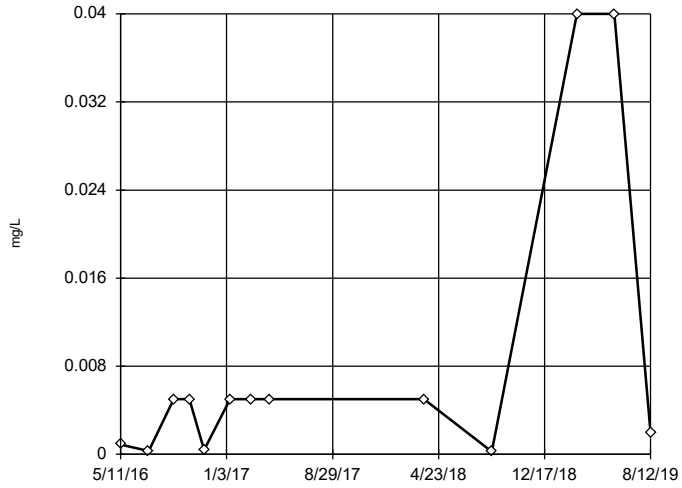
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Molybdenum, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 13

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

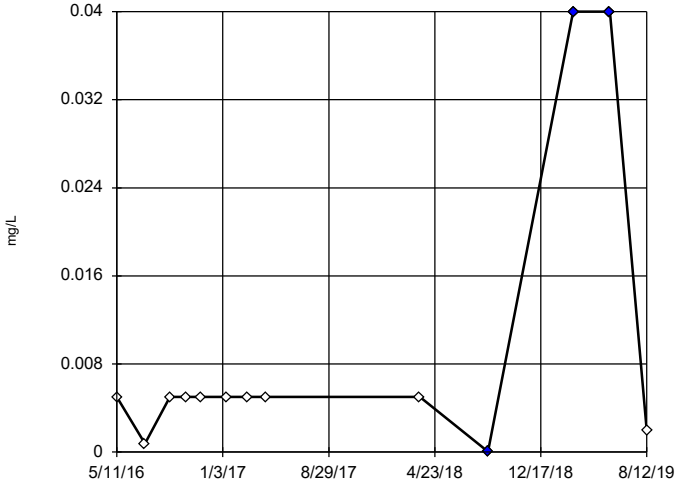
High cutoff = 2.906, low cutoff = 0.000001031, based on IQR multiplier of 3.

Constituent: Molybdenum, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

Outliers are drawn as solid.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

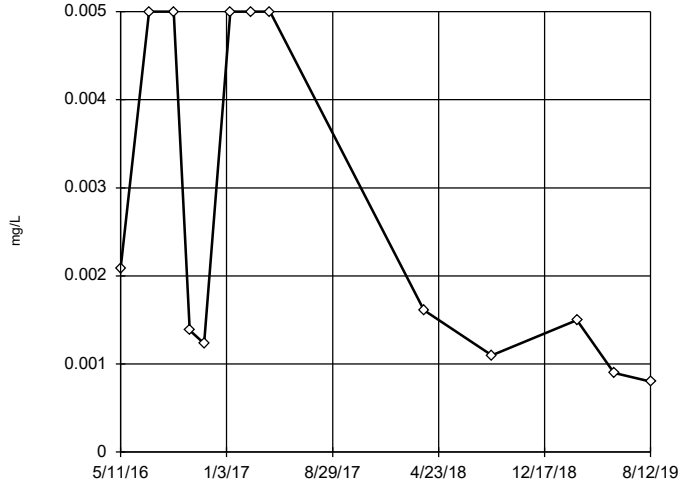
High cutoff = 0.01357, low cutoff = 0.0005312, based on IQR multiplier of 3.

Constituent: Molybdenum, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found.
Tukey's method selected by user.

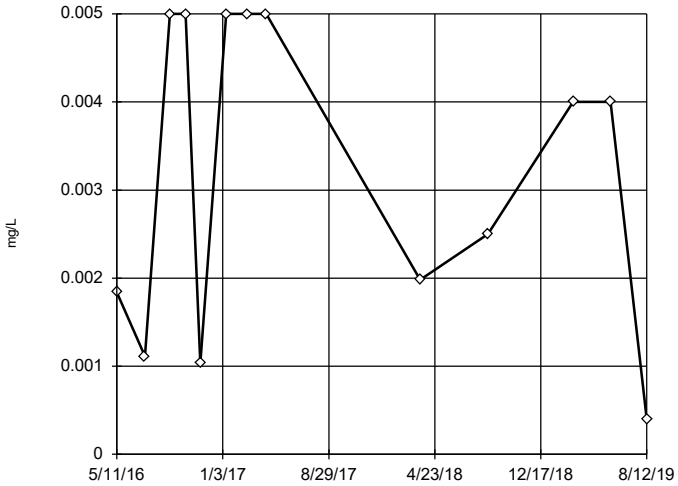
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.3964, low cutoff = 0.00001468, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening

AD-31



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

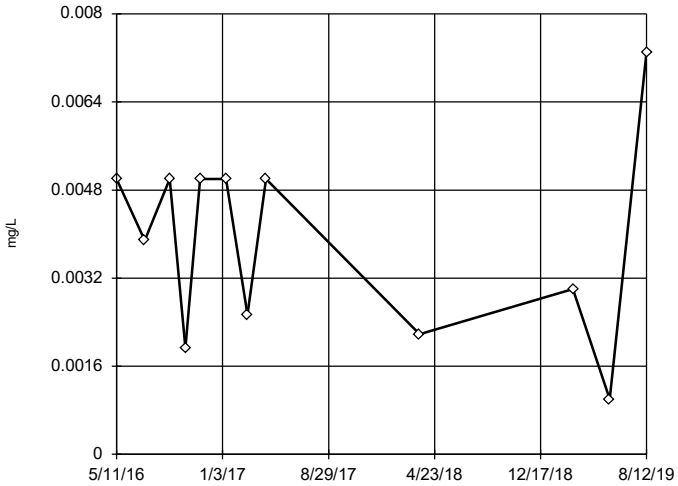
High cutoff = 0.02838, low cutoff = -0.003553, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 12

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

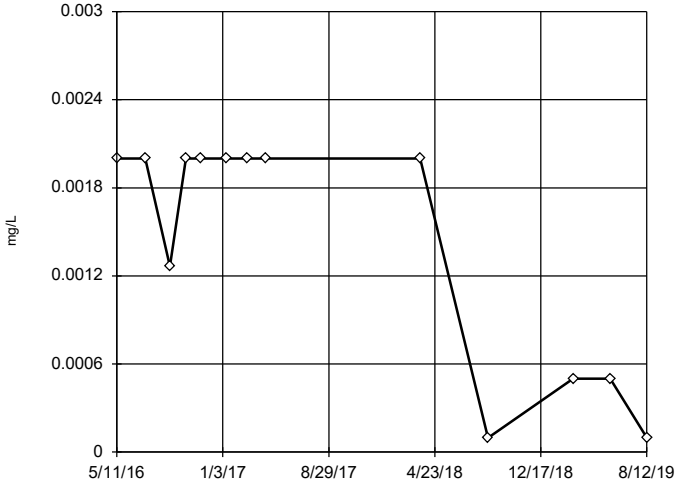
High cutoff = 0.01883, low cutoff = -0.0003234, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

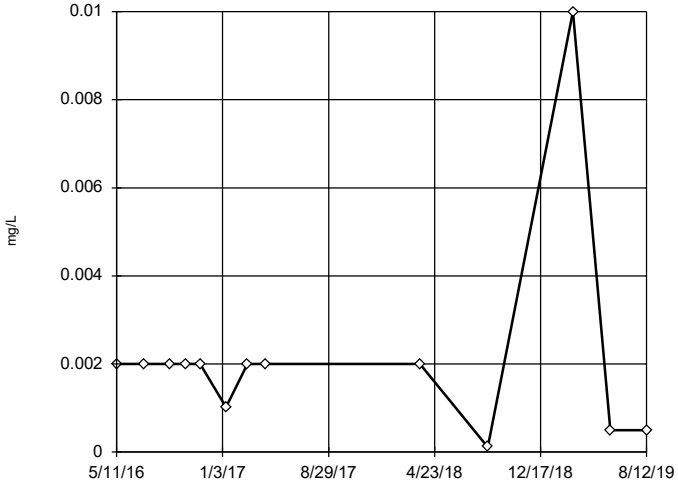
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Thallium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 13

No outliers found. Tukey's method selected by user.

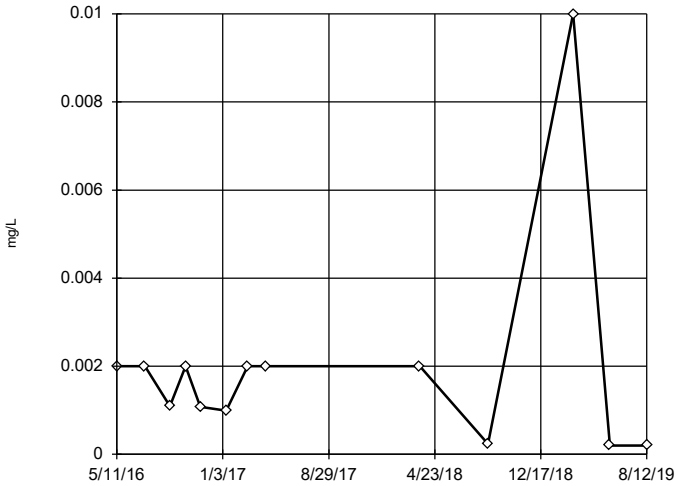
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.04398, low cutoff = 0.00003246, based on IQR multiplier of 3.

Constituent: Thallium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method select-ed by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1397, low cutoff = 0.000006954, based on IQR multiplier of 3.

Constituent: Thallium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

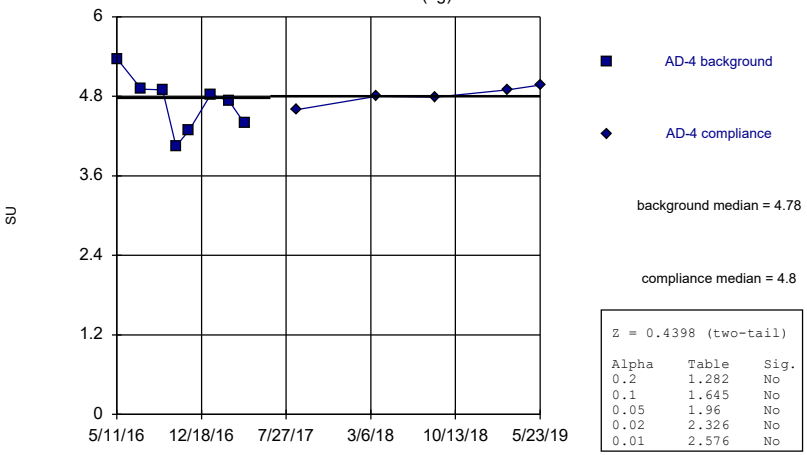
Mann-Whitney - All Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/7/2019, 1:55 PM

Constituent	Well	Calc.	0.01	Sig.	Method
pH, field (SU)	AD-4 (bg)	0.4398	No	No	Mann-W
pH, field (SU)	AD-2	0.8051	No	No	Mann-W
pH, field (SU)	AD-31	2.562	No	No	Mann-W
pH, field (SU)	AD-32	0.8807	No	No	Mann-W
pH, field (SU)	**AD-18 (bg)**	**2.858**	**Yes**	**Yes**	**Mann-W**
pH, field (SU)	AD-12 (bg)	1.537	No	No	Mann-W

Mann-Whitney (Wilcoxon Rank Sum)

AD-4 (bg)



background median = 4.78

compliance median = 4.8

Z = 0.4398 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

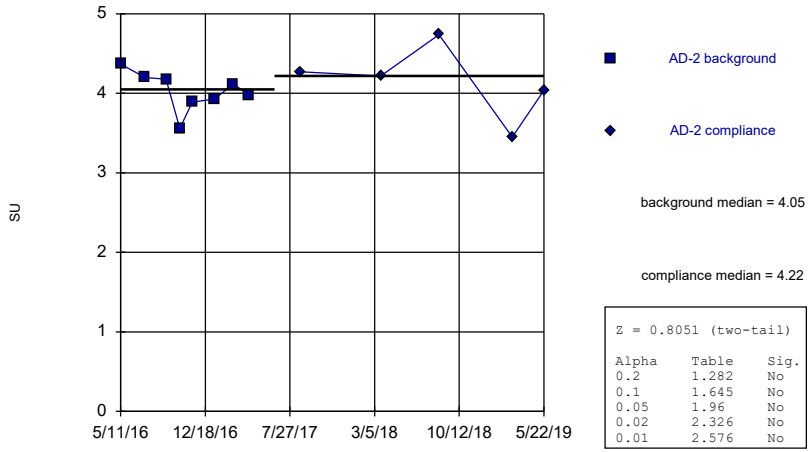
Constituent: pH, field Analysis Run 12/7/2019 1:53 PM View: PL's Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-2



background median = 4.05

compliance median = 4.22

Z = 0.8051 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

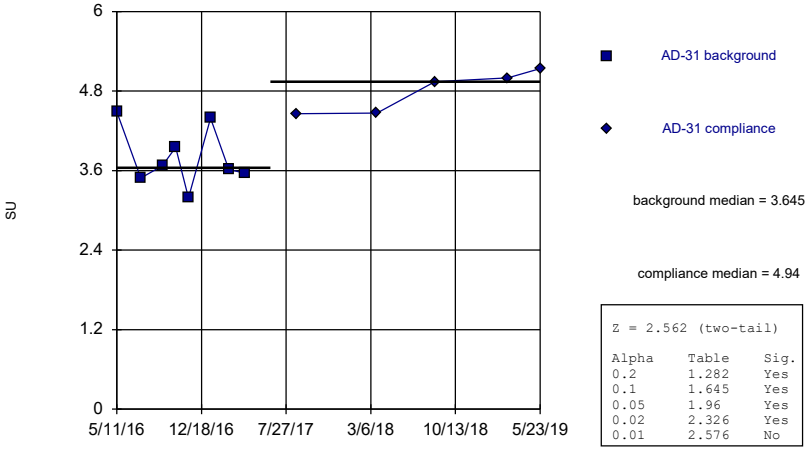
Constituent: pH, field Analysis Run 12/7/2019 1:53 PM View: PL's Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-31



background median = 3.645

compliance median = 4.94

Z = 2.562 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	Yes
0.01	2.576	No

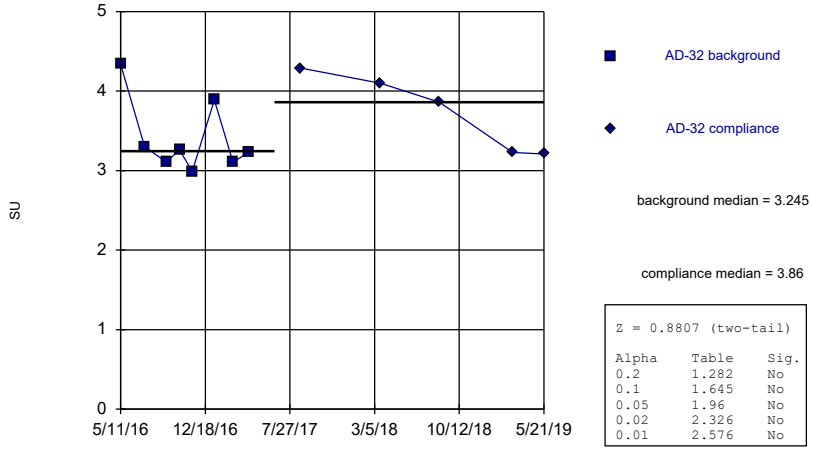
Constituent: pH, field Analysis Run 12/7/2019 1:53 PM View: PL's Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-32



background median = 3.245

compliance median = 3.86

Z = 0.8807 (two-tail)

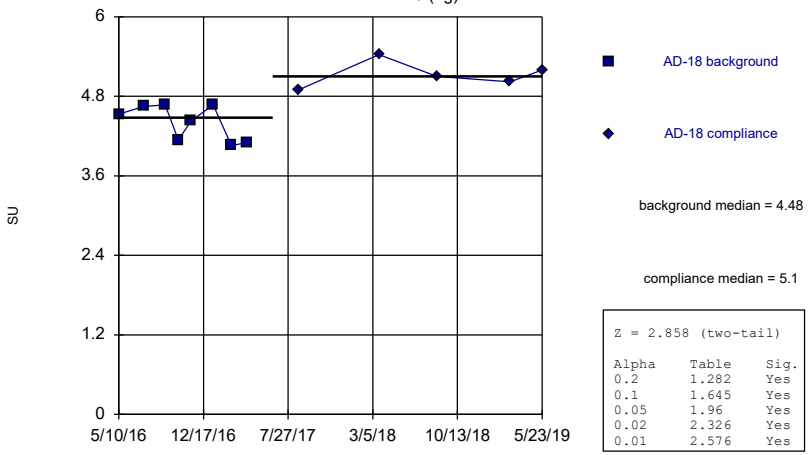
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: pH, field Analysis Run 12/7/2019 1:53 PM View: PL's Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Mann-Whitney (Wilcoxon Rank Sum)

AD-18 (bg)



Z = 2.858 (two-tail)

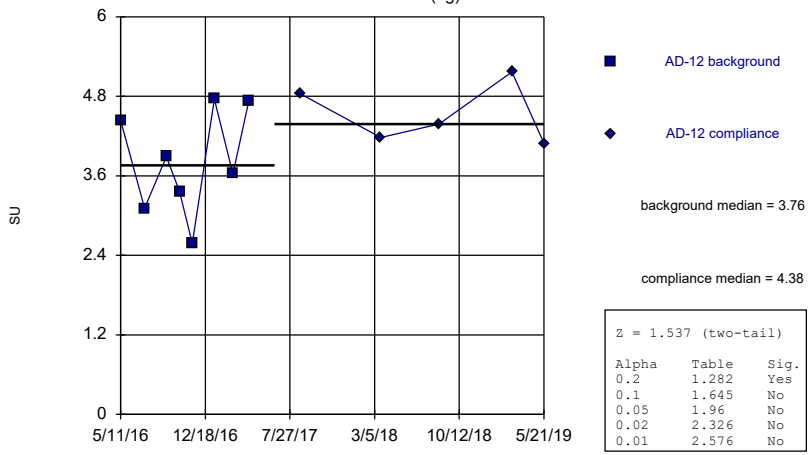
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	Yes
0.01	2.576	Yes

Constituent: pH, field Analysis Run 12/7/2019 1:53 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



Z = 1.537 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: pH, field Analysis Run 12/7/2019 1:53 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

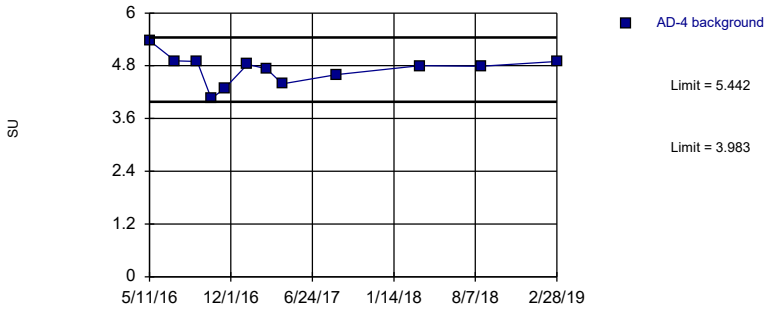
Intrawell Prediction Limit Summary

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/7/2019, 2:15 PM

Constituent	Well	Upper Lim.	Lower Lim.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH, field (SU)	AD-4	5.442	3.983	n/a	12	4.713	0.3454	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-2	4.812	3.339	n/a	12	4.076	0.3486	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-31	5.368	2.837	n/a	12	4.103	0.5991	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-32	4.613	2.506	n/a	12	3.559	0.4988	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-18	5.539	3.745	n/a	12	4.642	0.4247	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-12	5.754	2.427	n/a	12	4.091	0.7877	0	None	No	0.001253	Param Intra 1 of 2

Prediction Limit

Intrawell Parametric, AD-4 (bg)



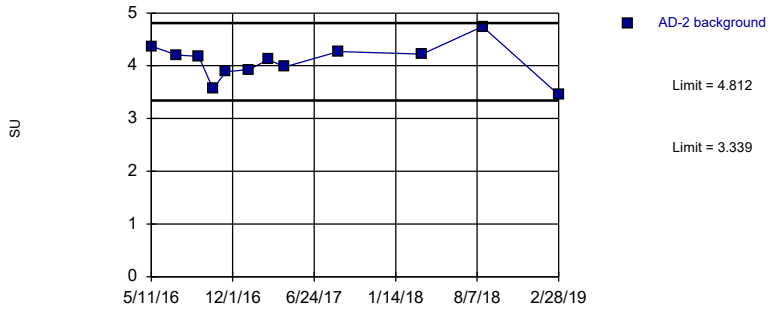
Background Data Summary: Mean=4.713, Std. Dev.=0.3454, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9373, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/7/2019 2:13 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-2



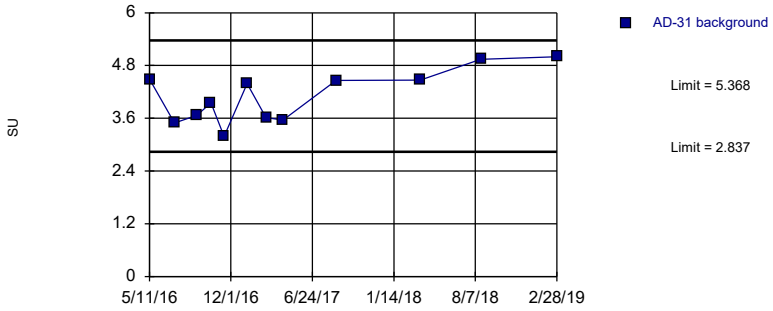
Background Data Summary: Mean=4.076, Std. Dev.=0.3486, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9599, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/7/2019 2:13 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-31



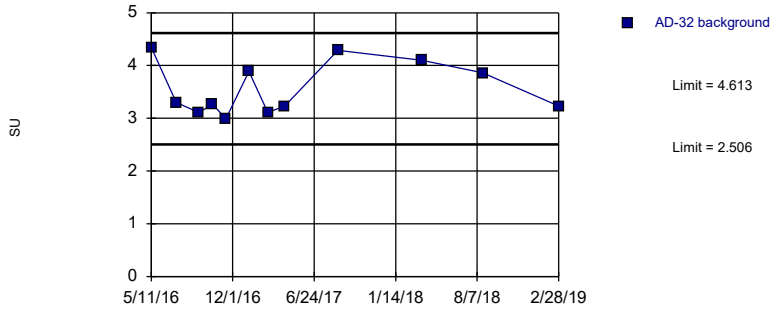
Background Data Summary: Mean=4.103, Std. Dev.=0.5991, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9264, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/7/2019 2:13 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-32

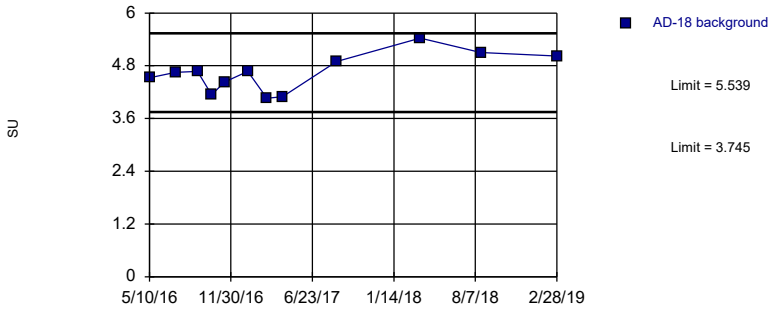


Background Data Summary: Mean=3.559, Std. Dev.=0.4988, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8528, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/7/2019 2:14 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Prediction Limit

Intrawell Parametric, AD-18 (bg)



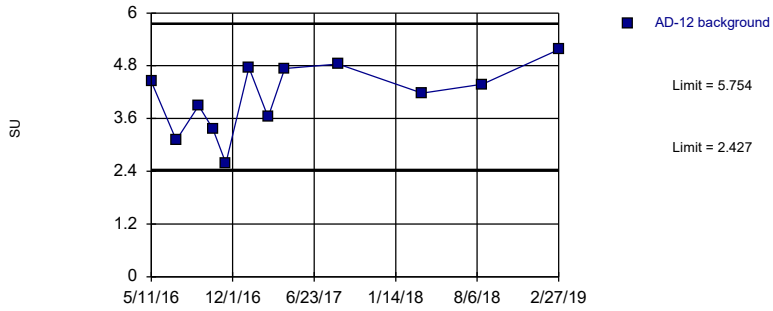
Background Data Summary: Mean=4.642, Std. Dev.=0.4247, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9561, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/7/2019 2:14 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-12 (bg)



Background Data Summary: Mean=4.091, Std. Dev.=0.7877, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9544, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/7/2019 2:14 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Trend Test - All Results (No Significant)

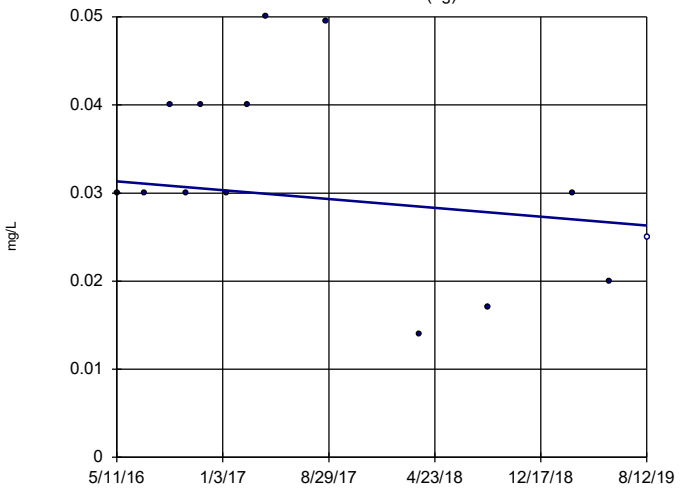
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 10:48 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-12 (bg)	-0.001536	-16	-48	No	14	7.143	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-18 (bg)	0.001347	35	48	No	14	14.29	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-4 (bg)	0.00035	11	48	No	14	7.143	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-12 (bg)	-0.008986	-7	-48	No	14	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-18 (bg)	0.03037	11	48	No	14	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-4 (bg)	-0.1891	-19	-48	No	14	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.1051	23	48	No	14	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-18 (bg)	0.0768	18	48	No	14	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-4 (bg)	0	0	48	No	14	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-12 (bg)	-0.08118	-46	-48	No	14	64.29	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-18 (bg)	0	-35	-48	No	14	78.57	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-4 (bg)	0	-32	-48	No	14	78.57	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.7952	-35	-48	No	14	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-18 (bg)	0	-4	-48	No	14	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-4 (bg)	0.9835	26	48	No	14	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (m...	AD-12 (bg)	-4.348	-10	-43	No	13	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (m...	AD-18 (bg)	-7.565	-34	-48	No	14	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (m...	AD-4 (bg)	-0.7733	-6	-48	No	14	0	n/a	n/a	0.01	NP

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.001536 units per year.

Mann-Kendall statistic = -16
critical = -48

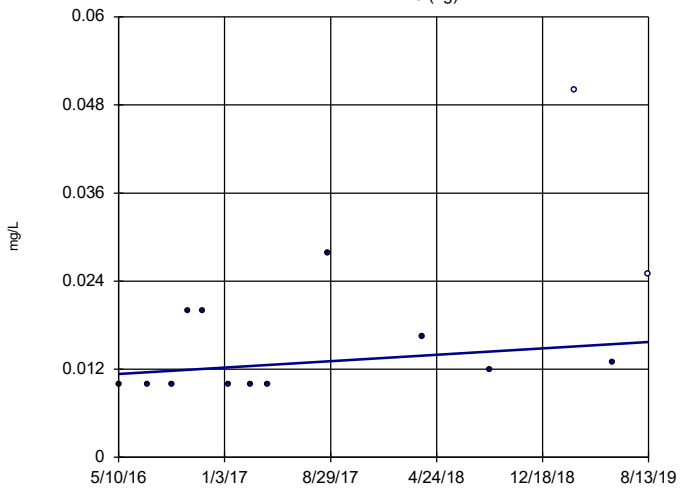
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0.001347 units per year.

Mann-Kendall statistic = 35
critical = 48

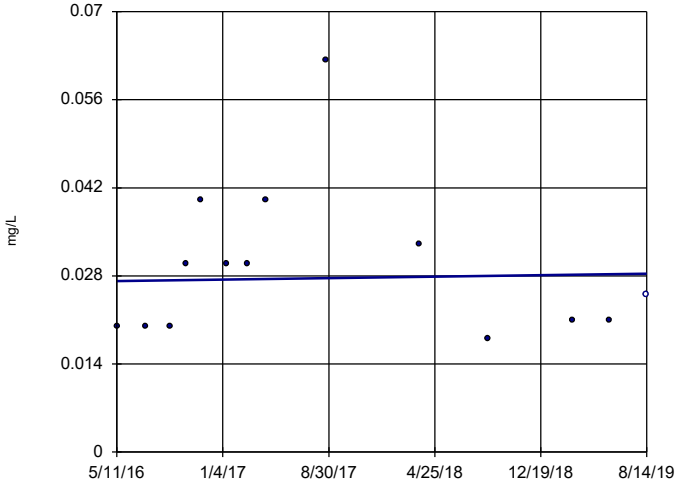
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-4 (bg)



n = 14

Slope = 0.00035 units per year.

Mann-Kendall statistic = 11
critical = 48

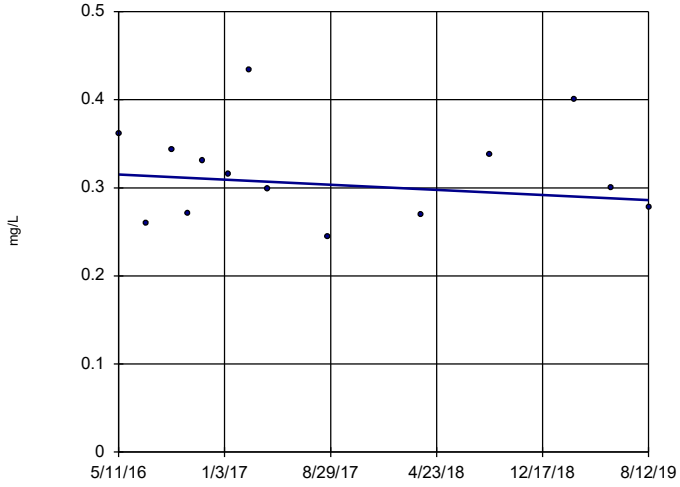
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.008986 units per year.

Mann-Kendall statistic = -7
critical = -48

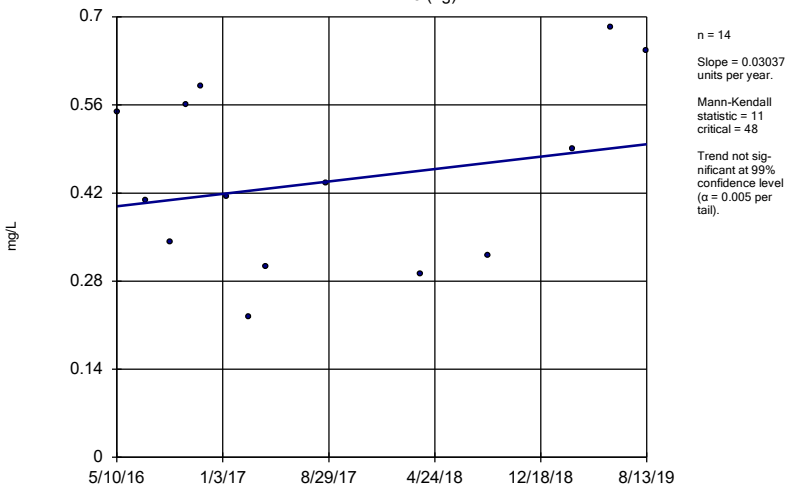
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Calcium, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0.03037 units per year.

Mann-Kendall statistic = 11 critical = 48

Trend not significant at 99% confidence level (α = 0.005 per tail).

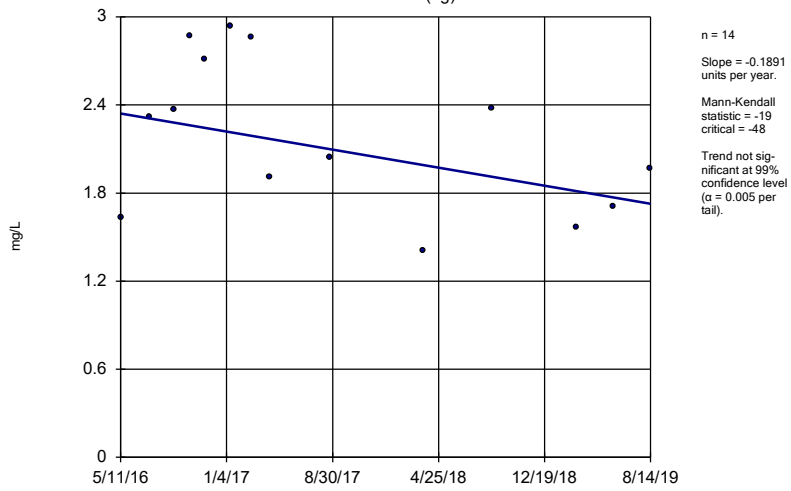
Constituent: Calcium, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-4 (bg)



n = 14

Slope = -0.1891 units per year.

Mann-Kendall statistic = -19 critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

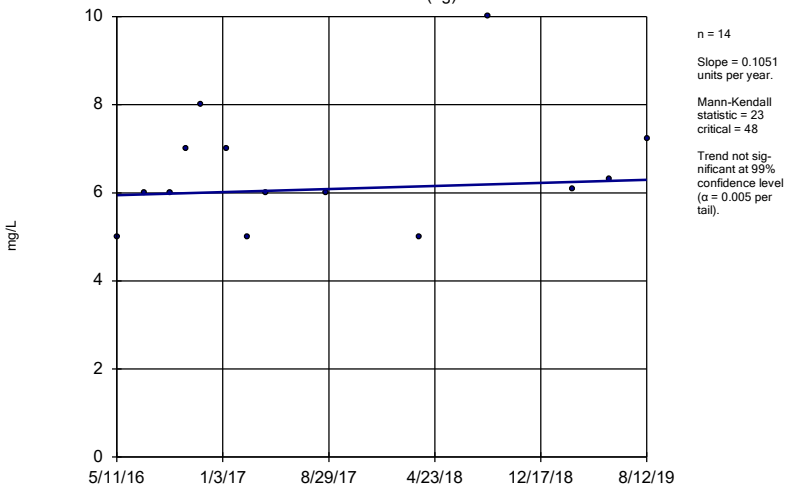
Constituent: Calcium, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = 0.1051 units per year.

Mann-Kendall statistic = 23 critical = 48

Trend not significant at 99% confidence level (α = 0.005 per tail).

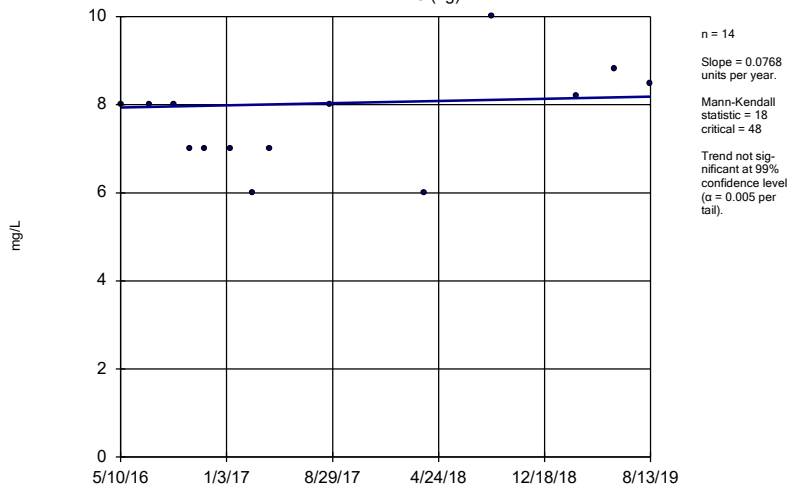
Constituent: Chloride, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0.0768 units per year.

Mann-Kendall statistic = 18 critical = 48

Trend not significant at 99% confidence level (α = 0.005 per tail).

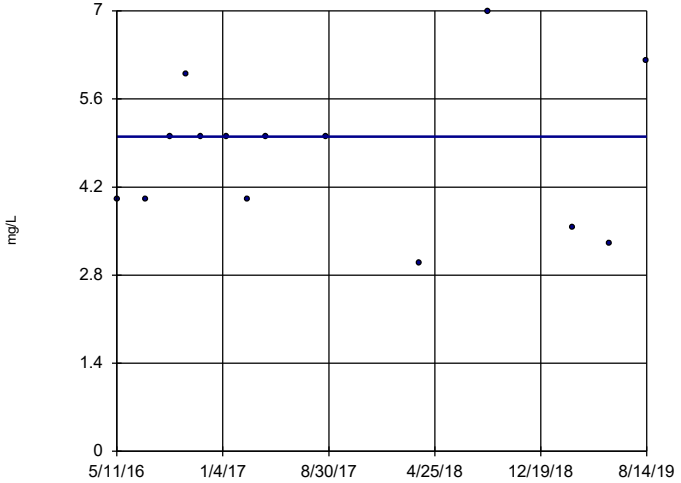
Constituent: Chloride, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-4 (bg)



n = 14

Slope = 0 units per year.

Mann-Kendall statistic = 0 critical = 48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII

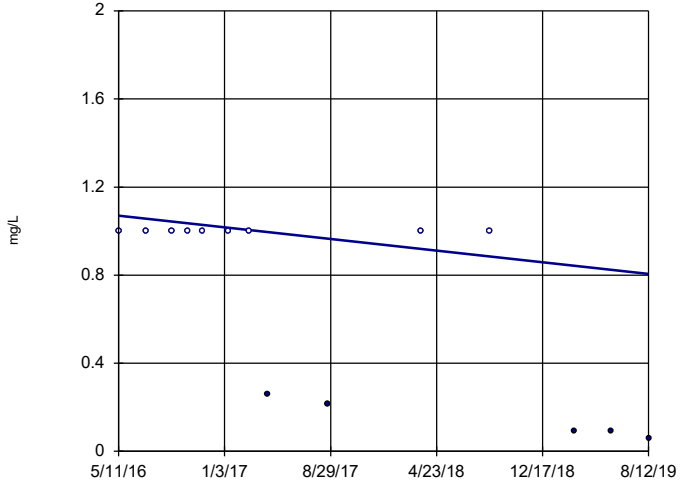
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.08118 units per year.

Mann-Kendall statistic = -46 critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII

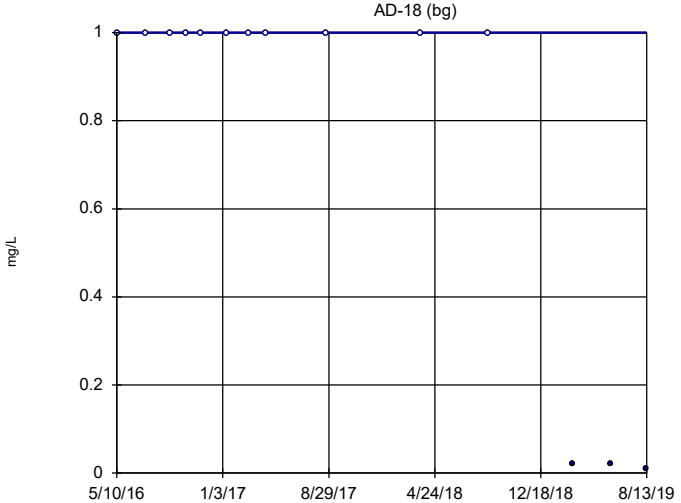
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0 units per year.

Mann-Kendall statistic = -35 critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII

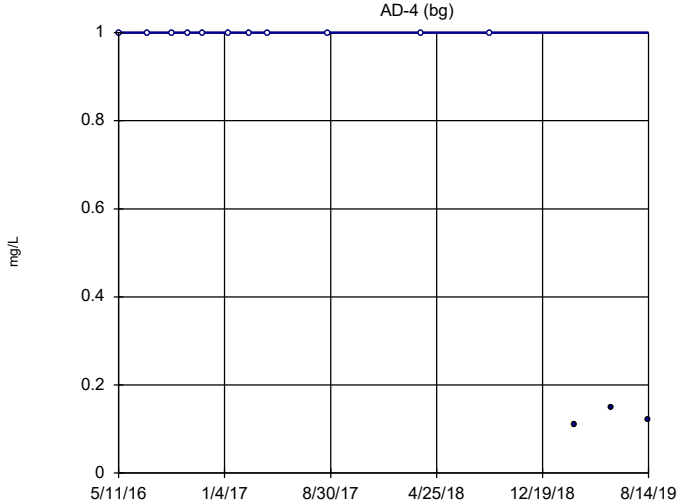
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-4 (bg)



n = 14

Slope = 0 units per year.

Mann-Kendall statistic = -32 critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

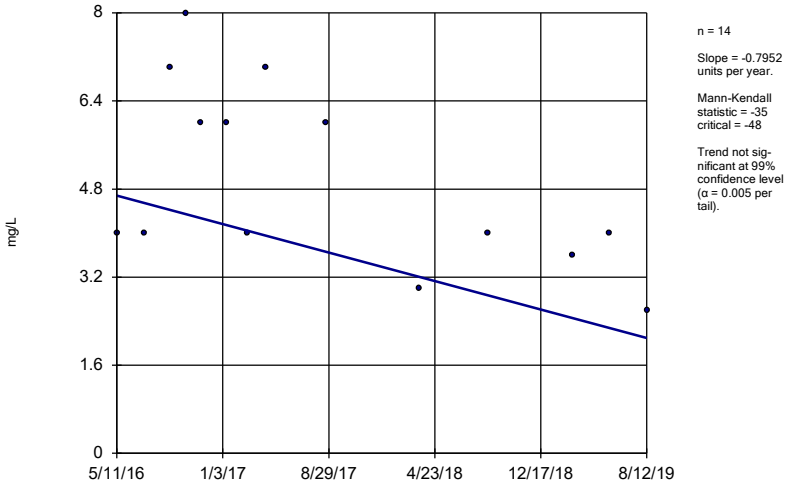
Constituent: Fluoride, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.7952 units per year.

Mann-Kendall statistic = -35 critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

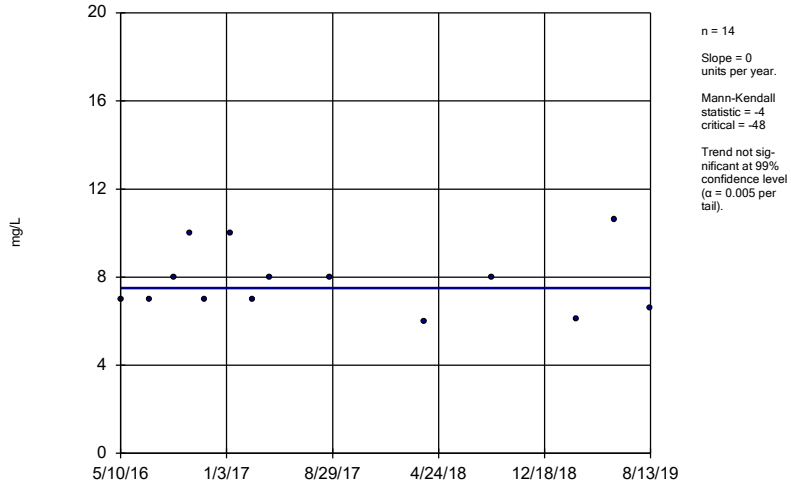
Constituent: Sulfate, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0 units per year.

Mann-Kendall statistic = -4 critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

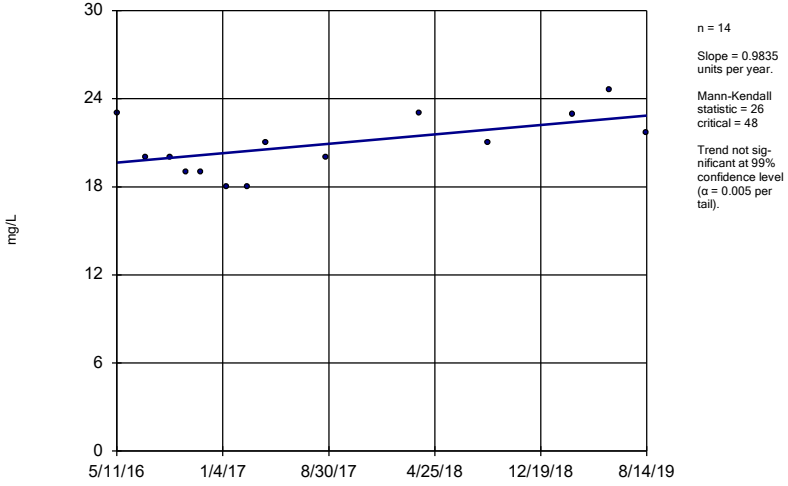
Constituent: Sulfate, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-4 (bg)



n = 14

Slope = 0.9835 units per year.

Mann-Kendall statistic = 26 critical = 48

Trend not significant at 99% confidence level (α = 0.005 per tail).

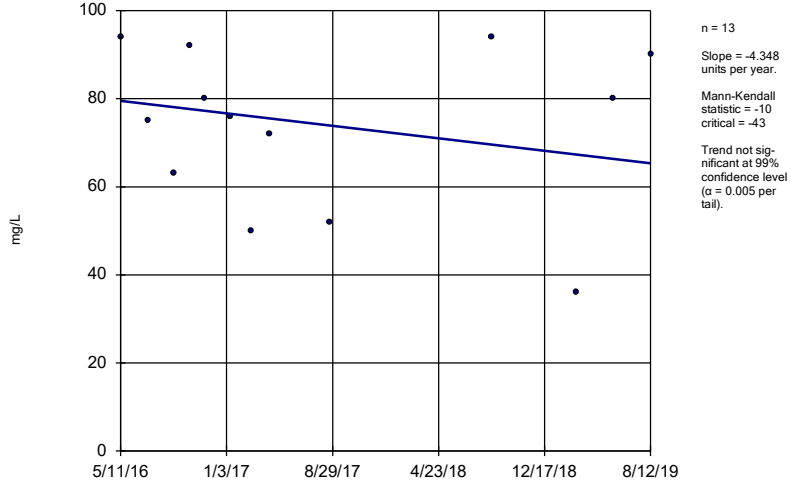
Constituent: Sulfate, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-12 (bg)



n = 13

Slope = -4.348 units per year.

Mann-Kendall statistic = -10 critical = -43

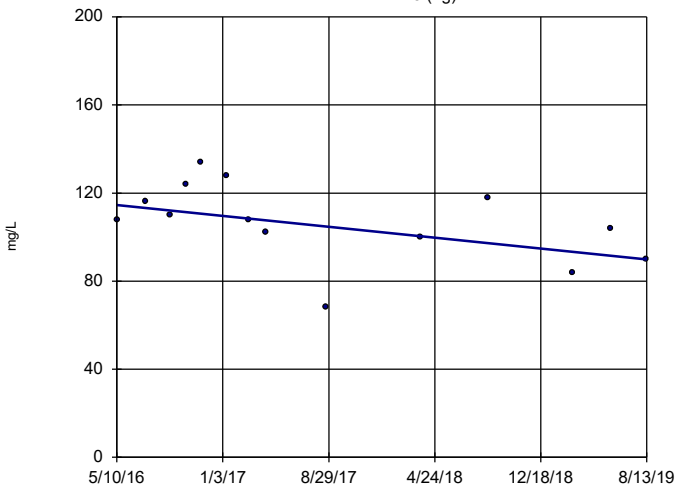
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/25/2019 10:48 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = -7.565 units per year.

Mann-Kendall statistic = -34
critical = -48

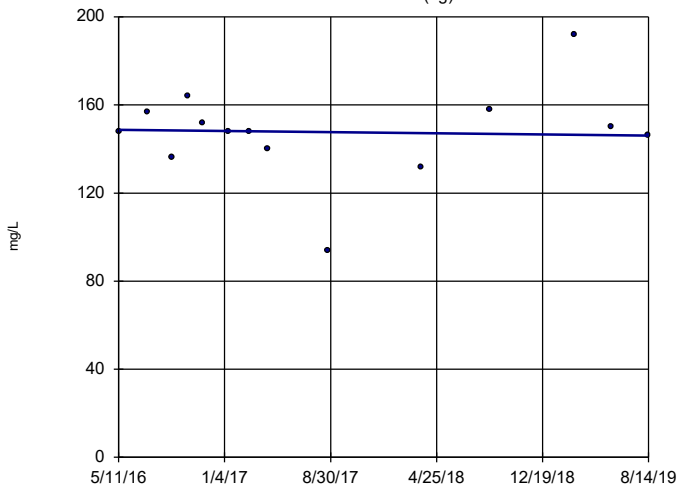
Trend not sig-nificant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-4 (bg)



n = 14

Slope = -0.7733 units per year.

Mann-Kendall statistic = -6
critical = -48

Trend not sig-nificant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Interwell Prediction Limit Summary

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/7/2019, 2:23 PM

Constituent	Well	Upper Lim.	Lower Lim.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	n/a	0.05098	n/a	n/a	36	0.02697	0.01359	2.778	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	n/a	2.94	n/a	n/a	36	n/a	n/a	0	n/a	n/a	0.001409	NP (normality) 1 of 2
Chloride, total (mg/L)	n/a	9.158	n/a	n/a	36	6.218	1.665	0	None	No	0.002505	Param 1 of 2
Fluoride, total (mg/L)	n/a	1	n/a	n/a	36	n/a	n/a	86.11	n/a	n/a	0.001409	NP (NDs) 1 of 2
Sulfate, total (mg/L)	n/a	23	n/a	n/a	36	n/a	n/a	0	n/a	n/a	0.001409	NP (normality) 1 of 2
Total Dissolved Solids [TDS] (mg/L)	n/a	175.6	n/a	n/a	35	110.1	37.01	0	None	No	0.002505	Param 1 of 2

Upper Tolerance Limits

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 11:27 AM

Constituent	Well	Upper Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.0025	n/a	n/a	n/a	39	97.44	n/a	0.1353	NP Inter(NDs)
Arsenic, total (mg/L)	n/a	0.011	n/a	n/a	n/a	39	69.23	n/a	0.1353	NP Inter(NDs)
Barium, total (mg/L)	n/a	0.183	n/a	n/a	n/a	39	0	n/a	0.1353	NP Inter(normal...
Beryllium, total (mg/L)	n/a	0.00115	n/a	n/a	n/a	39	10.26	n/a	0.1353	NP Inter(normal...
Cadmium, total (mg/L)	n/a	0.0005	n/a	n/a	n/a	39	74.36	n/a	0.1353	NP Inter(NDs)
Chromium, total (mg/L)	n/a	0.007	n/a	n/a	n/a	39	17.95	n/a	0.1353	NP Inter(Cohens...
Cobalt, total (mg/L)	n/a	0.00939	n/a	n/a	n/a	39	0	n/a	0.1353	NP Inter(normal...
Combined Radium 226 + 228 (pCi/L)	n/a	3.325	n/a	n/a	n/a	39	0	x^(1/3)	0.05	Inter
Fluoride, total (mg/L)	n/a	0.5	n/a	n/a	n/a	42	73.81	n/a	0.116	NP Inter(NDs)
Lead, total (mg/L)	n/a	0.0025	n/a	n/a	n/a	39	79.49	n/a	0.1353	NP Inter(NDs)
Lithium, total (mg/L)	n/a	0.0616	n/a	n/a	n/a	39	2.564	sqrt(x)	0.05	Inter
Mercury, total (mg/L)	n/a	0.000064	n/a	n/a	n/a	39	41.03	n/a	0.1353	NP Inter(normal...
Molybdenum, total (mg/L)	n/a	0.02	n/a	n/a	n/a	39	92.31	n/a	0.1353	NP Inter(NDs)
Selenium, total (mg/L)	n/a	0.0025	n/a	n/a	n/a	39	61.54	n/a	0.1353	NP Inter(NDs)
Thallium, total (mg/L)	n/a	0.001874	n/a	n/a	n/a	37	83.78	n/a	0.1499	NP Inter(NDs)

Confidence Interval Summary Table - Significant Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 11:31 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-2**	**0.0139**	**0.01**	**0.0094**	**Yes**	**13**	**0**	**No**	**0.01**	**NP (normality)**
Cobalt, total (mg/L)	**AD-32**	**0.06086**	**0.03096**	**0.0094**	**Yes**	**13**	**0**	**x^(1/3)**	**0.01**	**Param.**
Lithium, total (mg/L)	**AD-31**	**0.09599**	**0.08587**	**0.0616**	**Yes**	**13**	**0**	**x^6**	**0.01**	**Param.**
Lithium, total (mg/L)	**AD-32**	**0.112**	**0.08778**	**0.0616**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**

Confidence Interval Summary Table - All Results

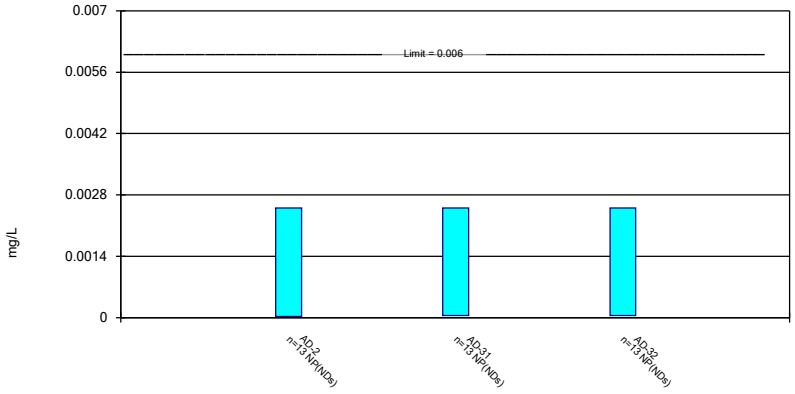
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 11:31 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-2	0.0025	0.000025	0.006	No	13	92.31	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-31	0.0025	0.00005	0.006	No	13	92.31	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-32	0.0025	0.00005	0.006	No	13	92.31	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-2	0.0025	0.00052	0.011	No	13	76.92	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-31	0.006	0.001	0.011	No	12	25	No	0.01	NP (Cohens/xfrm)
Arsenic, total (mg/L)	AD-32	0.006899	0.002442	0.011	No	13	7.692	sqrt(x)	0.01	Param.
Barium, total (mg/L)	AD-2	0.03766	0.0307	2	No	13	0	x^4	0.01	Param.
Barium, total (mg/L)	AD-31	0.08623	0.04485	2	No	12	0	No	0.01	Param.
Barium, total (mg/L)	AD-32	0.04373	0.0285	2	No	13	0	No	0.01	Param.
Beryllium, total (mg/L)	AD-2	0.0005146	0.0003761	0.004	No	13	7.692	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-31	0.002	0.00085	0.004	No	12	0	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-32	0.006729	0.003501	0.004	No	13	0	sqrt(x)	0.01	Param.
Cadmium, total (mg/L)	AD-2	0.0005	0.00006	0.005	No	13	76.92	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-31	0.0008589	0.0000944	0.005	No	13	53.85	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-32	0.0006183	0.0003591	0.005	No	13	0	No	0.01	Param.
Chromium, total (mg/L)	AD-2	0.0008854	0.0002438	0.1	No	13	46.15	No	0.01	NP (Cohens/xfrm)
Chromium, total (mg/L)	AD-31	0.01219	0.002111	0.1	No	11	18.18	No	0.01	Param.
Chromium, total (mg/L)	AD-32	0.009243	0.002217	0.1	No	13	0	sqrt(x)	0.01	Param.
Cobalt, total (mg/L)	**AD-2**	**0.0139**	**0.01**	**0.0094**	**Yes**	**13**	**0**	**No**	**0.01**	**NP (normality)**
Cobalt, total (mg/L)	AD-31	0.01159	0.009367	0.0094	No	12	0	No	0.01	Param.
Cobalt, total (mg/L)	**AD-32**	**0.06086**	**0.03096**	**0.0094**	**Yes**	**13**	**0**	**x^(1/3)**	**0.01**	**Param.**
Combined Radium 226 + 228 (pCi/L)	AD-2	1.813	0.983	5	No	13	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-31	4.122	2.631	5	No	13	0	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-32	5.578	3.893	5	No	12	0	No	0.01	Param.
Fluoride, total (mg/L)	AD-2	0.5	0.1	4	No	15	80	No	0.01	NP (NDs)
Fluoride, total (mg/L)	AD-31	0.5	0.16	4	No	15	80	No	0.01	NP (NDs)
Fluoride, total (mg/L)	AD-32	0.7468	0.4468	4	No	14	35.71	No	0.01	NP (normality)
Lead, total (mg/L)	AD-2	0.0025	0.000338	0.015	No	13	76.92	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-31	0.003933	0.001	0.015	No	12	66.67	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-32	0.0025	0.000714	0.015	No	13	76.92	No	0.01	NP (NDs)
Lithium, total (mg/L)	AD-2	0.05473	0.04944	0.0616	No	12	0	No	0.01	Param.
Lithium, total (mg/L)	**AD-31**	**0.09599**	**0.08587**	**0.0616**	**Yes**	**13**	**0**	**x^6**	**0.01**	**Param.**
Lithium, total (mg/L)	**AD-32**	**0.112**	**0.08778**	**0.0616**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Mercury, total (mg/L)	AD-2	0.00009047	0.00002986	0.002	No	12	0	No	0.01	Param.
Mercury, total (mg/L)	AD-31	0.0007825	0.0001414	0.002	No	12	0	sqrt(x)	0.01	Param.
Mercury, total (mg/L)	AD-32	0.007473	0.001912	0.002	No	13	0	No	0.01	Param.
Molybdenum, total (mg/L)	AD-2	0.02	0.0008627	0.1	No	13	84.62	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-31	0.02	0.0003161	0.1	No	13	69.23	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-32	0.02	0.0007621	0.1	No	13	84.62	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-2	0.0025	0.0009	0.05	No	13	38.46	No	0.01	NP (Cohens/xfrm)
Selenium, total (mg/L)	AD-31	0.0025	0.001034	0.05	No	13	53.85	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-32	0.003888	0.001935	0.05	No	12	41.67	No	0.01	NP (normality)
Thallium, total (mg/L)	AD-2	0.001264	0.0001	0.002	No	13	76.92	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-31	0.001019	0.00025	0.002	No	12	83.33	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-32	0.001078	0.0002	0.002	No	12	50	No	0.01	NP (normality)

Sanitas™ v.9.6.23 . EPA

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

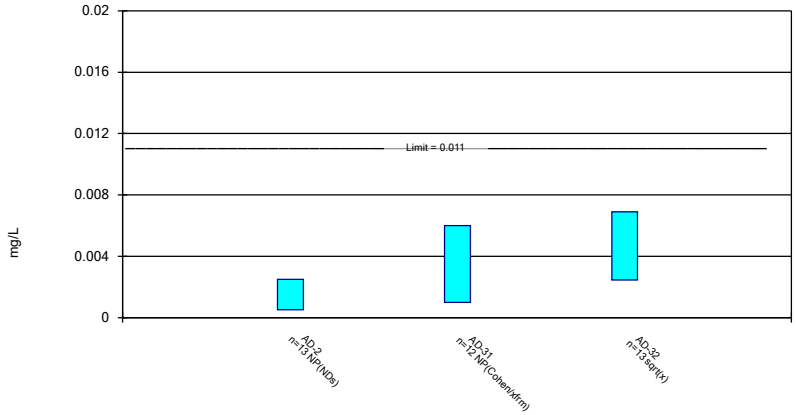


Constituent: Antimony, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

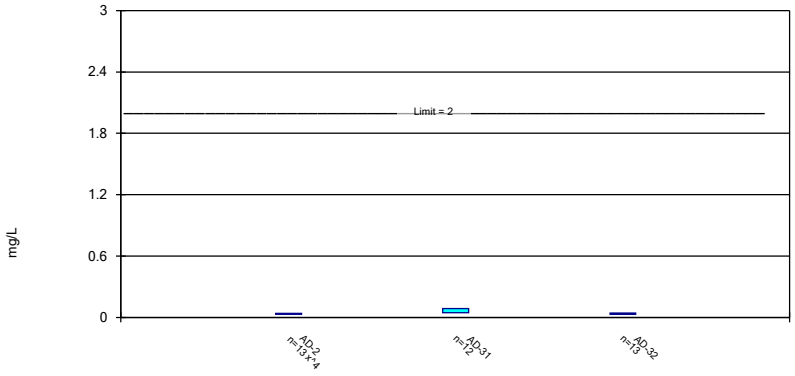


Constituent: Arsenic, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

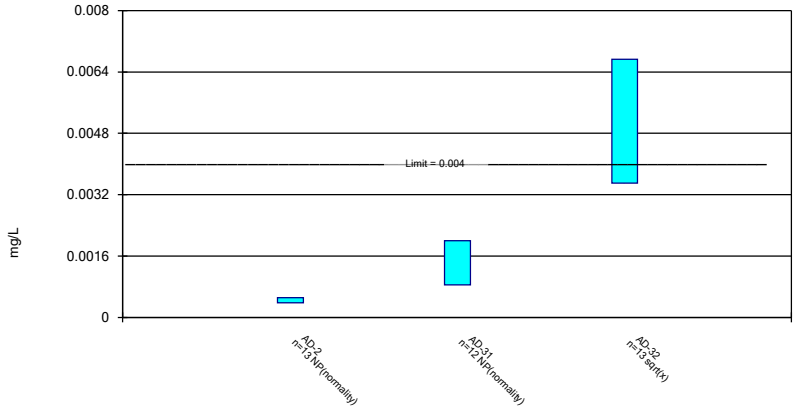


Constituent: Barium, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

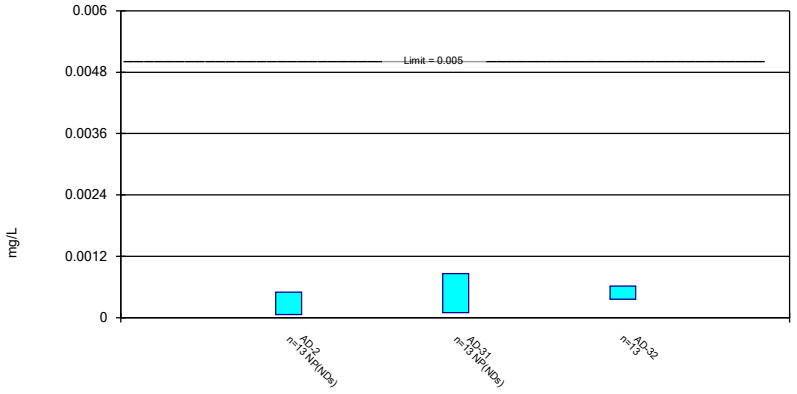


Constituent: Beryllium, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

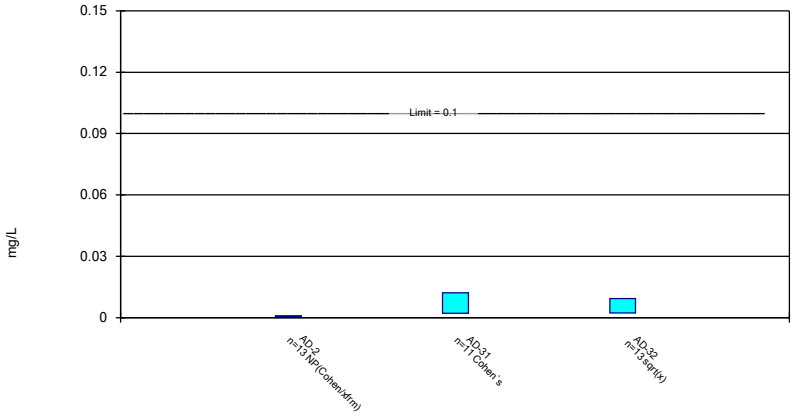


Constituent: Cadmium, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

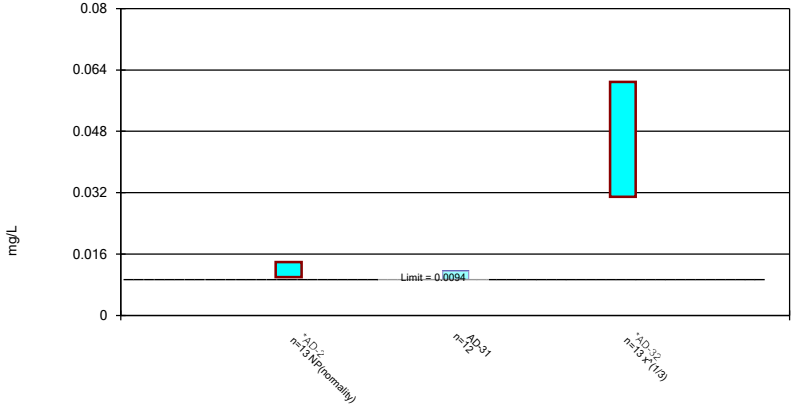


Constituent: Chromium, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

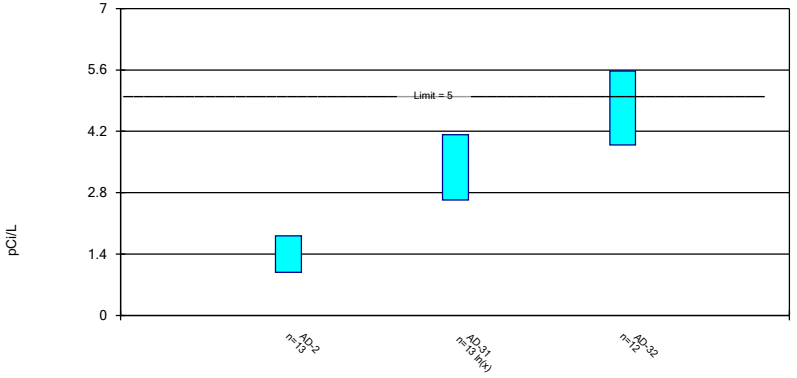


Constituent: Cobalt, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

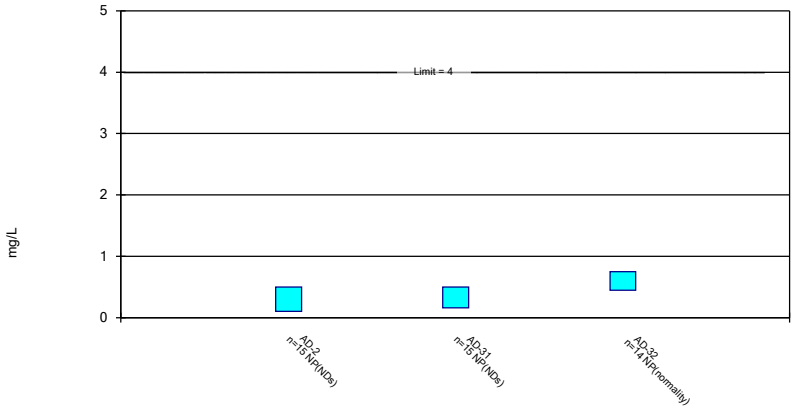


Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



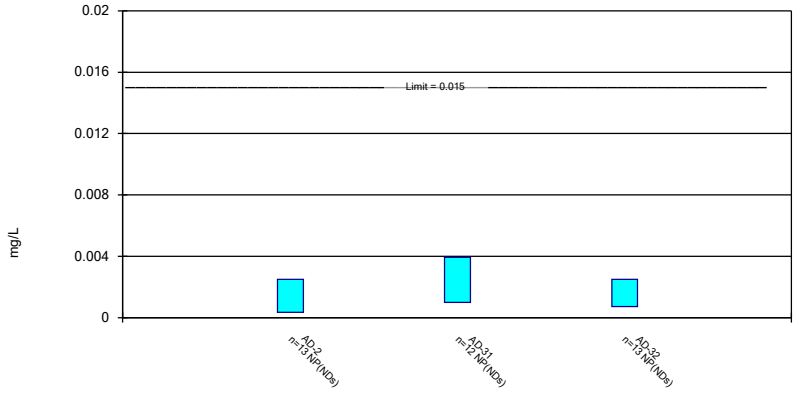
Constituent: Fluoride, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



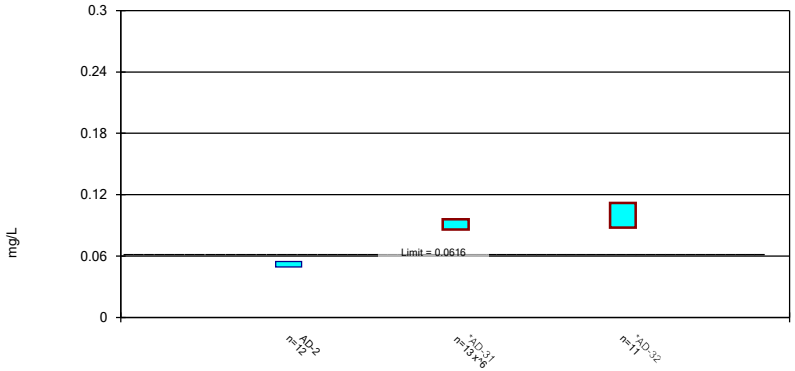
Constituent: Lead, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



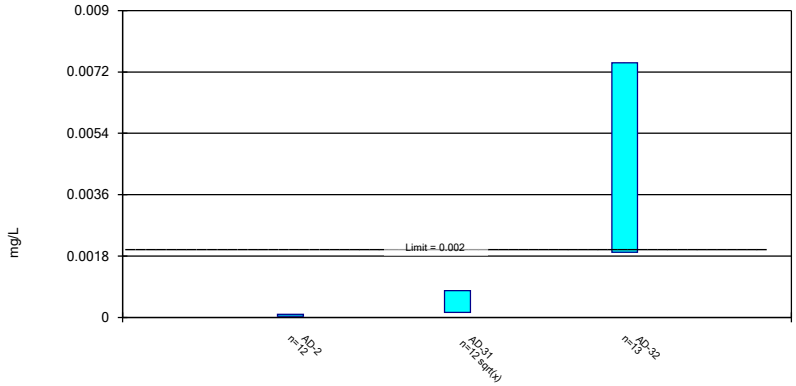
Constituent: Lithium, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



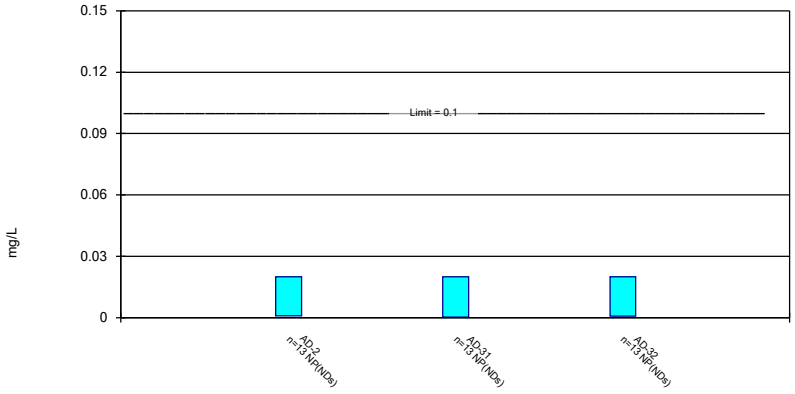
Constituent: Mercury, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

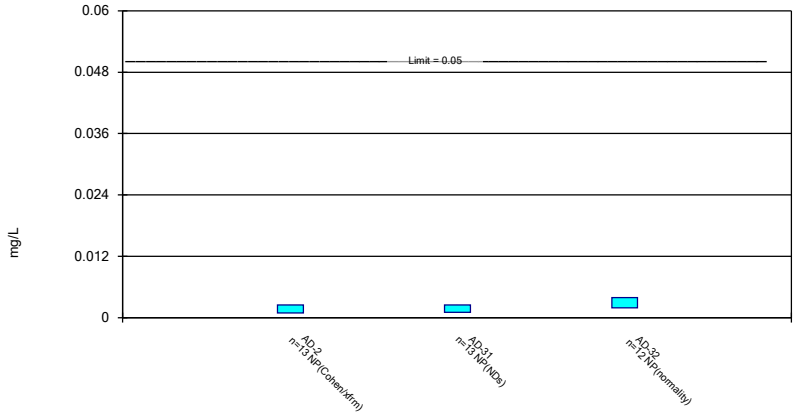


Constituent: Molybdenum, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

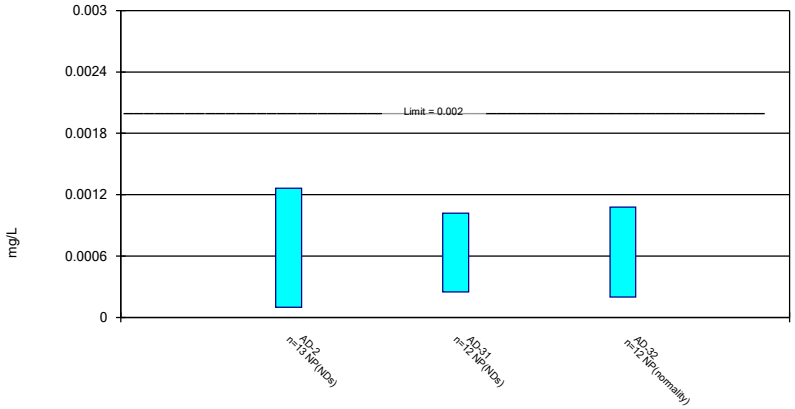


Constituent: Selenium, total Analysis Run 11/25/2019 11:30 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Thallium, total Analysis Run 11/25/2019 11:30 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
East Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

April 24, 2019

CHA8462

TABLE OF CONTENTS

FIGURES

TABLES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASL	Alternate Screening Level
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the East Bottom Ash Pond (EBAP, Figure 1). In 2018, two assessment monitoring events were conducted at the EBAP in accordance with 40 CFR 257.95. The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or alternate screening level (ASL) provided in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey EBAP:

- LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.010 mg/L), AD-31 (0.00949 mg/L), and AD-32 (0.0353 mg/L).
- LCLs for lithium exceeded the GWPS of 0.051 mg/L at AD-31 (0.0556 mg/L) and AD-32 (0.0722 mg/L).

No other SSLs were identified (Geosyntec, 2018).

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a*

> *qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSLs identified for cobalt should not be attributed to the EBAP. The SSLs identified for lithium will be addressed in a separate submittal.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for cobalt were based on a Type IV cause and not by a release from the Pirkey EBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for cobalt and the proposed alternative source are described below.

2.1 Alternative Source for Cobalt

Initial review of site geochemistry, site historical data, and laboratory QA/QC data did not identify alternative sources due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSLs for cobalt have been attributed to natural variation associated with the underlying geology, which is a Type IV issue.

The onsite hydrostratigraphic unit for the EBAP was identified as the clayey and silty sand stratum located between an elevation of approximately 325 and 340 feet above mean sea level (Arcadis, 2016). This unit is within the Reklaw Formation, which consists predominantly of clay and fine-grained sand and is underlain by the Eocene-age Carrizo Sand. The presence of lignite in the area is well-documented (Broom and Myers, 1966; ETTL, 2010).

Soil samples collected across the site identified cobalt in the aquifer material at varying concentrations, including locations near the EBAP (Table 1). While data are not available for AD-2, the highest reported cobalt concentration of 15 milligrams per kilogram (mg/kg) was collected at AD-30, which is located approximately 650 feet to the northwest of AD-2 (Figure 2). In addition, up to 1.9 mg/kg and 9.1 mg/kg of cobalt were detected in the samples at EBAP downgradient wells AD-31 and AD-32, respectively. Up to 3.6 mg/kg of cobalt was detected in the samples at upgradient well AD-18.

Mineralogic samples collected from across the site identified pyrite (cubic FeS_2) and marcasite (orthorhombic FeS_2) at concentrations up to 3% by dry weight (Table 1). Pyrite and marcasite were detected in the shallow (12 feet below ground surface [ft bgs]) sample collected at AD-31 at a combined concentration of 2%. Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2019).

While cobalt was detected in the samples collected at AD-32, pyrite and marcasite were not detected. However, the boring log for AD-32 noted that iron ore was present at 16 ft bgs, which is within the screened interval of the well (Attachment A). The presence of limonite (FeO(OH)) in the Reklaw formation has been noted (Brooms and Myers, 1966), which is a likely weathering product of the iron ore identified in the boring log. In addition to iron sulfides, cobalt can also substitute in or adsorb onto iron oxides such as limonite (Hitzman et al., 2019; Appelo and Postman, 2005). While soil analytical and mineralogical data are not available for AD-2, the wide

distribution of cobalt and iron-containing minerals across the site suggests that naturally occurring cobalt may be present in the aquifer media near AD-2.

Naturally occurring cobalt in the aquifer media is presented as the alternative source for cobalt concentrations in the groundwater which exceed the GWPS at the EBAP. Evidence from the EBAP itself shows that a release from the pond is not a probable source for cobalt in groundwater. An analysis of a sample of the bottom ash sluiced to the EBAP gave a reported cobalt concentration of 6.1 mg/kg (Attachment B). When Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-864 Test Method 1312, [USEPA, 1994]) was conducted on the ash sample to evaluate cobalt mobility under simulated landfill conditions, cobalt was not detected above the reporting limit of 0.010 milligrams per liter (mg/L) in the leachate sample (Attachment B). Cobalt was detected with an estimated concentration of 0.0024 mg/L in a grab sample of the pond water (Attachment C). However, the reported concentration of cobalt in the pond water sample is more than an order of magnitude lower than the average concentration of cobalt observed at all three wells where SSLs were identified. Results of the pond sample analyses are summarized in Table 2.

Because cobalt mobility is affected by pH, the SPLP test results are likely even more conservative than actual pond conditions, as SPLP is run at a pH of 5 SU, whereas the operational pH of the pond varies between approximately 5.8 and 7.0 SU. According to a recent study, cobalt mobility increases under more acidic conditions, although even at a pH of approximately 5 SU, only 2% of cobalt in fly ash is mobile (Izquierdo and Querol, 2012).

The EBAP was not identified as the source of cobalt at AD-2, AD-31, or AD-32 based on the documented low mobility of cobalt under the pond conditions. This is further supported by the lack of detected cobalt in the SPLP analysis and the low observed cobalt concentration in the pond water itself. Instead, the widespread distribution of cobalt within the aquifer material is presented as the alternate source. This cobalt could be present as substitutions within iron-containing minerals such as pyrite, marcasite, or limonite, all of which are observed across the site.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSLs for cobalt at AD-2, AD-31, and AD-32 identified during assessment monitoring in 2018 was not due to a release from the EBAP. The identified SSLs were, instead, attributed to natural variation in the underlying geology. Therefore, no further action for cobalt is warranted, and the EBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment D.

SECTION 4

REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

Appelo, C. and Postma, D. 2005. Geochemistry, Groundwater and Pollution. 2nd Edition, Balkema, Rotterdam.

Arcadis, 2016. East Bottom Ash Pond – CCR Groundwater Monitoring Well Network Evaluation. H.W. Pirkey Power Plant. May.

Broom, M.E. and Myers, B.N., 1966. Ground-Water Resources of Harrison County, Texas. Texas Water Development Board Report 27. August.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. 3002010920. October.

ETTL, 2010. Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas, Geotechnical Investigation. October.

Geosyntec Consultants, 2018. Statistical Analysis Summary, East Bottom Pond. H.W. Pirkey Power Plant. Hallsville, Texas. December.

Hitzman, M.W., Bookstrom, A.A., Slack, J.F., and Zientek, M.L., 2017. Cobalt – Styles of Deposits and the Search for Primary Deposits. USGS Open File Report 2017-1155.

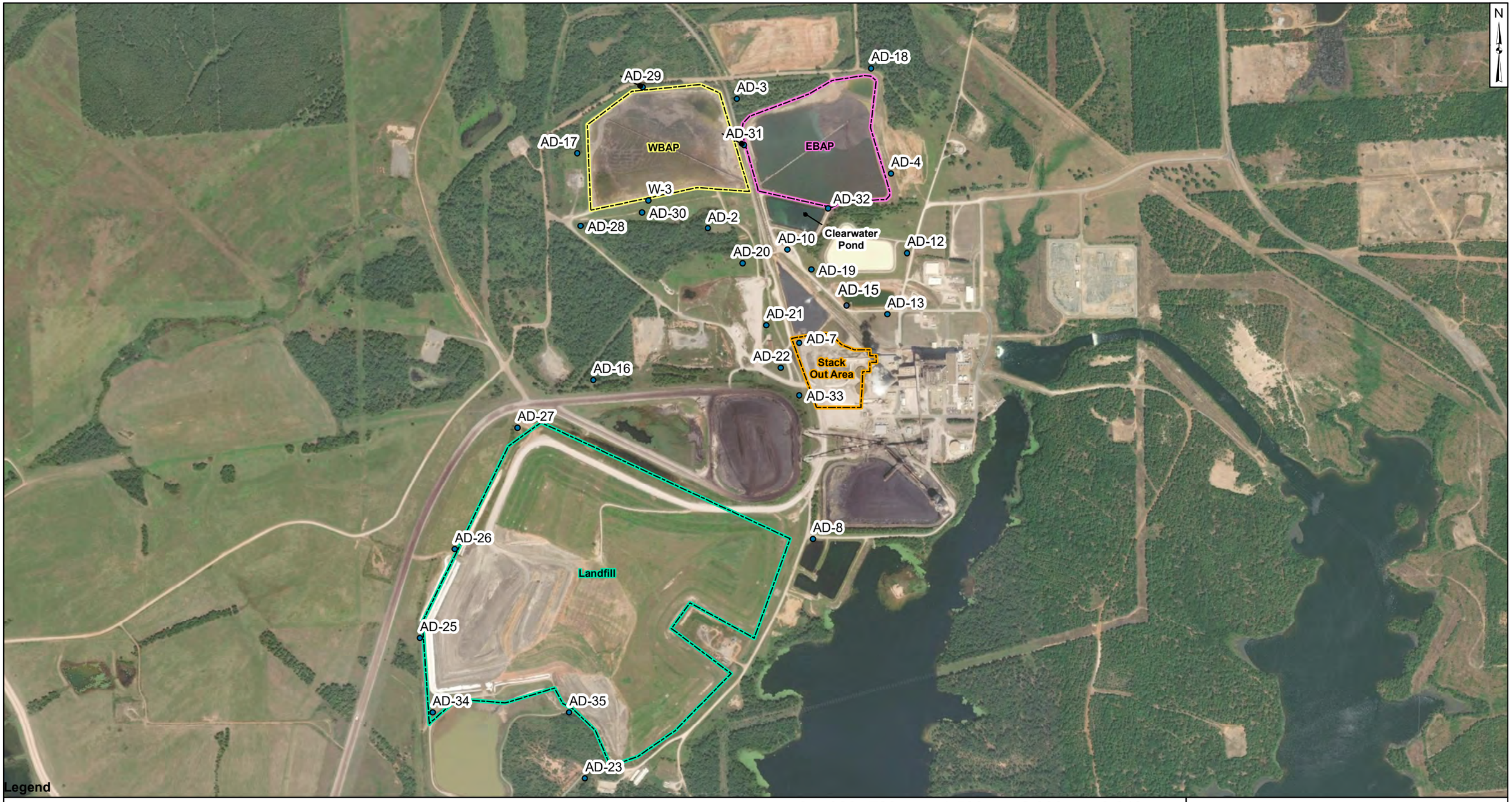
Izquierdo, M. and Querol, X., 2012. Leaching Behaviour of Elements from Coal Combustion Fly Ash: An Overview. *International Journal of Coal Geology*, 94, 54-66.

Krupka, K. M. and Serne, R. J., 2002. Geochemical Factors Affecting the Behavior of Antimony, Cobalt, Europium, Technetium, and Uranium in Vadose Sediments. Pacific Northwest National Lab, PNNL-14126. December.

United States Environmental Protection Agency (USEPA), 1994. Method 1312 – Synthetic Precipitation Leaching Procedure, Revision 0, September 1994, Final Update to the Third Edition of the Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA publication SW-846.

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

FIGURES



Legend

- AD-15
- Monitoring Wells

Location Boundaries

CCR Units

- EBAP
- Landfill
- Stack Out Area
- WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- AD-15 location is approximate.

0 380 760 1,520 2,280 3,040 Feet

Site Layout

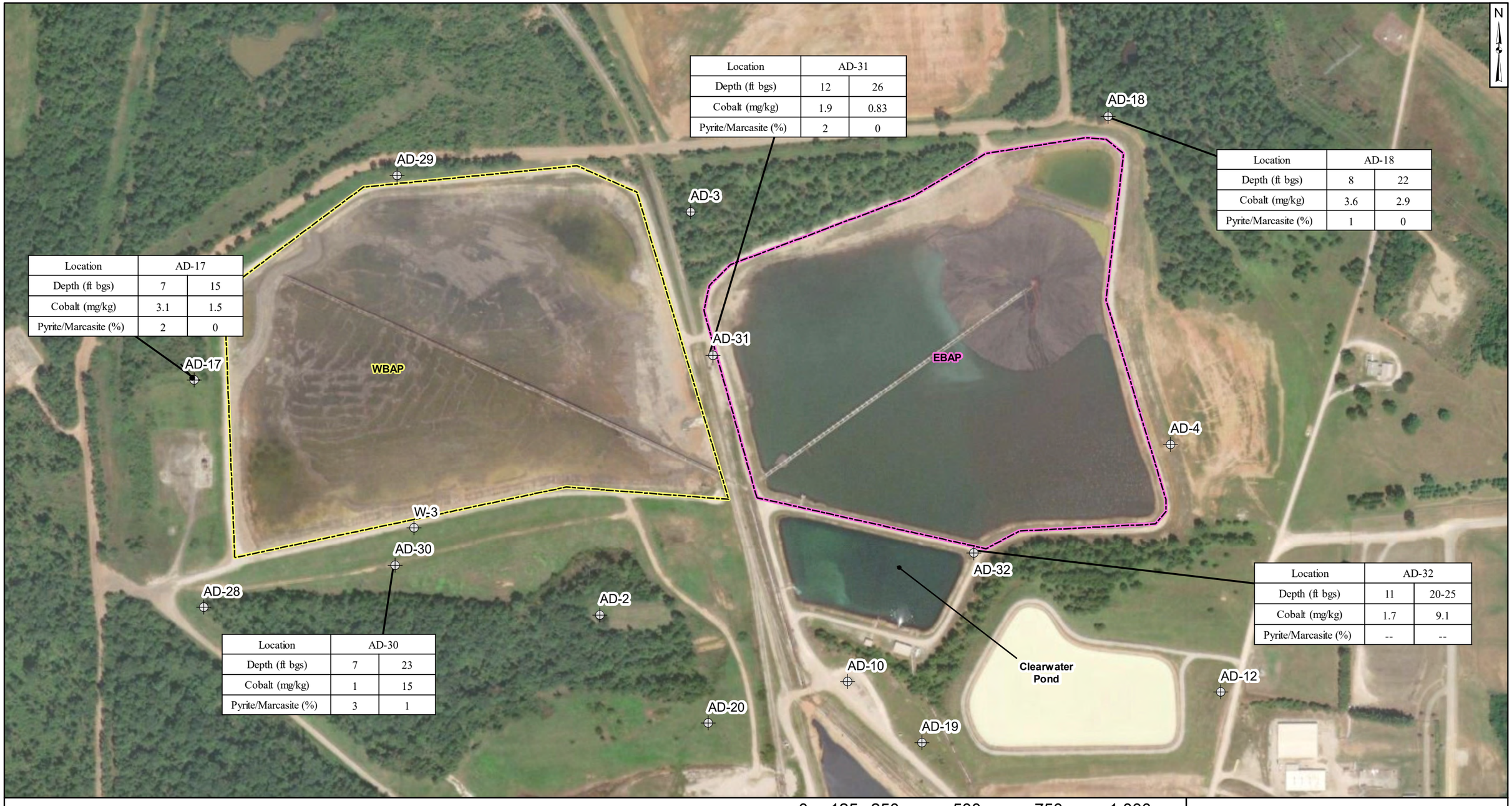
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/03/25

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_20190322.mxd. HDuff. 3/25/2019. Project/Phase/Task.



Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	AD-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

Legend

Monitoring Wells

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- ft bgs: feet below ground surface
- mg/kg: milligrams per kilogram

0 125 250 500 750 1,000 Feet

Soil Chemical and Mineralogical Analysis Results

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/03/25

Figure 2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Pirkey_SoilChem_minerals_March2019.mxd. SKaroly. 3/25/2019. Project/Phase/Task.

TABLES

Table 1: Soil Cobalt and Mineralogy Data
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Sample Depth (ft bgs)	Cobalt (mg/kg)	Pyrite/Marcasite (%)
AD-15	13	0.85	--
	40-43	0.79	--
AD-16	10	0.17	0
	19	0.44	1
AD-17	7	3.10	2
	15	1.50	0
AD-18	8	3.60	1
	22	2.90	0
AD-30	7	1.00	3
	23	15.0	1
AD-31	12	1.90	2
	26	0.83	0
AD-32	11	1.70	--
	20-25	9.10	--
AD-33	11	0.61	1
	21	0.64	--
AD-34	6	1.10	1
	24	6.50	2
AD-35	2	2.10	2
	17	0.18	0

Notes:
'--' - analysis not completed
mg/kg- milligram per kilogram
ft bgs - feet below ground surface

Samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation.

Table 2: Summary of Key Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant

Sample	Unit	Cobalt Concentration
Bottom Ash (Solid Material)	mg/kg	6.1
SPLP Leachate of Bottom Ash	mg/L	<0.01
EBAP Pond Water	mg/L	0.0024 J
AD-2 - Average	mg/L	0.0109
AD-31 - Average	mg/L	0.0107
AD-32 - Average	mg/L	0.0529

Notes:
mg/kg - milligram per kilogram
mg/L - milligram per liter
J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.
Average values were calculated using all cobalt data collected under 40 CFR 257 Subpart D.

ATTACHMENT A
AD-32 Boring Log

Hydrox ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: AD-32

PROJECT INFORMATION

PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-04-1021
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/11/2015
DEVELOPMENT:	12/16/2015
SITE LOCATION:	2400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

DRILLING INFORMATION

DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	60089
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	359.18 (Top of Casing)
HOLE DIAMETER:	8.25"
LATITUDE	32 27' 58.20" LONGITUDE 94 29' 11.88"

STATE OF TEXAS — JEFFREY D. SAMMONS — GEOLOGY #10070 — LICENSED PROFESSIONAL GEOSCIENTIST — JDS 1-21-16

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, dark reddish brown, moist - interbeds of sand and clay, yellowish brown and light gray at 1' - reddish brown and light gray at 2' - light gray and yellowish brown at 4', - grayish brown and light gray at 6' - grayish brown, light gray, and reddish brown at 7'	SC	25	46	35	22	13	
		26	44	37	20	17	
SANDY LEAN CLAY: some gravel seams and thin interbeds of cemented sand, light yellowish brown and light gray, moist to saturated within gravel seams - some iron ore gravel at 16', very moist to saturated	CL	28	54	37	22	15	
SILTY SAND: very fine to fine sand, trace clay, brownish gray and dark brownish gray, saturated - reddish brown and brown at 20'	SM						
SANDY LEAN CLAY: gray and dark gray, very moist	CL	26	51	37	24	13	
CLAYEY SAND: fine to very fine sand, gray and dark gray, very moist to saturated	SC	26	47	41	22	19	
SANDY LEAN CLAY: gray and dark gray, very moist	CL	26	59	35	21	14	

WELL CONSTRUCTION

- Locking Well Casing Cover
- Locking Well Cap
- Protective Well Casing
- Concrete Pad
- Ground Surface
- Cement
- Bentonite
- 2" Sch. 40 PVC Riser
- 20/40 Silica Sand
- 0.010" Slotted Sch. 40 PVC Well Screen
- PVC Bottom Cap

NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

ATTACHMENT B
Bottom Ash and Bottom Ash SPLP
Laboratory Analytical Data

Client Sample ID: CCR SAMPLE-EBAP-1

Date Collected: 02/11/19 17:00
Date Received: 02/13/19 09:40

Lab Sample ID: 490-168389-2

Matrix: Solid
Percent Solids: 75.6

Method: 9056 - Anions, Ion Chromatography - Soluble

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	1.3	U	1.3	1.1	mg/Kg	☼		02/14/19 01:19	1

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	13	U	13	1.3	mg/Kg	☼	02/13/19 16:11	02/19/19 19:24	1
Arsenic	**3.1**		2.6	1.6	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Barium	**330**		2.6	1.3	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Beryllium	**0.64**	**J**	1.3	0.26	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Boron	**110**		13	5.7	mg/Kg	☼	02/13/19 16:11	02/18/19 22:55	1
Cadmium	1.3	U	1.3	0.13	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Chromium	**13**		1.3	1.2	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Cobalt	**6.1**		2.6	1.3	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Lead	**0.82**	**J**	1.3	0.66	mg/Kg	☼	02/13/19 16:11	02/19/19 19:24	1
Lithium	**3.7**	**J**	13	1.3	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Molybdenum	13	U	13	6.6	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Selenium	2.6	U	2.6	1.5	mg/Kg	☼	02/13/19 16:11	02/19/19 19:24	1
Thallium	2.6	U	2.6	0.79	mg/Kg	☼	02/13/19 16:11	02/19/19 19:24	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.13	U	0.13	0.039	mg/Kg	☼	02/14/19 10:07	02/14/19 13:20	1

Client Sample ID: CCR SAMPLE-EBAP-1

Date Collected: 02/11/19 17:00
Date Received: 02/13/19 09:40

Lab Sample ID: 490-168389-2

Matrix: Solid

Method: 9056 - Anions, Ion Chromatography - SPLP West

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	**0.023**	**J B**	0.10	0.010	mg/L			02/19/19 23:58	1

Method: 6010C - Metals (ICP) - SPLP West

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:58	1
Arsenic	0.010	U	0.010	0.0086	mg/L		02/19/19 16:41	02/20/19 13:58	1
Barium	**0.23**		0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:58	1
Beryllium	0.0040	U	0.0040	0.0020	mg/L		02/19/19 16:41	02/20/19 13:58	1
Boron	**0.032**	**J**	0.050	0.020	mg/L		02/19/19 16:41	02/20/19 13:58	1
Cadmium	0.0010	U	0.0010	0.00050	mg/L		02/19/19 16:41	02/20/19 13:58	1
Chromium	0.0050	U	0.0050	0.0030	mg/L		02/19/19 16:41	02/20/19 13:58	1
Cobalt	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:58	1
Lead	0.0050	U	0.0050	0.0020	mg/L		02/19/19 16:41	02/20/19 13:58	1
Lithium	**0.011**	**J B ***	0.050	0.010	mg/L		02/19/19 16:41	02/20/19 13:58	1
Molybdenum	0.050	U	0.050	0.030	mg/L		02/19/19 16:41	02/20/19 13:58	1
Selenium	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:58	1
Thallium	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:58	1

Method: 7470A - Mercury (CVAA) - SPLP West

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.00020	U	0.00020	0.00010	mg/L		02/19/19 16:03	02/21/19 15:47	1

General Chemistry

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Solids	**75.6**		0.1	0.1	%			02/17/19 12:25	1

ATTACHMENT C

Bottom Ash Pond Water Laboratory Analytical Data

Client Sample ID: SW-EGAP-1

Date Collected: 12/15/18 14:50
Date Received: 12/18/18 10:30

Lab Sample ID: 490-165222-6

Matrix: Water

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	**0.30**	**J**	1.0	0.010	mg/L			12/20/18 19:46	1
Sulfate	**750**		500	3.0	mg/L			12/30/18 09:58	100
Chloride	**22**	**B**	6.0	0.40	mg/L			12/30/18 09:41	2

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.0030	U	0.0030	0.00080	mg/L		12/19/18 14:26	12/27/18 15:18	1
Arsenic	**0.00055**	**J**	0.0050	0.00040	mg/L		12/28/18 12:47	01/03/19 11:14	1
Barium	**0.050**	**J B**	0.20	0.00010	mg/L		12/19/18 14:26	12/27/18 15:18	1
Beryllium	0.0040	U	0.0040	0.00010	mg/L		12/19/18 14:26	12/26/18 22:18	1
Boron	**4.5**	**J**	5.0	0.18	mg/L		12/28/18 12:47	12/30/18 12:35	5
Cadmium	0.0050	U	0.0050	0.00010	mg/L		12/19/18 14:26	12/27/18 15:18	1
Calcium	**140**		1.0	0.053	mg/L		12/19/18 14:26	12/26/18 22:18	1
Chromium	0.0050	U	0.0050	0.00050	mg/L		12/19/18 14:26	12/27/18 15:18	1
Cobalt	**0.0024**	**J**	0.0050	0.00010	mg/L		12/19/18 14:26	12/27/18 15:18	1
Lead	0.0050	U	0.0050	0.00010	mg/L		12/19/18 14:26	12/21/18 21:34	1
Lithium	**0.023**	**J**	0.040	0.0030	mg/L		12/19/18 14:26	12/21/18 21:34	1
Molybdenum	**0.0075**	**J**	0.010	0.0010	mg/L		12/19/18 14:26	12/26/18 22:18	1
Selenium	**0.0059**	**J**	0.010	0.00030	mg/L		12/19/18 14:26	12/26/18 22:18	1
Thallium	0.0020	U	0.0020	0.00080	mg/L		12/19/18 14:26	12/21/18 21:34	1

Method: 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.00020	U	0.00020	0.00010	mg/L		12/20/18 12:26	12/21/18 12:23	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**1100**		25	7.0	mg/L			12/19/18 23:00	1

ATTACHMENT D
Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864	Texas	4/25/2019
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
East Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

July 22, 2019

CHA8462

TABLE OF CONTENTS

FIGURES

TABLES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASL	Alternate Screening Level
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
DPT	Direct Push Technology
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
HSA	Hollow Stem Auger
LCL	Lower Confidence Limit
LOI	Loss on Ignition
MCL	Maximum Contaminant Level
NTU	Nephelometric Turbidity Unit
PVC	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscope
SSL	Statistically Significant Level
TSS	Total Suspended Solids
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
USCS	Unified Soil Classification System
VAP	Vertical Aquifer Profiling
WBAP	West Bottom Ash Pond
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the East Bottom Ash Pond (EBAP, **Figure 1**). In 2018, two assessment monitoring events were conducted at the EBAP in accordance with 40 CFR 257.95. The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or alternate screening level (ASL) provided in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at statistically significant levels (SSLs) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey EBAP:

- LCLs for lithium exceeded the GWPS of 0.051 mg/L at AD-31 (0.0556 mg/L) and AD-32 (0.0722 mg/L); and

- LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.010 mg/L), AD-31 (0.00949 mg/L), and AD-32 (0.0353 mg/L).

No other SSLs were identified (Geosyntec, 2018).

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a*

> *qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSLs identified for lithium should not be attributed to the EBAP. An alternative source for cobalt at wells AD-2, AD-31, and AD-32 was previously identified and documented in an ASD (Geosyntec, 2019).

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for lithium were based on a Type IV cause and not by a release from the Pirkey EBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for lithium and the proposed alternative source are described below.

2.1 Alternative Source for Lithium

Initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify alternative sources due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSLs for lithium have been attributed to natural variation associated with the underlying geology, which is a Type IV issue.

Lithium concentrations vary spatially across the Site and do not necessarily appear correlated with the locations of CCR units or other Plant operations in general. While AD-31 and AD-32 have higher lithium concentrations than the upgradient wells in the EBAP network (i.e., AD-4, AD-12, and AD-18), upgradient as well as downgradient wells having similar or higher concentrations of lithium were observed within the networks for other CCR units at the Site (**Table 1**). Additionally, a boring advanced in November 2018 immediately upgradient of the EBAP (SB-01/AD-40) (**Figure 1**) revealed a strong dependence of lithium concentration with elevation, as groundwater collected at shallow intervals had low lithium concentrations e.g., (0.0207 mg/L at 30-40 feet below ground surface [ft bgs]) and groundwater collected at deeper intervals had elevated lithium concentrations (e.g., 0.0844 mg/L at 90-100 ft bgs).

These results suggest that lithium concentrations in groundwater at the site have variability in both their lateral and vertical distribution across the Site. In addition to variable lithium concentrations, it was noted that the recorded turbidity at each groundwater monitoring well is typically above the recommended maximum value of 10 nephelometric turbidity units (NTU) during groundwater sampling (**Table 1**). The recorded turbidity of samples collected during the background monitoring period was occasionally above 400 NTU, and some readings noted that the turbidity saturated the field instrument (~1000 NTU). Based on these observations, additional field work was completed to better understand the spatial distribution of lithium and its relationship to turbidity. The additional field investigation was conducted in May 2019.

2.1.1 May 2019 Field Investigation

Geosyntec advanced three borings upgradient of the EBAP between May 7 and 17, 2019 (**Figure 2**) to collect groundwater chemistry data at locations sufficiently far upgradient to completely avoid all known (present and historical) Plant activities. One shallow boring, B-1, was advanced to 36 ft bgs on a parcel owned by AEP approximately 2,000 feet to the north. Two deep borings, B-2 and B-3, were advanced to refusal at 93 and 97 ft bgs, respectively, in locations closer to the

plant, but upgradient of the EBAP. Permanent wells were installed at locations B-2 and B-3 for ongoing monitoring.

Prior to boring installation, all borings locations were hand-augured to five ft bgs to check for presence of utilities. A Geoprobe® drilling rig with 2" Direct Push Technology (DPT) was used to log and sample the shallow B-1 boring and the shallow intervals of borings B-2 and B-3. Upon refusal with the DPT rig, a truck-mounted 8" hollow stem auger (HSA) drilling rig with a continuous sampler was used to log and sample borings B-2 and B-3 below DPT refusal depth. Soils were logged continuously from the surface using the Unified Soil Classification System (USCS). Boring logs are provided in **Attachment A**. Both soil and groundwater sampling were conducted at each of the three borings. Boring B-1 was not used for a permanent well and was backfilled to the surface with Portland cement and bentonite.

2.1.1.1 Soil Sampling

The onsite hydrostratigraphic unit for the EBAP was identified as the clayey and silty sand stratum located between an elevation of approximately 325 and 340 feet above mean sea level (Arcadis, 2016). This unit is within the Reklaw Formation, which consists predominantly of clay and fine-grained sand and is underlain by the Eocene-age Carrizo Sand. The presence of lignite in the area is well-documented (Broom and Myers, 1966; ETTL, 2010). Geosyntec collected nine additional soil samples to better understand the distribution of lithium in soils in upgradient locations and with depth.

One soil sample at boring B-1, five samples at B-2 (including a sample of coal/lignite material found within the stratigraphic column), and three samples at boring B-3 were collected for total metals analysis via EPA Method 6010. Soil samples were collected just above the groundwater table, at the base of the deep borings, and at intervals of interest. The depths and rationale for each sample collected are summarized in **Table 2**. Except for the coal fragments collected in boring B-2 at 81.5 ft bgs, soil samples represent composite samples of the indicated depth interval.

Lithium concentrations of soil samples collected during the May 2019 field investigation varied from 2.59 mg/kg (B-3, 19.5-20.5 ft bgs) to 13.1 mg/kg (B-2, 87-88 ft bgs), which generally is consistent with soils previously sampled around the site. Results of the coal fragments from 81.5 ft bgs in boring B-2 indicated that the coal contained 4.32 mg/kg lithium. This is comparable to the lithium concentrations of the shallower (< 20 ft bgs) soil samples, which averaged 4.1 mg/kg (n=5), and less than the average concentrations observed in the co-located deeper lithology of 10.54 mg/kg (n=3). Lower lithium in shallower soil intervals could indicate weathering has mobilized lithium from those intervals.

2.1.1.2 Groundwater Sampling

Borings B-2 and B-3 were sampled via vertical aquifer profiling (VAP) techniques, in which multiple temporary well screens were set at the varying depth intervals of interest. Generally, a sample was taken after encountering the water table, followed by subsequent attempts to collect additional samples at ten-foot intervals. Shallow groundwater samples (< 24 ft bgs) were collected

from temporary drop screens installed via DPT in offsets from the originally logged location. Two sampling depths were attempted using DPT in borings B-2 and B-3, one at the water table and one ten feet below the water table. In both borings, only the shallower water-table interval produced enough water to sample due to clayey lithology below the water table. One shallow groundwater grab sample was collected at boring B-1 using DPT and temporary well screen methodology.

Following DPT refusal, VAP samples were collected from the same HSA borehole being logged and soil-sampled at borings B-2 and B-3. After removing the HSA continuous sampler, a four-inch diameter polyvinyl chloride (PVC) casing with a five-foot long well screen were temporarily installed through the HSA tooling, and the augers were retracted to expose the well screen to the formation. Following sampling, the well casing and screen was removed and decontaminated, and drilling resumed for another ten feet. Four samples from boring B-2 and six samples from boring B-3 were collected using the HSA VAP methodology. Five-foot intervals in boring B-2 at 68-73 and 88-93 ft bgs and boring B-3 at 92.5-97.5 bgs did not produce enough water to collect a sample due to clay lithology. **Table 3** summarizes the groundwater samples collected in May 2019.

Groundwater VAP sampling was generally completed using a modified low-flow methodology. When possible, flow rates below 500 ml/min were used during purging, and drawdown was monitored. Geochemical parameters and turbidity were monitored, though stability was not observed during purging the temporary well screens. Wells were purged for a minimum of 20 minutes prior to sampling. However, turbidity remained visibly high at all sampling intervals prior to sample collection.

Groundwater VAP samples were sent to the lab on ice for quick turn-around analysis of total lithium concentrations via EPA Method 6010. Due to the high turbidity in the total lithium samples, extra sample volume was collected in an unpreserved one-liter plastic sample bottle for lab filtration using a 0.45-µm filter and analysis of dissolved lithium. Groundwater samples were also analyzed a full scan of metals, total dissolved solids, major anions, and alkalinity.

Total (unfiltered) lithium concentrations varied from 45 µg/L to 1,140 µg/L (**Table 3**). Lithium concentrations in the lab filtered samples varied from 6 µg/L to 105 µg/L. The lab filtered results were generally lower than the total lithium results, suggesting a correlation between turbidity and lithium concentration. Select total lithium concentrations were higher than previously observed at the Site. This is likely due to the fact that the samples were collected without a developed filter pack and with elevated turbidity. Additional groundwater results are available in **Attachment B**. Total metals data for parameters other than lithium are not available for samples from B-2 as they were analyzed using incorrect laboratory techniques.

2.1.1.3 Permanent Well Sampling

Permanent wells were installed at boring B-2 and B-3, with the screened interval based on VAP sampling results. The HSA drilling rig was used to install a well screen at 38 to 48 ft bgs at boring B-2 and 29 to 34 ft bgs at boring B-3. These elevations are consistent with the screened elevations at AD-31 and AD-32. Well construction diagrams are available in **Attachment C**. Wells were

installed per state regulations and certified by a Texas licensed driller. After an appropriate set-up time for the bentonite seal, the wells were developed with a Proactive Typhoon pump until turbidity and geochemical parameters stabilized (**Attachment D**). Following well development, both new permanent wells were sampled using low-flow methodology (**Attachment E**).

Total lithium concentrations in permanent wells B-2 and B-3 were measured at 0.053 mg/l and 0.061 mg/l, respectively (**Figure 3**). These concentrations are slightly above the GWPS of 0.051 mg/L. Because these wells were installed at upgradient locations unimpacted by Site activities, they suggest that lithium concentrations above the GWPS are located in the vicinity of the EBAP, but not necessarily related to the prevailing groundwater flow direction. Samples were also collected from AD-31 and AD-32 using low-flow methodology, with special effort taken to purge the well until turbidity was below 10 NTU (**Attachment E**). The reported lithium concentrations for these samples were near or below the lowest value observed during monitoring at these locations to date (**Figure 4**). While not a direct correlation, these results suggest that elevated turbidity may be associated with higher lithium concentrations.

2.1.1.4 Investigation of Suspended Solids

It was noted during VAP and permanent well sampling that lithium is biased toward higher concentrations when samples are very turbid. Therefore, an additional investigation was conducted to evaluate the suspended matter and determine whether it could be serving as a background source of lithium. Unpreserved groundwater samples from intervals VAP-B3-(40-45) and VAP-B3-(50-55) were processed to separate the particulate from the groundwater. Aliquots of each sample were centrifuged at approximately 700 Relative Centrifugal Force for five minutes. The supernatant was then decanted, and the solid pellet was transferred to a small glass vial for chemical analysis. The supernatant had a yellowish color, suggesting that especially fine particulate remained in suspension, but accounted for very little mass.

In addition to the centrifuged material from VAP-B3-(40-45), a sample of the bulk soil from interval B2-(19-20) was submitted for analysis by X-ray diffraction (XRD). XRD is commonly used to identify and quantify crystalline solids among an assemblage of solids. Solids that are amorphous (non-crystalline), such as humic substances and other organic matter, cannot be detected with compositional specificity by XRD.

Results of the XRD analysis indicate the presence of common soil minerals (**Table 4**). The bulk soil [B-2-(19-20)] contained a higher fraction of quartz (67%), which is typical of an unconsolidated sandy aquifer. Soil in this depth interval also contained several percent by weight of clay minerals, including kaolinite, chlorite, illite and smectite. Goethite (a mineral composed of iron(III) hydroxide) comprises 2% of the sample and a form of amorphous (non-crystalline) matter makes up approximately 7% of the sample.

The centrifuged sample [VAP-B3-(40-45)] contained less quartz (15%), a higher fraction of clay minerals (42% kaolinite, 4% chlorite, 6% illite and 12% smectite), and 15% (roughly estimated) amorphous matter. According to the XRD results, this soil fraction contains 2% hematite, an iron(III) oxide (Fe_2O_3) and 3% pyrite.

Sulfur and iron were among the elements identified in the VAP-B3-(50-55) centrifuged solid material sample by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). Results, reported as weight percent oxides and sulfide in **Table 5**, show 3.4% FeS_2 and 2.8% Fe_2O_3. While these results express chemical composition rather than mineralogy, it is reasonable to infer that FeS_2 represents pyrite and Fe_2O_3 represents hematite (Fe_2O_3) and goethite ($Fe_2O_3 \cdot H_2O$) based on the XRD results. Silica, aluminum and potassium oxides correspond to the quartz and clay minerals identified in **Table 4**.

The abundance of smectite in both XRD samples bears consideration. Smectite is a group name for certain clay minerals with a 2:1 silicate structure which form crystals that are typically sub-micrometer in size. Common types of smectite include montmorillonite and beidellite, but a lithium-bearing form called hectorite is also well known (USGS, 2001). Smectites have among the highest cation-exchange capacities of all clay minerals: their interlayer regions can sorb roughly 100 milli-equivalents of cation charge per 100 grams of clay (100 meq/100 g). Exchangeable metals often include calcium and sodium, but almost all metals with +1 or +2 charge are potential exchange species. The SEM/EDS results also confirm that aluminum and silicon are major constituents, which supports the XRD finding that clays are the predominant mineral in suspension. The presence of potassium also helps confirm the presence of illite (mica), which was identified by XRD.

It is noteworthy that the centrifuged solid material had a higher fraction of amorphous (non-crystalline) material, which could include organic solids. Moreover, this amorphous material may be what contains the abundance of clay minerals. While the XRD results are inconclusive, one possibility is that the amorphous material is lignite and the clays are associated with its mineral fraction.

Because XRD cannot identify if lithium is present within a sample, the centrifuged solid material was submitted for total metals analysis. An additional sample of suspended matter from VAP interval B3-(50-55) was also submitted for metals analysis, as it had the highest total lithium of all the VAP samples that were collected. Lithium was detected in B3-(50-55) and B3-(40-45) (**Table 6**) at concentrations comparable to lithium in the bulk soil (**Table 2**). These results provide evidence that the particulates captured during groundwater sampling contain lithium.

Metals in a lignite sample from the nearby surficial mine were compared to concentrations in the suspended matter (**Figure 5)**. The concentrations of lithium and other constituents are similar, suggesting that some fraction of the suspended solids consists of degraded lignite. Thin seams of lignite were noted in boring logs at the depth most monitoring wells at the Site were installed (**Attachment A**).

Loss on ignition (LOI) testing was completed to quantify mass loss after heating the sample to 550°C in an oxygen-rich environment, which allows for measurement of the combustible carbon and loss of semi-volatile constituents. Centrifuged solid material from both the VAP B3-(40-45) and B3-(50-55) fraction were air-dried in pre-weighed pans to 103°C to remove excess water from the samples. The samples were weighed again and then heated to 550°C until the mass of the fraction was steady, signifying complete combustion of the volatile fraction. The B3-(40-45) sample had a volatile fraction of 13.1%, and the B3-(50-55) sample had a volatile fraction of 11.4% of the total mass, respectively. These fractions are believed to represent organic compounds, such as lignite. The volatile fraction in the 40-45 ft sample (13.1%) is in good agreement with the determination of 15% amorphous matter by XRD (**Table 4**). By difference, the solid fractions consist of 87-89% refractory minerals including clays, metal oxides, and pyrite. Because lignite typically contains ~20 % hydrocarbons (plus oxygen and nitrogen), and only 6-19% mineral matter (Ghassemi, 2001), the results of the LOI tests suggest that most of the organic fraction of the lignite has been lost to degradation, primarily leaving the mineral fraction in place of the original lignite deposit.

Based on chemical analysis of the two solid samples, the iron content is 1.1% for B-2 and 2.6% for B-3, which is comparable to the amount of iron in the lignite sample (1.4%) from the Plant (**Table 6**). While some of the iron is associated with the oxidized iron minerals, goethite and hematite, which were detected by XRD (**Table 4**), some iron is likely present in pyrite as well. As noted above, pyrite was detected by XRD in the particulate sample (B-3) and iron and sulfur were both detected in the particulate by SEM/EDS, but the results were not quantified.

Together with the evidence presented for pyrite in the suspended solids and in locally-mined lignite, the solid phase results support the proposed alternative source for lithium, which is naturally suspended matter that likely originates from lignite and is ubiquitous in the shallow aquifer.

The total metal concentrations in the centrifuged solid material samples and the total groundwater concentrations were used to calculated partition coefficients values (K_d) for multiple constituents, including lithium. The calculated K_d values were comparable to literature K_d values reported for organic-rich soil media such as bogs and peats (**Table 7**) (Sheppard et al, 2009; 2011). Additionally, total suspended solids (TSS) concentrations were calculated using the solids and groundwater concentrations and compared to TSS concentration measured using gravimetric techniques (**Table 7**). These values were also comparable, providing further evidence that lithium behavior at the site is similar to its adsorption and mobility at other organic-rich sites described in the literature.

2.1.2 Proposed Mechanism for Lithium Transport in Groundwater

Based on the chemistry results, it is proposed that lithium is associated with clay minerals that make up the mineral fraction of lignite, which is deposited in thin beds at various depths within the aquifer. Clay particles which remain suspended due to their association with the lignite matrix are the vehicle for lithium transport. It appears that these particles remain in suspension during

low-flow groundwater sampling even after very long purge times, as evidenced by the historical high turbidities measured in Site groundwater. During groundwater sampling, an abundance of suspended matter is mobilized with the sample which, after nitric-acid preservation, releases the lithium into solution where it often results in elevated concentrations.

A simple model to illustrate the effect of suspended solids on total (unfiltered) lithium is shown in **Figure 6**. This model used the partition coefficients described in Section 2.1.1 to calculate the dissolved phase concentrations of lithium plus the contribution of lithium to groundwater by the particulate (see **Table 7**). Although results for the two sources are not identical, the figure shows that when the abundance of suspended matter reaches a certain level (approximately 10 g/L or higher) the total lithium (dissolved plus suspended) can greatly exceed that of the dissolved phase alone. According to the model, lithium concentrations are less variable when lower concentrations of suspended solids are present in groundwater. This provides an explanation for why observed lithium concentrations at the Site are not clearly correlated with turbidity. The analytical data, geologic information, and sorption model presented above provide a mechanism for the distribution and transport of naturally occurring lithium in Site groundwater.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSLs for lithium at wells AD-31 and AD-32 identified during assessment monitoring in 2018 were not due to a release from the EBAP. The identified SSLs were, instead, attributed to natural variation in the underlying geology. Therefore, no further action for lithium is warranted, and the EBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in **Attachment F**.

SECTION 4

REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

Arcadis, 2016. East Bottom Ash Pond – CCR Groundwater Monitoring Well Network Evaluation. H.W. Pirkey Power Plant. May.

Broom, M.E. and Myers, B.N., 1966. Ground-Water Resources of Harrison County, Texas. Texas Water Development Board Report 27. August.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. 3002010920. October.

ETTL, 2010. Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas, Geotechnical Investigation. October.

Ghassemi, A. 2001. Handbook of Pollution Control and Waste Minimization. CRC Press, 2001.

Geosyntec Consultants, 2018. Statistical Analysis Summary, East Bottom Pond. H.W. Pirkey Power Plant. Hallsville, Texas. December.

Geosyntec Consultants, 2019. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Power Plant. April.

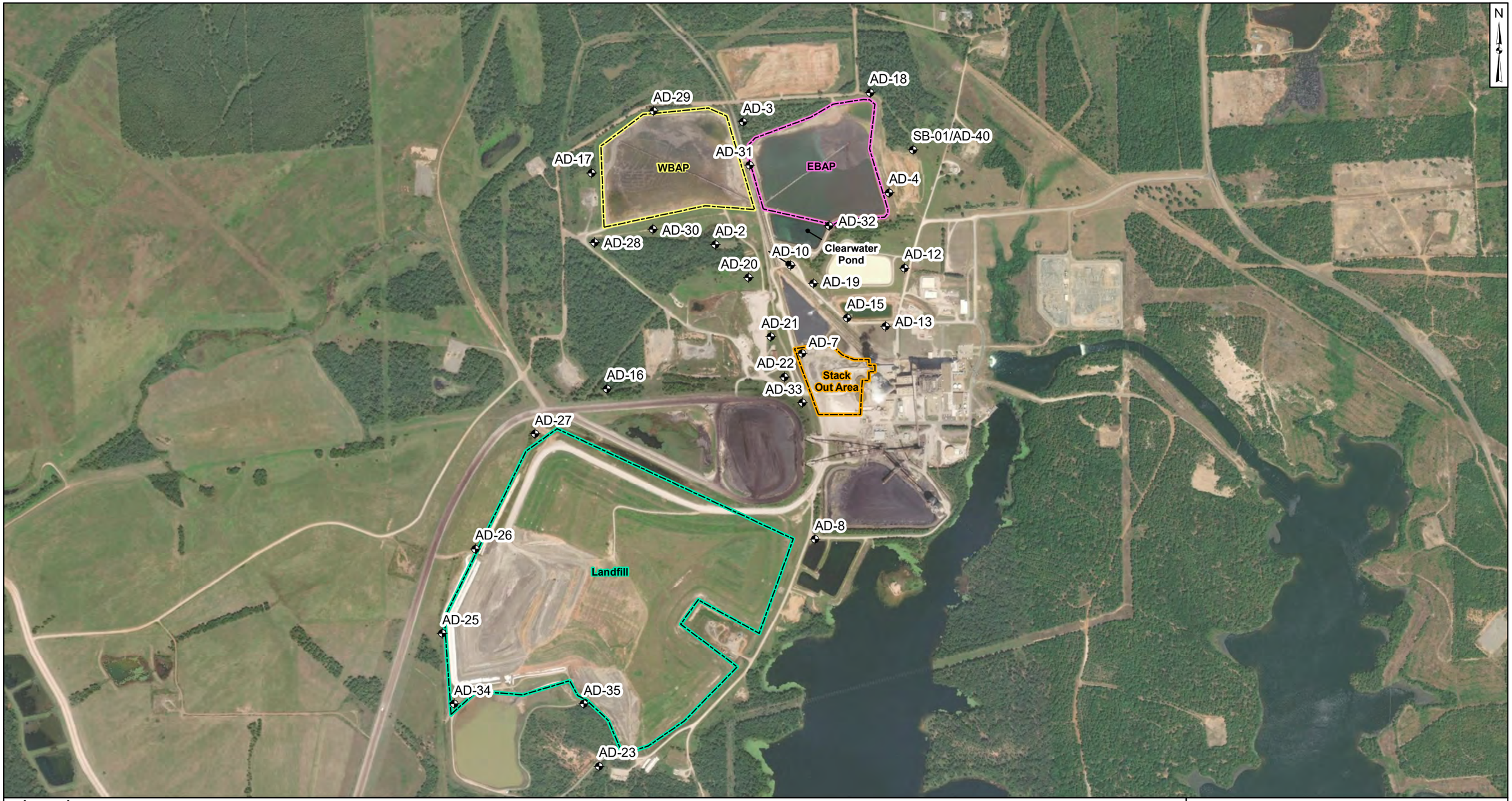
Sheppard, S., Long, J., Sanipelli, B., and Sohlenius, G. 2009. Solid/Liquid Partition Coefficients (Kd) for selected soils and sediments at Forsmark and Laxemar-Simpevarp. SKB – Swedish Nuclear Fuel and Waste Management Co. R-09-27. March.

Sheppard, S., Sohlenius, G., Omberg, L., Borgiel, M., Grolaner, S., and Nordén, S. 2011. Solid/liquid partition coefficients (Kd) and plant/soil concentration ratios (CR) for selected soils, tills, and sediments in Forsmark.

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

United States Geological Survey (USGS). 2001. A Laboratory Manual for X-Ray Powder Diffraction. Open-File Report 01-041.

Figures



Legend

- Monitoring Well
- EBAP
- Landfill
- Stack Out Area
- WBAP

Notes
- Monitoring well coordinates provided by AEP.
-AD-15 location is approximated

800 400 0 800 Feet

Site Layout

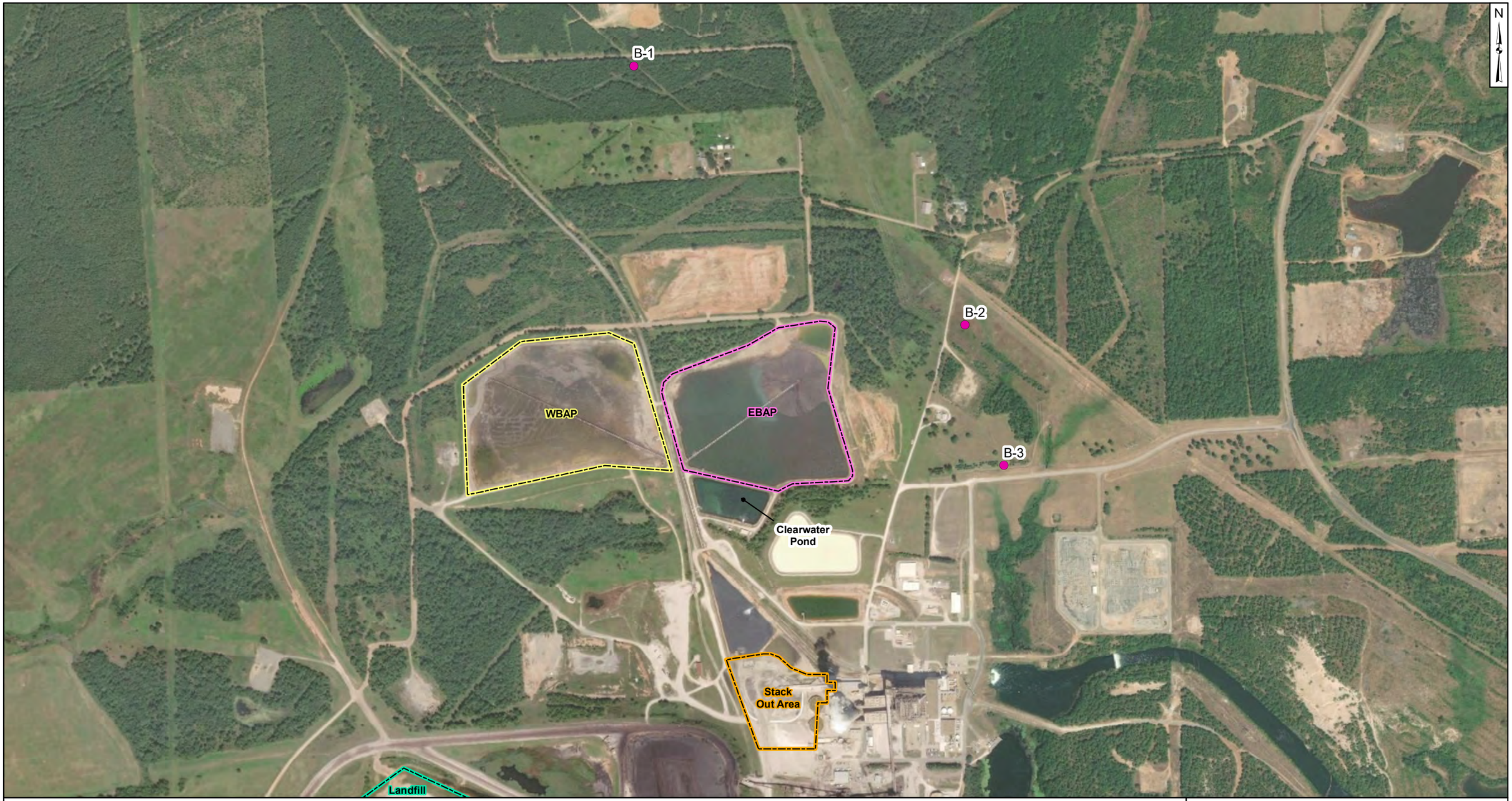
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/07/10

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_2019 ASD Site Layout.mxd. ARevezzo. 7/10/2019.



Legend

- Soil Boring Location
- EBAP
- Landfill
- Stack Out Area
- WBAP

Notes
-Data provided by AEP, 2019.
-Soil Boring locations are approximate.

0 350 700 1,400 2,100 Feet

Soil Boring Locations

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/07/10

Figure 2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_2019 ASD Soil Boring Locations.mxd. ARevezzo. 7/10/2019. Project/Phase/Task.

Legend

- Borehole
- Monitoring Well

Location Boundaries

- EBAP
- Landfill
- Stack Out Area
- WBAP

Notes
- Lithium concentrations in mg/l
- Monitoring well coordinates and water level data (collected on August 20-21, 2018) provided by AEP.
- Data provided by AEP 2019
- AD-15 location is approximated

0 150 300 600 900 1,200 Feet

Lithium Values
May 2019

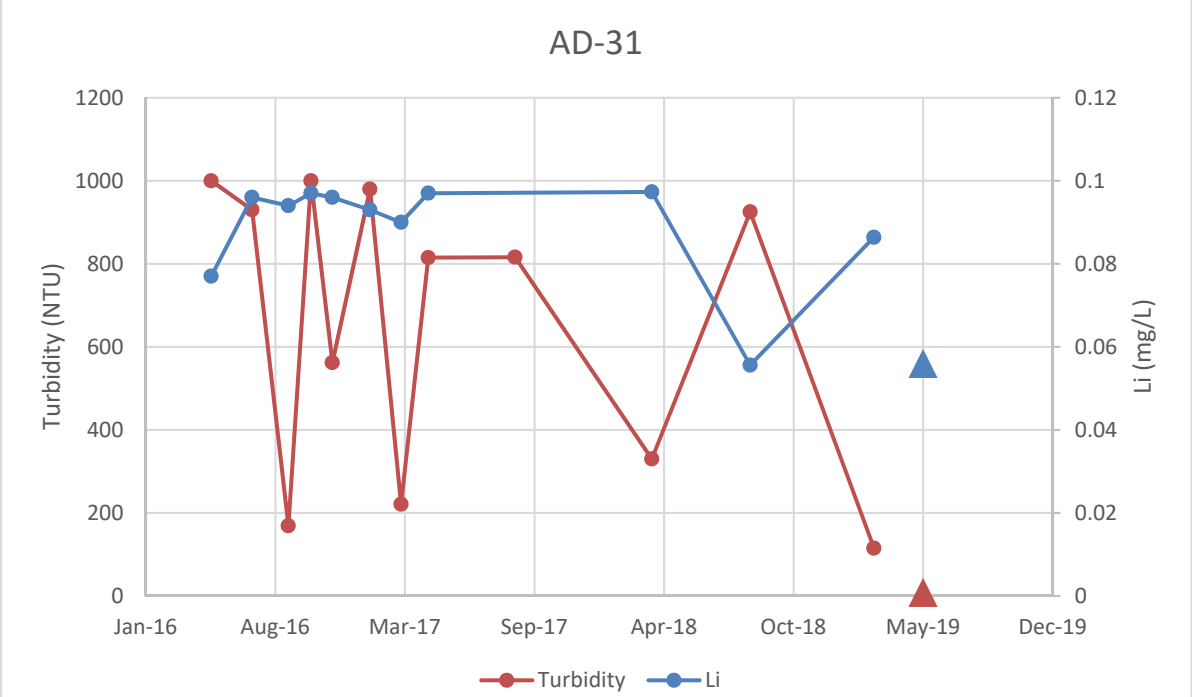
AEP Pirkey Power Plant
Hallsville, Texas

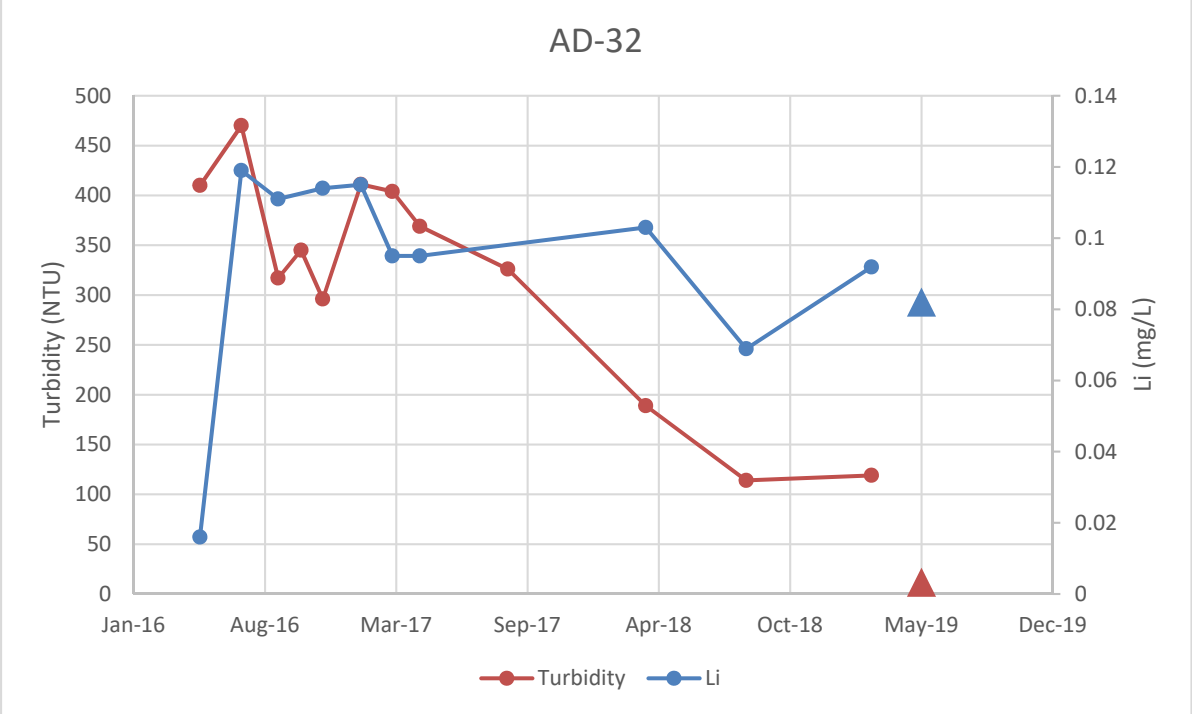
Geosyntec consultants

Columbus, Ohio | 2019/07/10

Figure 3

\\annarbor-01\data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_Li_201907.mxd. MBizjack. 7/10/2019. CHA8462/12/02.





Notes:
NTU: nephelometric turbidity units
mg/L: milligrams per liter

Lithium and Turbidity Time Series Graphs
Pirkey East Bottom Ash Pond

Geosyntec consultants

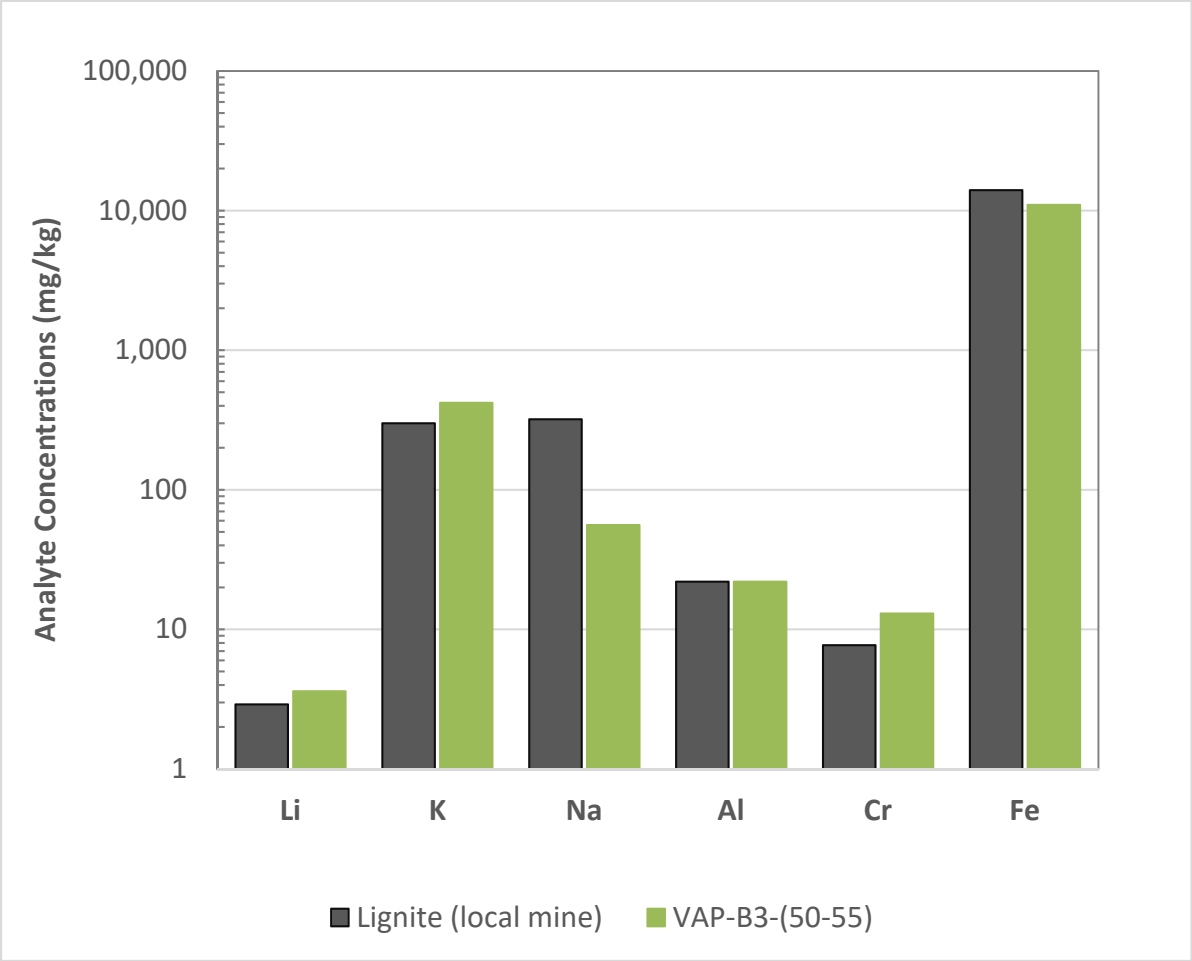
AMERICAN ELECTRIC POWER

Columbus, Ohio

7-Jul-2019

Figure **4**

internal info: path, date revised, author



Notes: VAP-B3-(50-55) sample was obtained by centrifuging suspended solids in groundwater at the 50-55 ft interval. Locally mined lignite was collected from the coal pile at the Site.

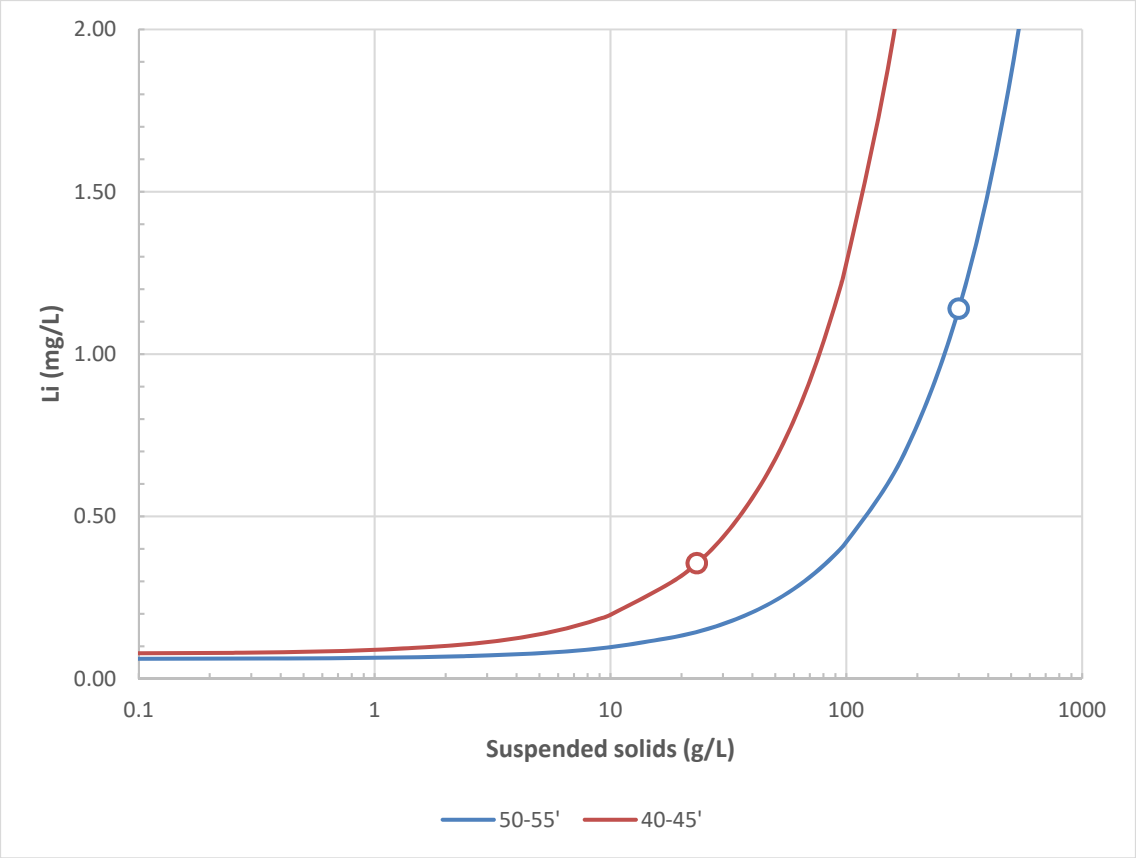
Total Metals Concentrations
Pirkey East Bottom Ash Pond

Geosyntec consultants | AMERICAN ELECTRIC POWER

Columbus, Ohio | 7-Jul-2019

Figure **5**

internal info: path, date revised, author



Notes: Model for lithium concentrations based on sorption on suspended solids. The model was generated using the results from VAP-B3-(50-55) and –(45-55). Symbols represent results of unfiltered samples.

Calculated Lithium Sorption Model
Pirkey East Bottom Ash Pond

Geosyntec consultants | AMERICAN ELECTRIC POWER | Figure 6

Columbus, Ohio | 7-Jul-2019

internal info: path, date revised, author

Tables

Table 1: August 2018 Groundwater Lithium and Turbidity Results
Pirkey Plant - East Bottom Ash Pond

Geosyntec Consultants, Inc.

Well	Lithium (mg/L)	Turbidity (NTU)	CCR Unit Network
AD-2	0.0479	155	EBAP
AD-3	0.0876	190	WBAP
AD-4	0.0294	201	EBAP
AD-7	0.0877	103	Stackout
AD-8	0.0221	103	Landfill
AD-12	0.0143	177	EBAP/WBAP/Landfill/Stackout
AD-13	0.146	181	Stackout
AD-16	0.0347	100	Landfill
AD-17	0.0234	124	WBAP
AD-18	0.0175	278	EBAP/WBAP
AD-22	0.132	235	Stackout
AD-23	0.00634	995	Landfill
AD-27	0.0921	279	Landfill
AD-28	0.0307	216	WBAP
AD-30	0.0118	142	WBAP
AD-31	0.0556	925	EBAP
AD-32	0.0689	114	EBAP
AD-33	0.0178	102	Stackout
AD-34	0.114	131	Landfill
AD-35	0.00876	258	Landfill

Notes:
mg/L: milligrams per liter
NTU: nephelometric turbidity units
EBAP: East Bottom Ash Pond
WBAP: West Bottom Ash Pond
Stackout: Stackout Pad

Table 2: Soil Sampling Results
Pirkey Plant - East Bottom Ash Pond

	Boring	B-1	B-2					B-3		
	Depth (ft bgs)	16-21	9.5-10.5	19-20	71-72	81.5	87-88	9.5-10.5	19.5-20.5	96.5-97
	Sampling Rationale	Soil above groundwater table	Soil 10 ft bgs	Soil above groundwater table	Soil with abundant coal material	Coal Fragments	Soil at auger refusal depth (93 ft bgs)	Soil 10 ft bgs	Soil above groundwater table	Soil at auger refusal depth (97 ft bgs)
	Soil Type	Sandy clay/clay/ clayey sand	Fat clay	Clay, medium plasticity	Coal/sand interbeds with clay	--	Silty clay, low plasticity	Silty clay	Fat clay	Silty clay, low plasticity
Metals Concentrations (mg/kg)	Aluminum	NM	NM	NM	NM	NM	NM	15600	8170	NM
	Antimony	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Arsenic	14.3	17.9	12.3	7.94	5.01	1.88	17.4	9.96	0.89
	Barium	51.7	53.8	39.5	39.4	53.7	27.5	47.2	206	35.5
	Beryllium	0.376	0.477	0.385	0.217	1.99	0.233	0.419	0.301	0.273
	Boron	11.9	11	13.1	13.6	48.3	12.1	11.2	5.44	7.8
	Cadmium	0.185	0.116	0.234	0.208	<0.05	<0.05	<0.05	<0.05	0.05
	Calcium	183	117	195	245	1820	479	36	45.4	226
	Chromium	37.6	33.3	26.2	6.93	42.5	16.1	31.2	19.6	13.2
	Cobalt	2.95	2.36	3.62	10.3	7.21	3.11	1.3	0.593	1.11
	Iron	41000	36900	42800	38100	22600	17300	25300	13800	2880
	Lead	12.1	9.31	8.29	6.87	9.5	10.5	8.8	5.21	9.1
	Lithium	5	5.3	3.97	7.42	4.32	13.1	3.64	2.59	11.1
	Magnesium	968	2840	1720	362	716	845	1400	528	365
	Manganese	15.6	10.4	12.7	38.8	48.8	32.1	10.5	6.9	16.1
	Molybdenum	0.828	0.608	0.479	3.38	1.63	0.8	0.692	0.654	0.334
	Nickel	NM	NM	NM	NM	NM	NM	3.05	4.26	NM
	Potassium	1370	2360	1860	456	276	663	2230	1120	437
	Selenium	1.57	1.02	1.13	2.04	2.52	1.84	0.666	0.448	1.39
	Sodium	53.1	139	51.7	57.6	86.3	53.7	47.3	56.3	39.9
	Strontium	62.5	47.9	13.4	6.52	15.5	10.5	12.8	6.51	8.24
	Thallium	<0.25	<0.25	<0.25	0.306	0.799	<0.25	<0.25	<0.25	<0.25
	Dry Weight (%)	74.3	78.5	78.9	84.7	75.3	87.3	80.3	78.5	86.8

Notes:
ft bgs - feet below ground surface
< - Analyte not detected above analytical detection limit
NM - Not measured

Table 3: Groundwater Lithium Sampling Results
Pirkey Plant - East Bottom Ash Pond

Geosyntec Consultants, Inc.

Boring	Depth Interval (ft bgs)	Drilling Method	Lithium Concentration (mg/L)	
			Total	Lab Filtered
B-1	16-21	DPT	0.202	0.022
B-2	10-14	DPT	0.045	0.006
	38-43	HSA	0.140 (0.142)	0.056 (<0.05)
	48-53	HSA	0.112	<0.05
	58-63	HSA	0.143	<0.05
	78-83	HSA	0.201	0.097
B-3	20-24	DPT	0.053	0.013
	33-37	HSA	0.152	0.105
	40-45	HSA	0.356	0.077
	50-55	HSA	1.140	0.061
	60-65	HSA	0.098	0.052
	72.5-77.5	HSA	0.812	0.009
	82.5-87.5	HSA	0.102	0.023

Notes:
< - Analyte not detected above analytical detection limit
DPT: Direct push technology
HSA: Hollow stem auger
Results for other groundwater parameters available for B-1 and B-3 in Attachment B.
Total lithium results from unfiltered sample volume collected in HNO3 preserved bottle.
Lab filtered results from laboratory vacuum-filtered sample volume collected in unpreserved bottle.
Duplicate results in parentheses.

Table 4: X-Ray Diffraction Results *Geosyntec Consultants, Inc.*
Pirkey Plant - East Bottom Ash Pond

	B-2(19-20)	VAP-B3-(40-45)
Quartz	67	15
Plagioclase Feldspar	ND	0.5
Orthoclase	<0.5	ND
Calcite	<0.5	ND
Dolomite	1	ND
Siderite	ND	0.5
Goethite	2	ND
Hematite	ND	2
Pyrite	ND	3
Kaolinte	4	42
Chlorite	1	4
Illite/Mica	2	6
Smectite	16	12
Amorphous	7	15

Notes:
ND: Not detected
<0.5 indicates mineral phase is present but below quantification limits.
B-2(19-20) sample represents bulk soil.
VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

Table 5: SEM/EDS Microscopy Results
Pirkey Plant - East Bottom Ash Pond

	Centrifuged Material (Weight Percent)
Al_2O_3	31.1%
SiO_2	60.9%
FeS_2	3.4%
K_2O	1.7%
TiO_2	ND
Fe_2O_3	2.8%

Notes:

ND: component not detected
concentration below the analytical detection limit

Centrifuged material was the solid material which separate from the groundwater sample at VAP interval B3-(50-55) after centrifugation.

Oxide calculations are expressed on a dry basis and do not include molecular structural water.

Table 6: Centrifuged Solids Total Metals Results
Pirkey Plant - East Bottom Ash Pond

Depth (ft bgs)		B3-(40-45)	B3-(50-55)	Lignite
Analyte Concentrations (mg/kg)	Aluminum	68 J	22 J	22 J
	Boron	6.4 J	2.3 J	77
	Calcium	1,200	160 J	7,700
	Chromium	37	13	7.7
	Iron	26,000	11,000	14,000
	Lithium	12	3.6 J	2.9 J
	Magnesium	880	260	1,900
	Potassium	960	420 J	300 J
	Sodium	270 J	56 J	320 J
	Mercury	1.1	0.026 J	0.13 J

Notes:
ft bgs - feet below ground surface
< - Analyte not detected above analytical detection limit
mg/kg: milligrams per kilogram
J - Estimated analyte concentration below the reporting limit and above the method detection limit
B-3 samples are centrifuged solid material separated from groundwater samples collected at the designated interval.
Lignite was collected from a local mine.

Table 7: Calculated Site-Specific Partition Coefficients
Pirkey Plant - East Bottom Ash Pond

Source	B-3 40-45 ft bgs						Literature Value
Unit	mg/L	mg/L	mg/L	mg/kg	g/L	L/kg	L/kg
Element	**Aqueous Phase**	**Aqueous + Suspended**	**Suspended**	**Adsorbed**	**Calculated Suspended Solids**	**Kd**	**Kd**
Li	0.0770	0.356	0.279	12	23	156	43-370
K	2.46	19.1	16.6	960	17	390	42-1200
Na	12.6	18.1	5.50	270	20	21	5.2-82
Mg	1.92	12.6	10.7	880	12	458	46-1400
Ca	1.84	7.00	5.16	1200	4	652	24-460
Cr	0.0442	0.253	0.209	37	6	838	140-5,500
B	0.02	0.03	0.01	6.4	2	320	63-170
Fe	2.03	361	359	26000	14	12808	4900-160000
Measured Total Suspended Solids					10		

Source	B-3 50-55 ft bgs						Literature Value
Unit	mg/L	mg/L	mg/L	mg/kg	g/L	L/kg	L/kg
Element	**Aqueous Phase**	**Aqueous + Suspended**	**Suspended**	**Adsorbed**	**Calculated Suspended Solids**	**Kd**	**Kd**
Li	0.061	1.14	1.079	3.6	300	59	43-370
K	2.86	53.3	50.44	420	120	147	42-1200
Na	12.8	17.9	5.1	56	91	4	5.2-82
Mg	0.925	41	40.075	260	154	281	46-1400
Ca	0.749	16.4	15.651	160	98	214	24-460
Cr	0.0213	1.9	1.879	13	145	611	140-5,500
B	0.203	0.675	0.472	2.3	205	11	63-170
Fe	3.88	1440	1436	11000	131	2835	4900-160000
Measured Total Suspended Solids					51		

Notes:
mg/L: milligrams per liter
mg/kg: milligrams per kilogram
g/L: grams per liter
L/kg: liters per kilogram
Kd: partition coefficient
Adsorbed values are total metals concentrations reported by USEPA Method 6010B.
Literature values represent maximum and minimum values for the parameter as reported in Sheppard et al, 2009 (Table 4-1, all sites) and Sheppard et al, 2011 (Table 3-3 cultivated peat and wetland peat only).

Attachment A
Boring Logs

Soil Boring Log

Project: AEP Pirkey

Boring/Well Name: B-1

Project Location: Hallsville, TX

Boring Date: 5/14/2019

Depth Scale Feet	Water Table	Soil Profile Description	PID
0		0.0' - 5.0' were hand augered on a previous date.	
		0.0'-1.0': No Recovery	
		1.0'-4.0': Light gray and dark red clay, medium plasticity, low stiffness; trace silt	
		4.0'-5.1': No Recovery	
5		5.1'-5.5': Light gray and dark red clay, high plasticity, low stiffness	
		5.5'-8.0': Light gray and orange clay, high plasticity, low stiffnedd; trace silt	
		8.0'-8.9': Light gray and dark red clay, high plasticity, low stiffness	
		8.9'-9.6': Light purple and gray clay, high plasticity, low stiffness; trace silt	
		9.6'-10.5': Light gray sandy clay, very fine grained; sand grains are orange	
10		10.5'-10.7': Light gray fine grained sand, very well sorted	
		10.7'-10.9': Moist, Tan and orange fine grained sand, very well sorted	
		10.9'-12.0': Light purple and gray sandy clay	
		12.0'-12.5': No Recovery	
		12.5'-13.0': Moist, Light brown silty clay	
15		13.0'-14.1': Moist, light brown silty sand, fine grained, moderate sorting	
		14.1'-16.0': Light purple and gray clay, medium stiffness, medium plasticity	
		16.0'-17.3': Wet, light brown sandy clay	
		17.3'-20.0': Maroon/Purple clay, high stiffness, medium plasticity	
20		20.0'-20.9': Wet, Light brown clayey sand	
		20.9'-24.0': Maroon/Purple clay, high stiffness, low plasticity; trace brown silt	
		24.0'-24.3': Maroon/Purple clay, high stiffness, low plasticity; trace brown silt	
		24.3'-26.5': Dark purple/black clay, high stiffness, no plasticity	
25		26.5'-28.0': Moist, Dark gray clayey sand, fine grained	
		28.0'-28.7': Wet, Brown and dark gray clayey sand	
		28.7'-29.7': Dark gray fine grained sand, well sorted; trace sand	
		29.7'-30.3': Dark gray clay, medium stiffness, Medium plasticity	
30		30.3'-30.6': Tan silt with gravel	
		30.6'-32.0': Dark gray/black and purple clay, very high stiffness, no plasticity	
		32.0'-33.8': Wet, Brown and dark green silty clay, low plasticity	
		33.8'-35.1': Moist, Dark green fine grained sand, well sorted	
35		35.1'-36.0': Moist, Dark gray fine grained sand, well sorted; trace clay	
		EOB @ 36' BGS	
		Boring backfilled with bentonite	
40			

Drill Rig: Geoprobe 7822 DT

Drilling Contractor: Best Drilling

Driller: Ramon Gutierrez

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey | Boring/Well Name: B-2

Project Location: Hallsville, TX | Boring Date: 5/13/2019 to 5/17/2019

Depth Scale Feet	Water Table	Soil Profile Description	PID
0		0.0' - 5.0' were hand augered on a previous date.	
		0.0'-0.5': Black, soft fine grained silty sand, vegetation	
		0.5-2.0': Red/brown fine grained sand, moderate sorting	
		2.5-5.0': Alternating layers red+brown sandy clay, low plasticity	
5		5.0-5.5': No Recovery	
		5.5-6.7': Gray + brown/red sandy clay, medium plasticity, low stiffness	
		6.7'-8.0': Gray clay, medium plasticity, medium hardness with brown/red sand lenses throughout	
		8.0-11.0': Gray clay with brown striations, high stiffness, high plasticity, tree roots present @ 8.3' bgs	
10		11.0-11.5': Gray clay, medium stiffness, high plasticity, trace gravel @ 11.25'	
		11.5-12.0': (Gray) clayey (red-brown) sand, poorly sorted, soft	
		12.0-14.0': No Recovery	
		14.0-14.75': Reddish brown + gray sandy clay, trace gravel @ 14.5', medium stiffness, medium plasticity	
15		14.75-16.0': Gray + red clay, medium hardness, high plasticity, trace brown fine grained sand	
		16.0-18.5': No Recovery	
	▮	18.5-18.75': Soft, red + gray clay, high plasticity, trace silt	
		18.75-18.95': Tan, sand fine-coarse grained, poorly sorted, small coal fragment	
		18.95-20.0': Red/dark gray clay, high stiffness, medium plasticity	
20		20.0-21.1': No recovery	
		21.1'-21.8': Wet, sandy clay, light brown + red	
		21.8-24.0': Red + dark gray clay, hard stiffness, medium plasticity; 1" gravel lens present @ 22.5'	
		24.0-24.5': Light brown sandy clay, wet, very soft, no plasticity	
25		24.5-24.8': Red-brown sandy clay, wet, medium plasticity	
		24.8-28.0': Purple + gray clay, high stiffness, no plasticity, trace fine grained sand @ 25.0' & 26.7'	
		28.0-29.9': Dark purple clay, high stiffness, no plasticity	
30		29.9-30.7': Black/dark gray clay, high stiffness, no plasticity	
		30.7-32.0': Balck/dark gray silty clay, medium stiffness, medium plasticity	
		32.0-33.5': Dark gray silty clay, soft, high plasticity	
		33.5-36': Black silty clay, high stiffness, no plasticity	
35		36-36.5': No recovery	
		36.5-40': Dark green fine grained sand, well sorted	
40		Geoprobe refusal @ 40' bgs. HSA continued drilling, log continued on next page.	

Drill Rig: Geoprobe 7822 DT & HSA Rig

Drilling Contractor: Best Drilling & AEP Drillers

Driller: Ramon Gutierrez & Zack Racer

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey | Boring/Well Name: B-2

Project Location: Hallsville, TX | Boring Date: 5/13/2019 to 5/17/2019

Depth Scale Feet	Water Table	Soil Profile Description	PID
35		0.0' - 40.0' were drilled with DPT, logged on previous page. HSA boring log follows.	
		38.1-38.3': Dark brown silty sand, fine grained, trace clay, loose, wet, well graded	
		38.3-38.4': Very dark brown clayey sand; thin seam of red-brown lean clay @ 38.4', med soft	
		38.4-38.5': Dark green silty sand, fine grained, wet	
		38.5-39.0': Dark brown silty sand, fine grained, trace clay, loose, wet, well graded	
		39.0-39.2': Laminated sandy clay/clayey sands, gray to dark gray, loose/soft, wet	
40		39.2-43.1': No Recovery	
		43.1-44.5': Greenish gray w. graded fine sand w/ trace silt, loose, wet; thin layer of light gray silty sand @ 44.5'	
		44.5-47.0': Dark brown clayey sand/sandy clay, fine sand, w. graded, low plastiicty, dense/stiff, moist	
		47.0-48.1': No Recovery	
45			
		48.1-54.2': Same clayey sand/sandy clay as above; thin bed of gray fine grained sand, trace clay @ 51.6'	
50			
		54.2-55.0': Dark brown hard, sandy clay, low plas	
55		55.0-57.1': Dark brown clayey sand/sandy clay, fine sand, w. graded, low plastiicty, dense/stiff, moist	
		57.1-58.1': Dark brown clayey sand w/ thin intermittent balck hard material layers, possible coal/plant debris	
		58.1-61.9': Dark grayish brown clayey sand, fine grained, w. graded, moise, med-dense to loose	
60		61.9-63.1': Same clayey sand as above with thin bands of mottled dark brown silty clay with gray silty sand	
		63.1-64.6': Gray silty sands mottled 50/50 w/ dark brown sandy clays, trace coal fragments, stiff/dense	
65		64.6-68.1 Grades from above to thinly laminated interbeds of silty/clayey sands and sandy clay. Clays are dark brown, sand is gray. Low plasticity, moist, dense/stiff	
		68.1-70.7': Dark brown sandy clay w/ 1% mottles of gray silty sand, low plasticity, trace moist, silty, stiff	
70		70.7-71.3': Dark brown clayey sand, fine grained, trace coal fragments, moist, dense/med dense	
		71.3-71.5': Interval of coal/sand interbeds w/ clay, friable	
		71.5-73.5': Dark brown sandy clay, low plas, trace moist, stiff to hard	
		73.5-74.5': Sandy clay grading to clayey sand (fine grained, w. graded moist)	
		74.5-75.1': Gray silty sand, fine grained, moist, w. graded, med. Dense	
75			

Drill Rig: Geoprobe 7822 DT & HSA Rig

Drilling Contractor: Best Drilling & AEP Drillers

Driller: Ramon Gutierrez & Zack Racer

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey

Boring/Well Name: B-2

Project Location: Hallsville, TX

Boring Date: 5/13/2019 to 5/17/2019

Depth Scale Feet	Water Table	Soil Profile Description		PID
75				
		75.1-75.3':	SAA except trace clay	
		75.3-75.6':	Interval of gray sand interbedded w/ dark brown silty/sandy clay	
		75.6-79.2':	Dark brown clayey sand w/ some 1-2 mm lenses of gray sand mottled throughout, moist, fine grained, dense. Dark brown interbeds of silty clay @ 78.1-79.2'	
		79.2-80.4':	Dark brown sandy clay mottled w/ gray sand, stiff, low plasticity, trace moist, trace coal fragments	
80		80.4-82.1':	Dark grayish brown silty sand w/ trace clay, loose; coal fragment @ 81.6'	
		82.1-83.6':	Dark brown silty clay w/ some sand, low plasticity, hard, trace moist; thin lighter color laminations @ 83.1'	
		83.6-85.5':	Dark grayish brown sandy clay, fine sand, low plasticity, very stiff, trace mottles of sandier material, trace moist	
85		85.5-93.1':	Dark reddish brown silty clay w/ trace fine sand, trace moist, hard, low plasticity, trace mottles of light gray sand, some black mottling. Color fades to dark brown when exposed to air.	
90		90.1'	Thin gray sand seam	
		92.3'	Thin gray sand seam	
			HSA refusal, EOB @ 93.1' bgs	
95			Boring grouted to surface, permanent well installed in offset w/ screen @ 38-48' bgs.	
100				
105				
110				
115				

Drill Rig: Geoprobe 7822 DT & HSA Rig

Drilling Contractor: Best Drilling & AEP Drillers

Driller: Ramon Gutierrez & Zack Racer

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey

Boring/Well Name: B-3

Project Location: Hallsville, TX

Boring Date: 5/7/19, 5/13/19

Depth Scale Feet	Water Table	Soil Profile Description	PID
0		0.0' - 5.0' were hand augered	
		0.0-2.0': Clay, medium-red brown, some fine to medium grain material, poorly graded, silty clays, medium plasticity, medium dense, dry, mottled	
		2.0-3.0': Clay, light brown, some fine to medium grain material, poorly graded, silty clays, medium plasticity, medium dense, dry, mottled	
		3.0-4.0': Organic clay, Grey to light brown, soft, medium density, some medium grain sand, moist	
		4.0-4.5': Organic clay, light brown, soft, medium density, moist	
5		4.5-5.0': Organic clay, light brown to reddish brown, soft, medium density, moist	
		5.0-9.5': Organic clay, light brown to reddish brown, soft, medium density, moist	
		9.5-10.5': Silty clay, reddish-orange, poorly graded, medium to low plasticity, wet (perched zone)	
10		10.5-11.0': Poorly-graded gravel, lense of cobbly material, moist	
		11.0-13.0': Clayey sand, mottled clay and sand	
		13.0-13.9': Sandy clay, brown to orange, low plasticity, some cobbles, loose, wet, nonplastic	
		13.9-15.0': Sand, orange, loose, nonplastic, very fine grained, moist	
15		15.0-16.0': Sandy clay, medium plasticity, cohesive, medium stiff, moist	
		16.0-18.0': Sand, orange, gray organic staining, moist	
		18.0-18.5': A lense of fat clay, grayish purple, medium to high plasticity, moist	
		18.5-19.5': Sand, orange to grayish orange, moist	
		19.5-20.0': Fat clay, greyish purple, dense, medium stiff to stiff, medium to high plasticity, moist.	
20		20.0-22.1': Sand, light brown to orange, fine to medium grained, wet	
		22.1-22.3': Lense of fat clay, dark grey to purple, stiff, high plasticity, wet	
		22.3-22.6': Sand, light brown to orange, fine grained, moist	
		22.6-23.0': Gravelly sand, orange to gray mottles, loose, well graded	
		23.0-24.0': Sandy clay, grayish purple and brown mottles, moist	
25		24.0-25.6': Sand, tan to light brown, fine to medium grained, well sorted, moist	
		25.6-26.4': Clay, purple and gray, medium plasticity, trace fine grained sand	
		26.4-26.8': Clayey sand, tan to light brown, fine grained, medium sorted	
		26.8-27.3': Clay, purple, medium stiffness, medium plasticity	
		27.3-28.0': Clay, dark gray, hard, trace silt, high plasticity	
30		28.0-28.6': no recovery	
		28.6-29.2': Sand, light brown, fine grained, moderate sorting, wet, from casing trip	
		29.2-29.5': Silty clay, dark gray, fine grained, low plasticity	
		29.5-32.0': Clay, dark gray to black, hard, low plasticity, trace silt	
		32.0-32.7': Clay, dark gray, medium stiff, medium plasticity, trace silt	
35		32.7-33.1': Clayey silt, dark gray, medium plasticity	
		33.1-36.0': Sand, dark gray, fine grained, well sorted, moist	
		36.0-36.3': no recovery	
		36.3-36.9': Silty sand, dark gray to black, very fine grained, well sorted, moist	
		36.9-37.3': Sand, gray, fine grained, well sorted, moist	
40		37.3-38.4': Silty clay, dark gray, soft, low plasticity, 1" coal seam at 37.8 ft bgs	

Drill Rig: Geoprobe 7822 DT & HSA Rig

Drilling Contractor: Best Drilling & AEP Drillers

Driller: Ramon Gutierrez & Zack Racer

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey | Boring/Well Name: B-3

Project Location: Hallsville, TX | Boring Date: 5/7/19, 5/13/19

Depth Scale Feet	Water Table	Soil Profile Description	PID
40		38.4-40.0': Clay, dark gray to black, very stiff, low plasticity (DPT refusal @ 40' bgs, HSA drilling continued below)	
		40.0-42.5': Silty clay with trace sand, dark gray, very stiff to hard, mottled	
		42.5-46.4': Interbedded sandy clays and clayey sands, dark gray to black, moist, very dense, stiff, low plasticity, low cohesivity, coal and plant fragments at 45.1 to 45.25 feet bgs	
45		46.4-47.5': Sandy clay with silt, dark gray to black, hard, low plasticity, moist, fine grained sand	
		47.5-48.7': Sand with trace silt, brown, poorly graded, some brown clay laminations, coal seam from 48.4 to 48.7 feet bgs,	
		48.7-49.6': Sand, gray to brown, well graded, with dark clayey interbeds/laminations, trace silt, loose to medium dense, moist	
		49.6-52.8': Sand, brown to grayish brown, well graded, trace silt, loose to medium dense, moist to wet	
50		52.8-53.6': Interbedded sandy clays and clayey sands, gray to dark gray, moist, dense to very dense	
		53.6-53.7': Silty clay, dark brown, very stiff	
		53.7-55.0': Interbedded sandy clays and clayey sands, gray to dark gray, moist, dense to very dense	
55		55.0-58.8': Interbedded sandy clays and clayey sands, gray to dark gray, moist, dense to very dense	
		58.8-59.0': Sand with some clay and silt, very dark gray, fine grained, massive bedding, moist	
		59.0-60.0': no recovery	
60		60.0-60.7': Sand with some silt and trace clay, very dark gray, fine grained, massive bedding, moist	
		60.7-61.6': Sand with some silt and trace clay, gray, fine grained, massive bedding, moist, laminations of dark gray clayey sand	
		61.6-61.8': Silty clay, dark gray, hard, no plasticity	
		61.8-63.0': Silty clay, dark gray, fine grained, well graded, at 62.8 feet bgs a layer of dark gray silty clay	
		63.0-65.0': no recovery	
65		65.0-67.5': Silty sand, grayish brown, fine grained, well graded, wet, loose	
		67.5-72.5': No recovery, heavy sands. Water introduced to retrieve samples. During flushing, some grayish brown silty sand observed	
70		72.5-73.1': Silty sand, grayish brown, fine grained, well graded, wet, loose	
		73.1-73.6': Sand with trace silt, gray, fine grained, well graded, wet, loose	
		73.6-74.7': Thin layer of dark brown friable material, possibly plant material	
		74.7-74.8': Thin layer of stiff sand and silt, dark brown	
		74.8-76.0': Silty sand, grayish brown, fine grained, well graded, wet, loose	
75		76.0-76.1': Thin layer of clay, dark brown, stiff, trace coal fragments	
		76.1-76.4': Silty sand, grayish brown, fine grained, well graded, wet, loose	
		76.4-76.5': Silty clay, dark brown, stiff	
		76.5-77.5': Silty sand, grayish brown, fine grained, well graded, wet, loose	
80		77.5-82.9': Silty sand, dark gray to brown, fine grained, well graded, medium dense to dense, moist to wet, trace clay	

Drill Rig: Geoprobe 7822 DT & HSA Rig

Drilling Contractor: Best Drilling & AEP Drillers

Driller: Ramon Gutierrez & Zack Racer

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey | Boring/Well Name: B-3

Project Location: Hallsville, TX | Boring Date: 5/7/19, 5/13/19

Depth Scale Feet	Water Table	Soil Profile Description	PID
80			
		82.9-84.3': Silty sand, gray to dark gray, fine grained, well graded, medium dense to dense, moist to wet, trace clay	
		84.3-85.2': Clayey sand, dark grayish brown, fine grained, well graded, moist	
		85.2-85.3': Silty sand, gray	
85			
		85.3-85.5': Silty sand, gray to dark gray, fine grained, well graded, medium dense to dense, moist to wet, trace clay	
		85.5-86.3': Silty clay with sand, dark brown, low plasticity, hard, moist, laminated with gray sand layers ~1-2mm thick	
		86.3-87.5': Clayey sand, dark grayish brown, fine grained, well graded, moist	
		87.5-88.2': Clayey sand, dark grayish brown, fine grained, well graded, moist	
		88.2-89.1': Clayey sand, dark grayish brown, fine grained, well graded, moist. Clay laminations darker than surrounding sand	
90			
		89.1-89.4': Interval of interbedded sandy clays and clayey sands, breaks apart along bedding planes, medium dense, medium stiff	
		89.4-92.5': Silty clay, dark brown to black, hard, trace moisture, low plasticity	
		92.5-97.5': Silty clay, dark brown to black, hard, trace moisture, low plasticity. Thin gray sand layer at 94.7 feet bgs	
95			
		HSA refusal, EOB @ 97.1' bgs	
		Boring grouted to surface.	
		Permanent well installed in offset boring, screen set @ 29-34' bgs.	
100			
105			
110			
115			
120			

Drill Rig: Geoprobe 7822 DT & HSA Rig

Drilling Contractor: Best Drilling & AEP Drillers

Driller: Ramon Gutierrez & Zack Racer

Geosyntec Consultants

Attachment B
Groundwater Analytical Results

Attachment B: Groundwater Analytical Data
Pirkey Plant - East Bottom Ash Pond

Boring	Depth (ft bgs)	Metals (mg/l)															
		Antimony		Arsenic		Barium		Beryllium		Boron		Cadmium		Calcium		Chromium	
		Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered
B-1	16-21	<0.00093	<0.0035805	0.214	0.0041586	3.28	0.0267562	0.01693	<0.000077	0.293	0.038043	0.03747	<0.0002695	41.8	1.34	1.08	<0.0008855
B-3	20-24	<0.00093	<0.0465	0.141	0.0472	0.779	0.132	0.00571	<0.001	0.105	0.308	0.00032	<0.0035	4.19	1.42	0.46	<0.0115
	33-37	0.00113	0.005776	0.02767	<0.113925	0.299	0.114	0.00427	<0.00217	0.104	0.443	<0.00007	<0.007595	15.6	5.95	0.208	<0.024955
	40-45	<0.00093	<0.17856	0.141	0.0851	1.64	0.0314	0.04958	<0.00384	0.292	0.453	0.00266	<0.01344	7	<1.8432	0.253	<0.04416
	50-55	<0.0465	<0.086025	0.662	<0.097125	4.76	0.09501	0.098	<0.00185	0.675	0.203	<0.0035	<0.006475	16.4	0.749	1.9	<0.021275
	60-65	<0.00093	<0.0465	0.05695	0.0472	0.412	0.0849	0.00559	<0.001	0.06661	0.071	0.00265	<0.0035	1.37	<0.48	0.307	<0.0115
	72.5-77.5	<0.00093	0.0022	0.932	0.0116	7.97	0.0123	0.132	<0.0002	1.52	0.375	0.277	<0.0007	36.9	0.209	3.25	0.0005
	82.5-87.5	<0.00093	0.0014372	0.04923	0.0058415	0.583	0.0083163	0.00297	<0.000111	0.214	0.311	0.00368	<0.0003885	1.44	0.21	0.152	<0.0012765

Boring	Depth (ft bgs)	Metals (mg/l)															
		Cobalt		Iron		Lead		Lithium		Magnesium		Manganese		Molybdenum		Potassium	
		Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered
B-1	16-21	0.192	0.001279	988	0.669	0.392	<0.002618	0.202	0.0217358	40	0.59	1.14	0.0206	0.02491	<0.0011165	37.1	1.07
B-3	20-24	0.02653	0.01	430	3.91	0.07225	<0.034	0.05327	0.0127	8	1.15	0.189	<0.05	0.00807	0.0022	15.2	1.26
	33-37	0.02721	0.00368	95.2	<1.085	0.0148	<0.07378	0.152	0.105	5.19	3.12	1.02	0.599	0.07587	0.012642	9.29	5.39
	40-45	0.23	0.00467	361	2.03	0.149	<0.13056	0.356	0.07701	12.6	<1.92	0.819	<0.192	0.01355	<0.05568	19.1	2.46
	50-55	0.786	0.01441	1440	3.88	0.703	<0.0629	1.14	0.060508	41	<0.925	3.46	0.0968	0.106	<0.026825	53.3	2.86
	60-65	0.07494	0.004	122	2.07	0.04529	<0.034	0.09786	0.0518	2.75	0.6	0.29	0.07	0.01507	0.0019	7.59	2.76
	72.5-77.5	1.37	0.0015	3250	0.587	0.636	<0.0068	0.812	0.0089	67.3	0.139	7.78	0.01	0.057	0.0013	57.9	1.26
	82.5-87.5	0.05576	0.000855	281	0.0745	0.05542	<0.003774	0.102	0.0228905	2.75	0.124	0.282	0.00751	0.01954	0.0172347	11.1	1.59

Boring	Depth (ft bgs)	Metals (mg/L)								General Chemistry (mg/L)		Anions (mg/L)			
		Selenium		Sodium		Strontium		Thallium		Total Alkalinity	Total Dissolved Solids	Chloride	Fluoride	Sulfate	Bromide
		Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Total	Total	Total	Total	Total
B-1	16-21	0.0124	<0.0038115	10.7	8.31	2.3	0.00834	0.00339	0.002654	5.72	220	4.31	<0.04	13.8	<0.1
B-3	20-24	0.00647	<0.0495	25.6	22.6	0.078	<0.05	0.00309	0.026	0.76	156	33.7	0.04	14.6	0.2
	33-37	0.00142	<0.107415	22	17.1	0.079	<0.1085	0.00151	0.00642	49.54	132	10.9	0.1	19.4	<0.1
	40-45	0.01837	<0.19008	18.1	12.6	0.229	<0.192	0.00229	<0.16512	1.54	1394	8.91	<0.04	21.1	<0.1
	50-55	0.0269	<0.091575	17.9	12.8	0.686	<0.0925	0.067	<0.07955	12.68	734	13.4	<0.04	17.3	<0.1
	60-65	0.00539	<0.0495	8.13	7.64	0.053	<0.05	<0.00086	<0.043	3.14	148	12	<0.04	7.9	<0.1
	72.5-77.5	0.04618	<0.0099	156	65.5	0.575	0	0.00092	<0.0086	140.74	632	44.5	0.04	24.5	<0.1
	82.5-87.5	0.00987	<0.0054945	148	103	0.101	0.00278	0.00224	<0.004773	210.08	1026	35.8	0.35	13	<0.1

Notes:

< - Analyte not detected above analytical detection limit

NM - Not measured

Total lithium results from unfiltered sample volume collected in HNO3 preserved bottle.

Lab filtered results from laboratory vaccum-filtered sample volume collected in unpreserved bottle.

Total metals data are not available for B-2 sample intervals due to incorrect analytical techniques.

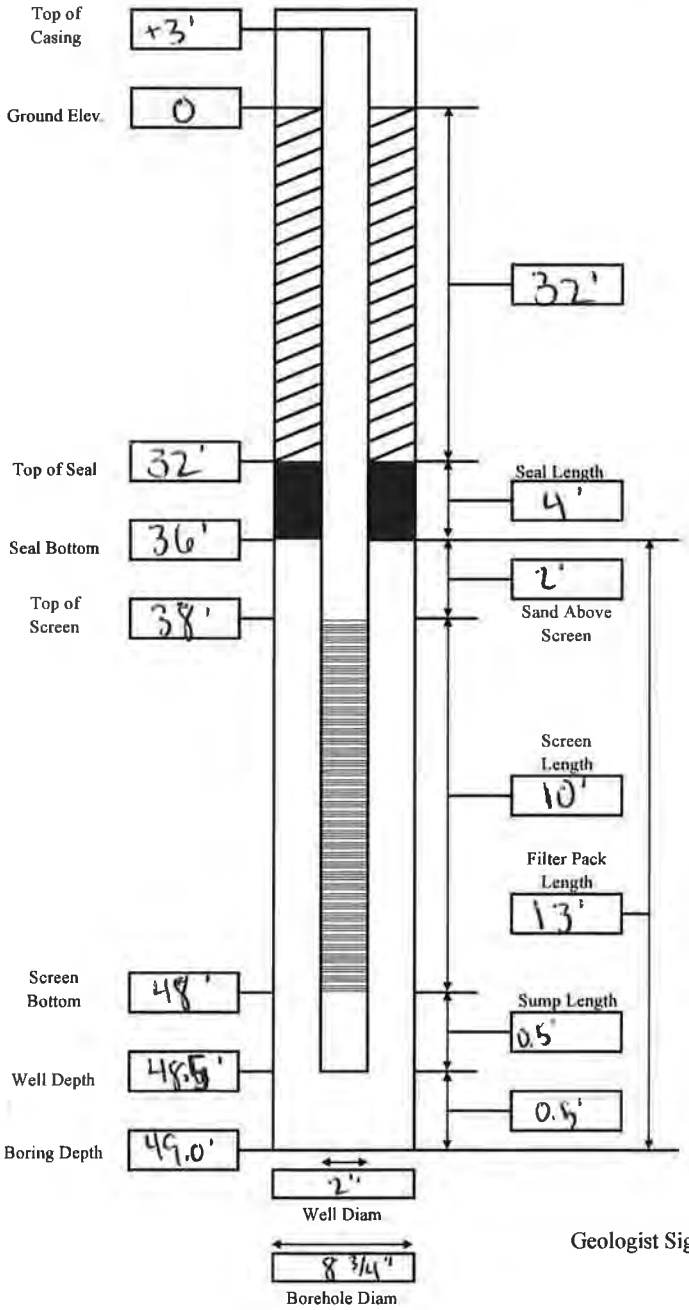
Attachment C
Well Construction Diagrams

Geosyntec
consultants

Well Construction Log

Site: AEP Pirney Power Plant
Well ID: B-2
Drilling Company: AEP Service
Drillers: Zach Racer
Geologist: Nathan Quick

Date: 5/20/19
Drilling Method: Hollow Stem Auger
Boring Depth: 49'
Boring Diameter: 8 3/4"
Well Depth: 48.5'
Well Diameter: 2"



Well Construction:
- Material: Sch. 40 PVC
- Inside Diamter: 2"
- Screen Slot Size: 0.01'
- Screen Beg.: 38 End: 48
- Sump (Y) / N
- Type/Lenth: sch. 40 PVC, 10"

Filter Pack:
- Type/Brand: Pioneer Sands 20/40
- Amount Used: 8.5 bags (50 lbs per bag)
- Placement Method: surface

Seal:
- Type/Brand: Plug Pel coated bentonite chips
- Amount Used: 100 lbs
- Vol. Fluid Added:
- Set-up Time: 1.5 hours
- Placement Method: surface

Grout:
- Type/Brand:
- Amount Used:
- Vol. Fluid Added:
- Placement Method: tremie

Well Completion:
- (Above Grade) / Below Grade
- Guard Posts? (Y) / N
- Pad Size: 2x2
- Cover Type/Size: stainless steel

Comments:

Geologist Signature: Nathan Quick

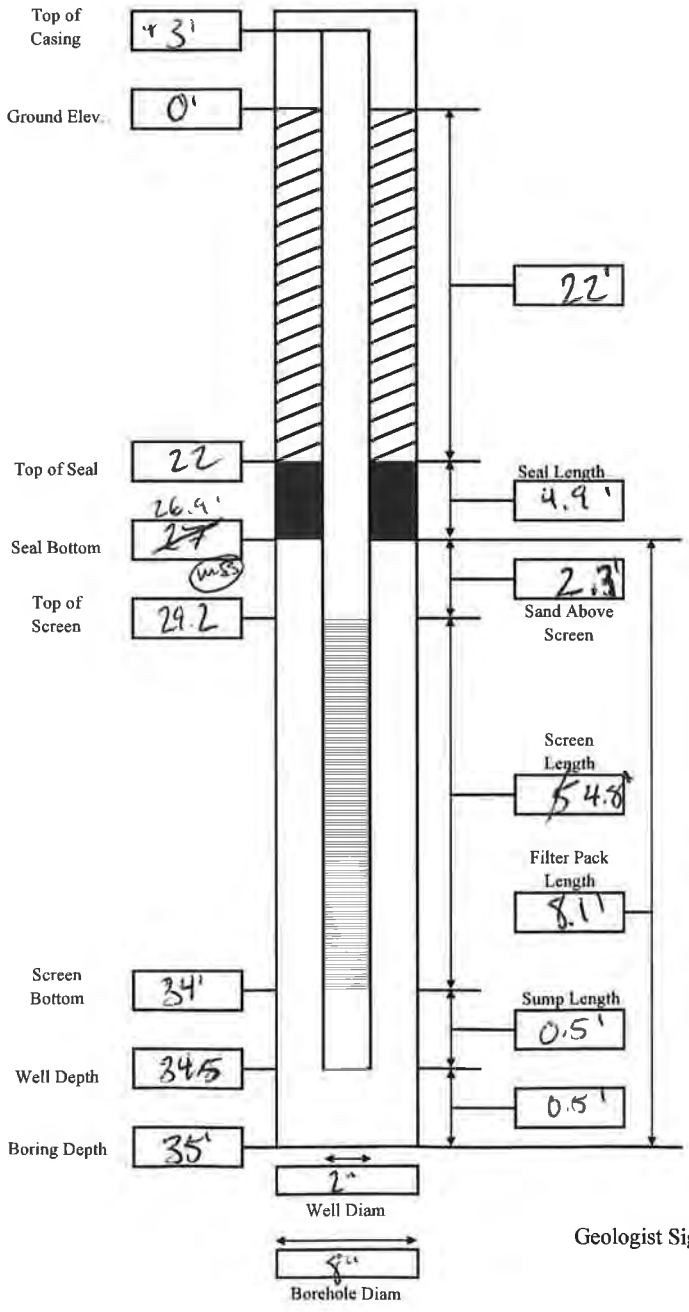
Nathan Quick

Geosyntec
consultants

Well Construction Log

Site: AEP Pickaway Power Plant
Well ID: B-3
Drilling Company: AEP / Best Drilling
Drillers: Z. Rowe
Geologist: M. Bizjack

Date: 5/15/19
Drilling Method: HSA
Boring Depth: 35'
Boring Diameter: 8"
Well Depth: 35'
Well Diameter: 2"



Well Construction:
- Material: Sched 40 PVC
- Inside Diamter: Sched 40
- Screen Slot Size: 10 slot
- Screen Beg.: ~~34~~ 29' End: 34'
- Sump (Y) N
- Type/Lenth: End cap, 0.5'

Filter Pack:
- Type/Brand: Pioneer 20/40 0.45-0.48
- Amount Used: ~~6~~ 5.5 bags (275 lbs)
- Placement Method: Manual

Seal:
- Type/Brand: 3/8" Pel-plug coated Bentonite Pellets
- Amount Used: 2 buckets (100 lbs)
- Vol. Fluid Added:
- Set-up Time: >8hr
- Placement Method: Manual

Grout:
- Type/Brand: Halliburton Quick Grout
- Amount Used:
- Vol. Fluid Added:
- Placement Method: Pump

Well Completion:
- (Above Grade) / Below Grade
- Guard Posts? Y / N
- Pad Size: 2x2
- Cover Type/Size:

Comments:

Geologist Signature: Matt Bizjack

Attachment D
Well Development Logs

well development

LOW FLOW GROUNDWATER SAMPLING LOG

Geosyntec consultants

MONITORING WELL ID: B-2

PROJECT: AEP Pirkey

PROJECT NO: CHA8462.12

SITE LOCATION: Hallsville, TX

DATE MONITORED: 5/22/19 **WATER QUALITY METER MAKE/MODEL:** Horiba

DATE PURGED: 5/22/19 **LATEST CALIBRATION DATE/TIME:** 5/22/19

SAMPLING PERSONNEL: N. Quick **DUP OR MS/MSD:**

MONITORING WELL INFORMATION

Well Diameter:	2	IN.	
Static Depth to Groundwater (DTW):	12.31	FT.	**Coversion Factors:**
Total Depth of Monitoring Well (TD):	51.50	FT. btoc	Well Volume (2-in): Hx0.17 gal/ft
Screen Length (SL) from Boring Logs:	10	FT.	1 L = 0.264 gal
Depth to Top of Well Screen (TD-SL):	NA	FT.	
Height of Water Column in Monitoring Well (H=TD-DTW):		FT.	**Purge Method:**
Pump Depth		FT.	Tornado pump

LOW FLOW MONITORING PARAMETERS

Time	Volume Purged	pH	Specific Conductivity	Dissolved Oxygen	Temp.	ORP	Depth to Water	Flow Rate	Turbidity, Odor, Color
Hr : Min	mL	-	mS/cm	mg/L	C	mV	Feet	L/min	--
Targets	--	+/- 0.1	+/- 3%	+/- 10%	+/- 1 C	+/- 10 mV	<0.3 ft. drawdown	<0.5 L/min	NTU --
1157		5.89	0.219	9.87	24.01	42	21.31	.5	1000+ light brown, silty
1202		5.93	0.241	9.47	22.11	25	22.21	.5	950 light brown
1207		5.94	0.217	9.36	22.09	23	22.31	.5	890 "
1212		5.87	0.214	9.64	21.89	30	22.83	.5	669 "
1217		5.82	0.201	9.50	22.18	42	22.31	.5	390 "
1222		5.82	0.201	9.50	22.25	38	20.58	.5	260 cloudy
1227		5.82	0.198	9.102	22.12	41	19.41	.5	152 cloudy
1232		5.76	0.194	9.44	22.11	40	18.83	.5	84.9
1237		5.76	0.194	8.92	22.08	46	18.15	.5	75.2
1242		5.72	0.194	9.54	22.15	45	17.97	.5	72.4
1247		5.73	0.194	9.34	22.21	42	17.45	.5	66.9
1252		5.75	0.195	9.50	22.34	44	22.15	.5	146 light brown
1302		5.74	0.200	9.76	22.31	49	22.41	.5	352 "
1312		5.75	0.194	9.41	22.30	51	22.71	.5	105 cloudy
1322		5.75	0.189	9.43	22.41	53	23.00	.5	57.4 clear
1332		5.75	0.189	9.53	22.48	56	23.15	.5	50.7 "

Notes: 1) well was surged using pump to make sure all fines were removed — end of development

1. Water quality parameter measurements obtained every 3 to 5 minutes.
2. Well is **STABLE** once 3 consecutive measurements have been obtained for as many as 3 water quality parameters
3. Low flow rate target is 0.1 to 0.5 liters/min (0.026 to 0.132 Gallons per Minute).

Purge Flow Rate (pump purge only) _____ gal per min _____ liter per min (3.8 x gpm)

TOTAL Volume Purged _____ gallons _____ liters

Date & Time of Sample Collection _____ - **DATE** _____ - **TIME** NA **INITIALS** *revised: Feb. 2007*

Well Development

~~LOW FLOW~~ GROUNDWATER SAMPLING LOG

Geosyntec consultants

MONITORING WELL ID: B-3
PROJECT: AEP Pirkey
PROJECT NO: CHA8462.12
SITE LOCATION: Hallsville, TX
DATE MONITORED: 5/17/16 **WATER QUALITY METER MAKE/MODEL:** Horiba
DATE PURGED: 5/17/16 **LATEST CALIBRATION DATE/TIME:** 5/17/16
SAMPLING PERSONNEL: N. Quick **DUP OR MS/MSD:** —

MONITORING WELL INFORMATION

Well Diameter:	2 IN.	
Static Depth to Groundwater (DTW):	9.07' FT.	**Coversion Factors:**
Total Depth of Monitoring Well (TD):	36.95 FT.	Well Volume (2-in): Hx0.17 gal/ft
Screen Length (SL) from Boring Logs:	FT.	1 L = 0.264 gal
Depth to Top of Well Screen (TD-SL):	FT.	
Height of Water Column in Monitoring Well (H=TD-DTW):	FT.	**Purge Method:**
Pump Depth	FT.	tornado pump

LOW FLOW MONITORING PARAMETERS

Time	Volume Purged	pH	Specific Conductivity	Dissolved Oxygen	Temp	ORP	Depth to Water	Flow Rate	Turbidity, Odor, Color
Hr : Min	mL	-	mS/cm	mg/L	C	mV	Feet	L/min	--
Targets	--	+/- 0.1	+/- 3%	+/- 10%	+/- 1 C	+/- 10 mV	<0.3 ft. drawdown	~~<0.5 L/min~~ NTU	--
0944		6.07	.1005	3.30	20.34	89			brown, silty
0947		6.14	0.516	0.51	20.72	28			brown
0951		5.84	.438	3.42	21.37	64			brown
		well is purging to let well recha	dry, pump is kicking off & rge & continue to d				on due to	low wate	r level;
1034		6.18	.450	4.01	22.09	88	19.34		
		pump	remove to	check connections;					
1100		6.17	0.263	3.78	22.15	78	15.25		
					went dry				
1216		5.81	0.282	2.64	22.74	85	15.32		lightbrown
1220		5.64	0.195	2.07	22.04	102			cloudy
1225		5.65	0.194	1.87	22.24	98	23.05	888	cloudy
1235		5.71	0.191	1.59	22.58	85		683	cloudy
1240		5.71	0.190	1.48	23.05	87	25.75	605	cloudy
1250		5.69	0.188	1.43	23.36	83		462	
1257		5.69	0.184	1.19	23.14	81	28.14	370	

Notes:

1. Water quality parameter measurements obtained every 3 to 5 minutes
2. Well is **STABLE** once 3 consecutive measurements have been obtained for as many as 3 water quality parameters
3. Low flow rate target is 0.1 to 0.5 liters/min (0.026 to 0.132 Gallons per Minute)

Purge Flow Rate (pump purge only) _____ gal per min _____ liter per min (3.8 x gpm)
TOTAL Volume Purged _____ gallons _____ liters

Date & Time of Sample Collection — **DATE** — **TIME** NQ **INITIALS** *revised: Feb. 2007*

Nathan

Development

~~LOW FLOW~~ GROUNDWATER SAMPLING LOG

Geosyntec consultants

MONITORING WELL ID: B-3
PROJECT: AEP Pirkey
PROJECT NO: CHA8462.12
SITE LOCATION: Hallsville, TX
DATE MONITORED: 5/17/19 **WATER QUALITY METER MAKE/MODEL:** Horiba
DATE PURGED: 5/17/19 **LATEST CALIBRATION DATE/TIME:** 5/17/19
SAMPLING PERSONNEL: N. Quick **DUP OR MS/MSD:** —

MONITORING WELL INFORMATION

Well Diameter:	2	IN.
Static Depth to Groundwater (DTW):	6.02	FT.
Total Depth of Monitoring Well (TD):	30.65	FT.
Screen Length (SL) from Boring Logs:		FT.
Depth to Top of Well Screen (TD-SL):		FT.
Height of Water Column in Monitoring Well (H=TD-DTW):		FT.
Pump Depth		FT.

Coversion Factors:
Well Volume (2-in): Hx0.17 gal/ft
1 L = 0 264 gal

Purge Method: tornado pump

LOW FLOW MONITORING PARAMETERS

Time	Volume Purged	pH	Specific Conductivity	Dissolved Oxygen	Temp.	ORP	Depth to Water	Flow Rate	Turbidity, Odor, Color
Hr : Min	mL	-	mS/cm	mg/L	C	mV	Feet	L/min	--
Targets	--	+/- 0.1	+/- 3%	+/- 10%	+/- 1 C	+/- 10 mV	<0.3 ft. drawdown	<0.5 L/min	NTU --
1305		5.68	0.182	1.08	23.31	87	28.09		312
1310		5.67	0.181	1.03	23.25	83			275
1315		5.67	0.179	1.01	23.70	81	25.81		238
1325		5.66	0.178	1.00	23.62	82			192
1330		5.65	0.176	0.89	23.80	81	25.34		165 clear/slightly cloudy
			end of development						

Notes:
1. Water quality parameter measurements obtained every 3 to 5 minutes
2. Well is **STABLE** once 3 consecutive measurements have been obtained for as many as 3 water quality parameters
3. Low flow rate target is 0.1 to 0.5 liters/min (0.026 to 0.132 Gallons per Minute)

Purge Flow Rate (pump purge only) _____ gal per min _____ liter per min (3.8 x gpm)
TOTAL Volume Purged _____ gallons _____ liters

Date & Time of Sample Collection — **DATE** — **TIME** NQ **INITIALS** *revised: Feb. 2007*

Nat Quick

Attachment E
Low-Flow Groundwater Sampling Logs

Geosyntec consultants

GROUNDWATER SAMPLING LOG

SITE NAME: **AEP Pirkey Power Plant**	SITE LOCATION: **Hallsville, TX**

WELL NO: B-2		SAMPLE ID: B-2-well-20190522-1 + -2		DATE: 5/22/19
WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 3/8	WELL SCREEN INTERVAL: 38 feet to 48 feet bgs	STATIC DEPTH TO WATER (feet): 12.61	PURGE PUMP TYPE OR BAILER: hurricane

WELL VOLUME PURGE: (TOTAL WELL DEPTH − STATIC DEPTH TO WATER) X WELL CAPACITY = WELL VOLUME

(51.50 ft − 12.61 ft) X 0.16 gal/ft = 6.22 gallons

EQUIPMENT VOLUME PURGE: PUMP VOL. + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOL = EQUIPMENT VOLUME

Gal + (0.0006 gal/ft X ft) + gal = gal

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 45	FINAL PUMP OR TUBING DEPTH IN WELL (feet): 45	PURGING INITIATED AT: 1630	PURGING ENDED AT: 1825	TOTAL VOLUME PURGED (gallons):

TIME	CUMUL.VOL. PURGED (gallons)	PURGE RATE (gpm or mL/min)	DEPTH TO WATER (feet)	pH (S.U.)	TEMP. (°C)	COND. (mS/cm)	DO (mg/L)	TURBIDITY (NTUs)	ORP (mV)
1637		250	14.24	5.74	22.99	0.195	2.50	1000+	79
1642		250	15.08	5.72	21.89	0.184	3.95	1000+	54
1647		250	16.62	5.71	21.52	0.196	5.47	705	53
1652		250	17.38	5.72	21.29	0.201	9.21	454	56
1657		250	18.24	5.70	21.23	0.197	8.33	271	61
1702		250	18.51	5.68	21.22	0.197	2.25	178	52
1707		250	18.66	5.65	21.12	0.196	2.42	136	68
1712		250	19.21	5.64	20.83	0.195	1.89	92.2	65
1717		250	19.29	5.61	21.16	0.192	1.95	89.2	69
1722		250	19.40	5.60	20.91	0.195	2.42	90.6	65
1727		250	19.55	5.59	20.54	0.193	2.97	102	71
1732		250	19.61	5.58	20.89	0.195	3.09	102.5	74

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88

TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016

SAMPLED BY (PRINT) / AFFILIATION: Nathan Quick / Geosyntec	SAMPLER(S) SIGNATURES: Nat Qu	SAMPLING INITIATED AT: 1825	SAMPLING ENDED AT:
PUMP OR TUBING DEPTH IN WELL (feet): 45	SAMPLE PUMP FLOW RATE (mL per minute): 250	TUBING MATERIAL CODE:	

FIELD DECON: Y N	FLD-FILTERED: Y (N) FILTER SIZE: 45 µm Filtration Equipment:	EQUIPMENT. BLANK: Y (N) Sample ID:	DUPLICATE: Y (N)

SAMPLE ID CODE	# Bottles	MATERIAL CODE	VOLUME	PRESERV. USED	ANALYSIS/ METHOD	SAMPLING EQUIPMENT CODE

REMARKS:

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING/PURGING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP** = Peristaltic Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **VT** = Vacuum Trap; **O** = Other (Specify)

STABILIZATION CRITERIA	pH = **± 0.2**	ORP = **± 20 mV**	Specific Conductance = 3 **readings within ± 3%**
Dissolved Oxygen =	A) **≤ 10% saturation** (≤ 1.82 mg/l @ 20 °C, ≤ 1.65 mg/l @ 25 °C, ≤ 1.51 mg/l @ 30 °C)		
	B) **readings within ± 0.2 mg/L (for readings ≤ 2 mg/L), whichever greater**		
Turbidity =	**A)** ≤ 10 NTUs; OR		
	B) 3 readings within ± 10%		

Nat Qu

Geosyntec consultants

GROUNDWATER SAMPLING LOG

SITE NAME: **AEP Pirkey Power Plant**	SITE LOCATION: **Hallsville, TX**

WELL NO: B-2		SAMPLE ID: B-2-well-20190522-1/-2		DATE: 5/22/19
WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 3/8	WELL SCREEN INTERVAL: 38 feet to 48 feet bgs	STATIC DEPTH TO WATER (feet): 12.61	PURGE PUMP TYPE OR BAILER: hurricane

WELL VOLUME PURGE: (TOTAL WELL DEPTH − STATIC DEPTH TO WATER) X WELL CAPACITY = WELL VOLUME

(51.50 ft − 12.61 ft) X 0.16 gal/ft = 6.22 gallons

EQUIPMENT VOLUME PURGE: PUMP VOL. + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOL = EQUIPMENT VOLUME

Gal + (gal/ft X ft) + gal = gal

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 45	FINAL PUMP OR TUBING DEPTH IN WELL (feet): 45	PURGING INITIATED AT: 1630	PURGING ENDED AT: 1825	TOTAL VOLUME PURGED (gallons):

TIME	CUMUL.VOL. PURGED (gallons)	PURGE RATE (gpm or mL/min)	DEPTH TO WATER (feet)	pH (S.U.)	TEMP. (°C)	COND. (mS/cm)	DO (mg/L)	TURBIDITY (NTUs)	ORP (mV)
1737		250	19.64	5.56	20.80	0.197	3.42	61.2	75
1742		250	19.67	5.55	20.85	0.199	1.71	52.9	74
1747		250	19.70	5.53	20.86	0.200	1.87	44.3	72
1752		250	19.68	5.53	20.81	0.200	1.93	42.4	76
1757		250	19.64	5.52	20.75	0.202	2.01	30.7	70
1802		250	19.62	5.50	20.82	0.200	1.97	25.7	73
1807		250	19.62	5.49	20.73	0.198	1.93	25.0	75
1812		250	19.63	5.49	20.75	0.199	1.93	40.2	74
1817		250	19.60	5.48	20.82	0.193	1.67	27.7	80
1822		250	19.61	5.48	20.77	0.192	1.65	19.5	79
		sampled via disconnected tubing ; 2 hour mark left							

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88

TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016

SAMPLED BY (PRINT) / AFFILIATION: Nathan Quick / Geosyntec	SAMPLER(S) SIGNATURES: Nat Quick	SAMPLING INITIATED AT: 1825	SAMPLING ENDED AT:
PUMP OR TUBING DEPTH IN WELL (feet):	SAMPLE PUMP FLOW RATE (mL per minute): 250	TUBING MATERIAL CODE:	

FIELD DECON: Y N	FLD-FILTERED: (Y) N FILTER SIZE: 45 µm Filtration Equipment:	EQUIPMENT. BLANK: Y (N) Sample ID:	DUPLICATE: Y (N)

SAMPLE ID CODE	# Bottles	MATERIAL CODE	VOLUME	PRESERV. USED	ANALYSIS/ METHOD	SAMPLING EQUIPMENT CODE

REMARKS:

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING/PURGING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP** = Peristaltic Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **VT** = Vacuum Trap; **O** = Other (Specify)

STABILIZATION CRITERIA	pH = ± 0.2	ORP = ± 20 mV	Specific Conductance = 3 **readings within** ± 3%
Dissolved Oxygen =	A) ≤ **10% saturation** (≤ 1.82 mg/l @ 20 °C , ≤ 1.65 mg/l @ 25 °C , ≤ 1.51 mg/l @ 30 °C)		
	B) **readings within** ± **0.2 mg/L (for readings ≤ 2 mg/L), whichever greater**		
Turbidity =	**A)** ≤ 10 NTUs; OR		
	B) 3 readings within ± 10%		

Geosyntec consultants

GROUNDWATER SAMPLING LOG

SITE NAME: **AEP Pirkey Power Plant**	SITE LOCATION: **Hallsville, TX**

WELL NO: B-3		SAMPLE ID: B-3-well-20190521		DATE: 5/21/19
WELL DIAMETER (inches): 2"	TUBING DIAMETER (inches): 3/8	WELL SCREEN INTERVAL : feet to feet	STATIC DEPTH TO WATER (feet): 10.15	PURGE PUMP TYPE OR BAILER: hurricane

WELL VOLUME PURGE: (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY = WELL VOLUME

(ft – 10.15 ft) X 0.16 gal/ft = gallons

EQUIPMENT VOLUME PURGE: PUMP VOL. + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOL = EQUIPMENT VOLUME

Gal + N/A 0.0004 gal/ft X ft) + gal = gal

INITIAL PUMP OR TUBING DEPTH IN WELL (feet):	FINAL PUMP OR TUBING DEPTH IN WELL (feet):	PURGING INITIATED AT:	PURGING ENDED AT:	TOTAL VOLUME PURGED (gallons):
38.5	38.5	1106	1245	

TIME	CUMUL.VOL. PURGED (gallons)	PURGE RATE (gpm or mL/min)	DEPTH TO WATER (feet)	pH (S.U.)	TEMP. (°C)	COND. (mS/cm)	DO (mg/L)	TURBIDITY (NTUs)	ORP (mV)
1110		200	10.87	6.57	26.79	0.241	9.14	47.7	125
1115		200	11.91	6.16	24.77	0.257	9.78	525	98
1120		200	14.72	6.01	23.45	0.218	3.01	504	105
1125		200	18.01	5.98	22.95	0.207	5.89	550	87
1130		200	22.18	5.82	23.18	0.250	8.87	602	85
1135		200	24.91	5.81	23.29	0.225	8.82	625	88
1145		200	25.52	5.76	23.56	0.217	8.79	572	89
1155		200	26.12	5.78	23.51	0.189	8.90	501	89
1205		200	26.23	5.68	23.39	0.180	4.71	128	88
1210		200	26.31	5.66	23.28	0.181	5.02	58	88
1215		200	26.51	5.65	23.40	0.174	4.64	64	90
1225		200	26.63	5.65	23.53	0.166	4.52	66.2	81

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88

TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016

SAMPLED BY (PRINT) / AFFILIATION: Nathan Quirk / Geosyntec	SAMPLER(S) SIGNATURES:	SAMPLING INITIATED AT: 1245	SAMPLING ENDED AT: 1305
PUMP OR TUBING DEPTH IN WELL (feet):	SAMPLE PUMP FLOW RATE (mL per minute): 200	TUBING MATERIAL CODE:	

FIELD DECON: Y N	FLD-FILTERED: Y (N) FILTER SIZE: 45 µm Filtration Equipment:	EQUIPMENT. BLANK: Y (N) Sample ID:	DUPLICATE: Y (N)

SAMPLE ID CODE	# Bottles	MATERIAL CODE	VOLUME	PRESERV. USED	ANALYSIS/ METHOD	SAMPLING EQUIPMENT CODE

REMARKS:

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING/PURGING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP** = Peristaltic Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **VT** = Vacuum Trap; **O** = Other (Specify)

STABILIZATION CRITERIA	pH = ± 0.2	ORP = ± 20 mV	Specific Conductance = 3 **readings within ± 3%**
Dissolved Oxygen =	A) **≤ 10% saturation** (≤ 1.82 mg/l @ 20 °C , ≤ 1.65 mg/l @ 25 °C , ≤ 1.51 mg/l @ 30 °C)		
	B) **readings within ± 0.2 mg/L (for readings ≤ 2 mg/L), whichever greater**		
Turbidity =	**A)** ≤ 10 NTUs; OR		
	B) 3 readings within ± 10%		

Nate Quirk

LOW FLOW GROUNDWATER SAMPLING LOG

Geosyntec consultants

MONITORING WELL ID: B-3
PROJECT: AEP Pirkey
PROJECT NO: CHA8462.12
SITE LOCATION: Hallsville, TX
DATE MONITORED: 5/21/19 **WATER QUALITY METER MAKE/MODEL:** Horiba
DATE PURGED: 5/21/19 **LATEST CALIBRATION DATE/TIME:** 5/21/19
SAMPLING PERSONNEL: N. Quick **DUP OR MS/MSD:** -

MONITORING WELL INFORMATION

Well Diameter:	2	IN.
Static Depth to Groundwater (DTW):	10.15	FT.
Total Depth of Monitoring Well (TD):	39.	FT.
Screen Length (SL) from Boring Logs:	10	FT.
Depth to Top of Well Screen (TD-SL):		FT.
Height of Water Column in Monitoring Well (H=TD-DTW):		FT.
Pump Depth		FT.

Coversion Factors:
Well Volume (2-in): Hx0.17 gal/ft
1 L = 0.264 gal

Purge Method:
Low flow

LOW FLOW MONITORING PARAMETERS

Time	Volume Purged	pH	Specific Conductivity	Dissolved Oxygen	Temp.	ORP	Depth to Water	Flow Rate	Turbidity, Odor, Color
Hr : Min	mL	-	mS/cm	mg/L	C	mV	Feet	L/min	--
Targets	--	+/- 0.1	+/- 3%	+/- 10%	+/- 1 C	+/- 10 mV	<0.3 ft. drawdown	<0.5 L/min	nTU --
1230		5.63	0.169	4.01	23.88	103		.20	74.2
	Sampled via dedicated tubing								

Notes:
1. Water quality parameter measurements obtained every 3 to 5 minutes.
2. Well is **STABLE** once 3 consecutive measurements have been obtained for as many as 3 water quality parameters
3. Low flow rate target is 0.1 to 0.5 liters/min (0.026 to 0.132 Gallons per Minute)

Purge Flow Rate (pump purge only) _____ gal per min _____ liter per min (3.8 x gpm)
TOTAL Volume Purged _____ gallons _____ liters

Date & Time of Sample Collection 5/21/19 **DATE** 1245 **TIME** NQ **INITIALS** *revised: Feb. 2007*

Nat Ok

Geosyntec consultants

GROUNDWATER SAMPLING LOG

SITE NAME: **AEP Pirkey Power Plant**	SITE LOCATION: **Hallsville, TX**

WELL NO: AD-31		SAMPLE ID: AD-31-20190515		DATE: 5/15/19
WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 3/8	WELL SCREEN INTERVAL: 30.5 feet to 40.5 feet	STATIC DEPTH TO WATER (feet): 10.90	PURGE PUMP TYPE OR BAILER: Hurricane SS

WELL VOLUME PURGE: (TOTAL WELL DEPTH − STATIC DEPTH TO WATER) X WELL CAPACITY = WELL VOLUME

(40.5 ft − 10.92 ft) X 0.16 gal/ft = 4.73 gallons

EQUIPMENT VOLUME PURGE: PUMP VOL. + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOL = EQUIPMENT VOLUME

Gal + (gal/ft X ft) + gal = gal

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 35.0	FINAL PUMP OR TUBING DEPTH IN WELL (feet): 35.0	PURGING INITIATED AT: 1220	PURGING ENDED AT: 1250	TOTAL VOLUME PURGED (gallons):

TIME	CUMUL.VOL. PURGED (gallons)	PURGE RATE (gpm or mL/min)	DEPTH TO WATER (feet)	pH (S.U.)	TEMP. (°C)	COND. (mS/cm)	DO (mg/L)	TURBIDITY (NTUs)	ORP (mV)
1223	NM	400	11.32	3.19	26.94	0.302	3.81	736	435
1229	NM	400	11.43	3.18	25.04	0.311	0.48	610	439
1236	NM	400	12.54	3.11	24.13	0.319	0.38	87.9	450
06 ~~1241~~ 1243	NM	400	11.49	3.03	23.83	0.317	0.33	13.1	452
1248	NM	350	11.39	3.06	24.34	0.319	0.32	8.38	449

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88

TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016

SAMPLED BY (PRINT) / AFFILIATION: Olivia Bramlet / Geosyntec	SAMPLER(S) SIGNATURES:	SAMPLING INITIATED AT: 1259	SAMPLING ENDED AT: 1337
PUMP OR TUBING DEPTH IN WELL (feet): 35.0	SAMPLE PUMP FLOW RATE (mL per minute):	TUBING MATERIAL CODE:	

FIELD DECON: Y N	FLD-FILTERED: Y N FILTER SIZE: ____ µm Filtration Equipment: _____	EQUIPMENT. BLANK: Y (N) Sample ID:	DUPLICATE: Y (N)

SAMPLE ID CODE	# Bottles	MATERIAL CODE	VOLUME	PRESERV. USED	ANALYSIS/ METHOD	SAMPLING EQUIPMENT CODE

REMARKS:

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING/PURGING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP** = Peristaltic Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **VT** = Vacuum Trap; **O** = Other (Specify)

STABILIZATION CRITERIA	pH = **± 0.2**	ORP = **± 20 mV**	Specific Conductance = 3 **readings within ± 3%**
Dissolved Oxygen =	A) **≤ 10% saturation** (≤ 1.82 mg/l @ 20 °C , ≤ 1.65 mg/l @ 25 °C , ≤ 1.51 mg/l @ 30 °C)		
	B) **readings within ± 0.2 mg/L (for readings ≤ 2 mg/L), whichever greater**		
Turbidity =	**A)** ≤ 10 NTUs; OR		
	B) 3 readings within ± 10%		

Geosyntec consultants

GROUNDWATER SAMPLING LOG

SITE NAME: **AEP Pirkey Power Plant**	SITE LOCATION: **Hallsville, TX**

WELL NO: AD32		SAMPLE ID: AD-32-20190515		DATE: 5/15/2019
WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 3/8	WELL SCREEN INTERVAL: 13.0 feet to 33.0 feet	STATIC DEPTH TO WATER (feet): 4.61	PURGE PUMP TYPE OR BAILER: Hurricane SS

WELL VOLUME PURGE: (TOTAL WELL DEPTH − STATIC DEPTH TO WATER) X WELL CAPACITY = WELL VOLUME

(33.0 ft − 4.61 ft) X 0.16 gal/ft = 4.54 gallons

EQUIPMENT VOLUME PURGE: PUMP VOL. + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOL = EQUIPMENT VOLUME

Gal + (gal/ft X ft) + gal = gal

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 23.0	FINAL PUMP OR TUBING DEPTH IN WELL (feet):	PURGING ~~DATE~~ 1015 INITIATED AT: ~~1015~~	PURGING ENDED AT: 1113	TOTAL VOLUME PURGED (gallons):

TIME	CUMUL.VOL. PURGED (gallons)	PURGE RATE (gpm or ~~mL/min~~)	DEPTH TO WATER (feet)	pH (S.U.)	TEMP. (°C)	COND. (mS/cm)	DO (mg/L)	TURBIDITY (NTUs)	ORP (mV)
1021	NM	250	4.89	2.35	24.22	0.339	0.68	82.7	389
1030	NM	300	4.99	2.23	23.04	0.226	0.37	92.3	402
1040	NM	400	5.06	2.05	22.85	0.348	0.30	39.7	418
1046	NM	400	5.08	2.00	22.95	0.351	0.28	26.8	~~433~~ 422
1054	NM	450	5.24	1.96	22.76	0.354	0.37	20.1	427
1102	NM	400	5.08	1.89	23.72	0.354	0.29	18.2	428
1110	NM	350	5.05	1.85	23.81	0.354	0.26	11.8	431

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88

TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016

SAMPLED BY (PRINT) / AFFILIATION: Olivia Bramlet / Geosyntec	SAMPLER(S) SIGNATURES:	SAMPLING INITIATED AT: 1115	SAMPLING ENDED AT: 1128
PUMP OR TUBING DEPTH IN WELL (feet): 23.0	SAMPLE PUMP FLOW RATE (mL per minute): 350	TUBING MATERIAL CODE:	

FIELD DECON: Y N	FLD-FILTERED: Y N FILTER SIZE: ____ µm Filtration Equipment:	EQUIPMENT. BLANK: Y (N) Sample ID:	DUPLICATE: (Y) N

SAMPLE ID CODE	# Bottles	MATERIAL CODE	VOLUME	PRESERV. USED	ANALYSIS/ METHOD	SAMPLING EQUIPMENT CODE
AD-32-20190515	4					
AD-32-20190515 DUP	4					

REMARKS: After sampling the Horiba unit, checked w/ cal solution & reading low @ 2.96 pH – pH on form likely low. All WL measurements from top of casing.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING/PURGING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP** = Peristaltic Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **VT** = Vacuum Trap; **O** = Other (Specify)

STABILIZATION CRITERIA	pH = **± 0.2**	ORP = **± 20 mV**	Specific Conductance = 3 **readings within ± 3%**
Dissolved Oxygen =	A) **≤ 10% saturation** (≤ 1.82 mg/l @ 20 °C, ≤ 1.65 mg/l @ 25 °C, ≤ 1.51 mg/l @ 30 °C)		
	B) **readings within ± 0.2 mg/L (for readings ≤ 2 mg/L), whichever greater**		
Turbidity =	**A)** ≤ 10 NTUs; OR		
	B) 3 readings within ± 10%		

Attachment F

Certification by a Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864	Texas	July 22, 2019
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
East Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

September 23, 2019

CHA8462

TABLE OF CONTENTS

FIGURES

TABLES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
VAP	Vertical Aquifer Profiling
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the East Bottom Ash Pond (EBAP, Figure 1). In February 2019, a semi-annual assessment monitoring event was conducted at the EBAP in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey EBAP:

- LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.0100 mg/L), AD-31 (0.00943 mg/L), and AD-32 (0.0333 mg/L).
- LCLs for lithium exceeded the GWPS of 0.052 mg/L at AD-31 (0.077 mg/L) and AD-32 (0.075 mg/L).

No other SSLs were identified (Geosyntec, 2019a).

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a*

> *qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSLs identified for cobalt and lithium should not be attributed to the EBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for cobalt and lithium were based on a Type IV cause and not by a release from the Pirkey EBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for cobalt and lithium and the proposed alternative source are described below.

2.1 Proposed Alternative Sources

Initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify alternative sources due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSLs for cobalt and lithium have been attributed to natural variation associated with the underlying geology, which is a Type IV issue.

2.1.1 Cobalt

In a previous ASD for cobalt at the EBAP, evidence was provided to show that the observed cobalt concentrations were due to natural variation (Geosyntec, 2019b). The previous ASD discussed that the EBAP itself did not appear to be a source for cobalt in downgradient groundwater, based on observed concentrations of cobalt both in the ash material and in leachate from Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-864 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP leachate above the reporting limit of 0.01 mg/L. Because cobalt mobility is affected by pH, the SPLP test results are likely even more conservative than actual pond conditions. SPLP is run at a pH of 5 SU, whereas the operational pH of the pond varies between approximately 5.8 and 7.0 SU. Cobalt mobility increases under more acidic conditions, although even at a pH of approximately 5, only 2% of cobalt in fly ash is mobile (Izquierdo and Querol, 2012).

Cobalt was detected at an estimated concentration of 0.0024 mg/L in a grab sample of the pond water. However, the reported concentration of cobalt in the pond water sample is significantly lower than the average concentration of cobalt observed at all three wells where SSLs were identified (Table 1). Since the previous ASD was prepared, there have been no notable changes in coal handling or sourcing at the plant that would have affected the composition of the ash or pond water.

Since completion of the prior ASD, four additional permanent wells (B-2, B-3, AD-40, and AD-41) have been installed upgradient of the EBAP. The most recent data available for select wells in the vicinity of the EBAP, including the new upgradient locations, are shown in Figure 2. Groundwater cobalt concentrations at upgradient locations vary from 0.0008 mg/L to 0.0345 mg/L at AD-40 and B-3, respectively. This wide range in cobalt concentrations provides further

evidence for the natural variation of cobalt at the Site, particularly as the concentrations at B-3 exceed both the GWPS for the EBAP and the LCLs calculated for cobalt at the wells of interest.

As noted in the prior ASD, soil samples collected across the site, including from locations near the EBAP, identified cobalt in the aquifer solids at varying concentrations. Since completion of the prior ASD, additional soil samples have been collected from locations upgradient of the EBAP. Select soil sample data from the previous ASD and recently collected data are summarized in Table 2. Cobalt was identified in the aquifer solids at varying concentrations, with the highest value of 23.5 milligrams per kilogram (mg/kg) reported at AD-41, which is upgradient of the EBAP (Figure 3). Other testing included collection of aquifer solids to evaluate for the presence of cobalt-containing minerals. X-ray diffraction evidence identified pyrite and marcasite (both iron sulfides) at select locations at concentrations up to 3% by weight (Table 2). Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2019).

Groundwater samples were collected from upgradient location B-3 via vertical aquifer profiling (VAP), as described in an ASD previously generated for lithium exceedances at the EBAP (Geosyntec, 2019c). The VAP groundwater samples were centrifuged to separate solid and liquid phases, and the solid material was submitted for analysis of total metals and mineralogy by X-ray diffraction (XRD). The samples were also submitted for analysis of chemical composition and mineralogy by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). Following installation of permanent monitoring wells at B-2 and B-3, groundwater samples were collected by purging groundwater through the filter pack using a submersible pump. An additional groundwater sample was collected at AD-32. These permanent well groundwater samples were filtered through a 1.5-micron filter and the solid material retained on the filter was submitted for analysis of total metals and by SEM/EDS.

Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from B-2 and B-3 (Table 2). Cobalt was detected in the AD-32 solid material at 5.4 mg/kg, which is comparable to the concentration observed in bulk soil collected at the same location at the screened interval (9.1 mg/kg). These results provide further evidence that cobalt concentrations reported during groundwater sampling are naturally occurring and associated with the solid phase in the aquifer.

According to XRD results of the centrifuged solid sample [VAP-B3-(40-45)], pyrite was present as approximately 3% of the solid phase, with hematite (an iron(III) oxide) present at 2% (Table 3). Logging completed while the VAP boring was advanced identified lignite at several intervals, including 45 and 48 ft bgs (Figure 4). Furthermore, SEM/EDS of both centrifuged solid samples [VAP-B3-(40-45) and VAP-B3-(50-55)] identified pyrite in backscattered electron micrographs by the distinctive framboid pattern (Harris, 1981; Sawlowicz, 2000). Major peaks involving iron and sulfur were identified in the EDS spectrum, which further support the identification of pyrite (Attachment A). While cobalt was not identified in the EDS spectrum, it would likely be present

at concentrations below the detection limit. Pyrite was also identified during SEM/EDS analysis of lignite which is mined immediately adjacent to the site.

The wide distribution of pyrite across the site provides evidence that naturally occurring cobalt, which may substitute for iron in pyrite, may also be present in the aquifer solids near the EBAP. The presence of lignite in the area is well-documented, including at upgradient and downgradient locations relative to the EBAP (Broom and Myers, 1966; ETTL, 2010). Additionally, the pond was not identified as the source of cobalt at wells downgradient of the EBAP in the previous ASD based on the documented low mobility of cobalt under the pond conditions and lack of detectable cobalt in the pond itself.

2.1.2 Lithium

An ASD was previously generated for lithium exceedances at the EBAP which attributed the observed concentrations to natural variation in the aquifer, and more specifically to variations in naturally suspended matter that likely originates from lignite and is ubiquitous in the aquifer (Geosyntec, 2019c). New data gathered since completion of the prior ASD provides additional evidence that the observed lithium concentrations at AD-31 and AD-32 are due to natural variation in the aquifer.

Groundwater samples were collected in August 2019 at B-2, B-3, and AD-32 using low-flow sampling techniques. Total lithium concentrations in permanent upgradient wells B-2 and B-3 were measured at 0.055 mg/l and 0.090 mg/l, respectively, both of which are above the GWPS of 0.052 mg/L (Figure 5). Lithium was detected at AD-32 at 0.103 mg/L, which is comparable to the observed concentration at B-3. Because B-2 and B-3 were installed at upgradient locations Site activities, they suggest that lithium concentrations above the GWPS are naturally present in the vicinity of the EBAP.

The previous ASD generated for lithium at the EBAP developed a proposed mechanism for lithium mobility in groundwater which pointed to desorption from clay minerals associated with naturally occurring lignite material as the source of lithium in both up and downgradient wells at the EBAP (Geosyntec, 2019c).

As described in Section 2.1.1, groundwater samples were collected from B-2, B-3, and AD-32 and filtered to separate captured solid material. Both the solid material and the filtered groundwater were submitted for total metals analysis. Lithium was detected in the solid material at concentrations comparable to bulk soil at all locations, providing evidence that the particulates captured during groundwater sampling contain lithium (Table 4).

The total metal concentrations in the solid materials separated from the groundwater samples during filtration and the filtered groundwater concentrations were used to calculated partition coefficients values (K_d) for lithium, potassium, and sodium. These constituents were selected as they are all monovalent cations, and so have similar geochemical behavior. Partition coefficients are used to express the tendency of a chemical (e.g. lithium) to become adsorbed onto soil (or

sediment). K_d is a ratio of the amount of chemical adsorbed per unit weight of the soil to the concentration of the chemical in solution (i.e., groundwater), as shown in the following equation:

$$K_d = \frac{mg\ adsorbed/kg\ soil}{mg/L\ solution}$$

K_d is characteristic of the soil, so its value varies with soil type. While K_d values were previously calculated using results from the VAP samples, the K_d values presented in this ASD are more likely to represent turbid groundwater which would be captured during regular sampling events, as they were calculated using material collected from permanent wells with conventional filter packs.

K_d values for groundwater and particulate collected from wells B-2, B-3, and AD-32 are comparable to literature K_d values reported for organic-rich media such as bogs and peat beds (Table 5) (Sheppard et al., 2009; 2011). These calculations provide further evidence that lithium mobility in Site groundwater is similar to other sites with organic-rich soils. Additionally, the calculated K_d values for Pirkey soils are consistent with the literature, with potassium being the largest (most sorbable) and sodium the smallest (least sorbable). Furthermore, the values are similar for groundwater from all three wells, suggesting a universal mechanism is controlling the mobilities of lithium, sodium, and potassium in groundwater.

Previously completed XRD analysis of the centrifuged solid material samples [VAP-B3-(40-45) and VAP-B3-50-55] found that clay minerals made up at least 60% of the aquifer solid (Table 3). Clay minerals include kaolinite, smectite, and illite/mica. SEM/EDS analysis identified the presence of silicon, aluminum and oxygen, all of which are indicative of clay minerals (Attachment A). The backscattered electron micrographs of these samples also identified clay particles by morphology. The largest clay particles (> 5 µm) are likely kaolinite, while smectite and illite dominate the smaller size fraction. These results are comparable to preliminary investigation of the VAP material completed by SEM/EDS described in the previous ASD, all of which presented evidence for clay fractions (Geosyntec, 2019c).

These multiple lines of evidence show that elevated lithium concentrations at AD-31 and AD-32 are not due to a release from the EBAP, and instead can be attributed to natural variation. This variation appears related to the distribution of clay fractions associated with lignite materials in the soil aquifer material.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSLs are not due to a release from the Pirkey EBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and provides evidence that the SSLs for cobalt at AD-2, AD-31, and AD-32 and for lithium at AD-31 and AD-32 identified during assessment monitoring in February 2019 were not due to a release from the EBAP. The identified SSLs were, instead, attributed to natural variation in the underlying geology. Therefore, no further action for cobalt or lithium is warranted, and the EBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment B.

SECTION 4

REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

Broom, M.E. and Myers, B.N., 1966. Ground-Water Resources of Harrison County, Texas. Texas Water Development Board Report 27. August.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. 3002010920. October.

ETTL, 2010. Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas, Geotechnical Investigation. October.

Geosyntec Consultants, 2019a. Statistical Analysis Summary – East Bottom Ash Pond. H. W. Pirkey Plant. Hallsville, Texas. July.

Geosyntec Consultants, 2019b. Alternative Source Demonstration – Federal CCR Rule. H. W. Pirkey Power Plant. East Bottom Ash Pond. Hallsville, Texas. April.

Geosyntec Consultants, 2019c. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, East Bottom Ash Pond. Hallsville, Texas. July.

Harris, L. A, Kenik, E. A., and Yust, C. S. 1981. Reactions in pyrite framboids induced by electron beam heating in a HVEM. *Scanning Electron Microscopy*, 1, web.

Hitzman, M.W., Bookstrom, A.A., Slack, J.F., and Zientek, M.L., 2017. Cobalt – Styles of Deposits and the Search for Primary Deposits. USGS Open File Report 2017-1155.

Izquierdo, M. and Querol, X., 2012. Leaching Behaviour of Elements from Coal Combustion Fly Ash: An Overview. *International Journal of Coal Geology*, 94, 54-66.

Krupka, K. M. and Serne, R. J., 2002. Geochemical Factors Affecting the Behavior of Antimony, Cobalt, Europium, Technetium, and Uranium in Vadose Sediments. Pacific Northwest National Lab, PNNL-14126. December.

Sawlowicz, Z. 2000. *Framboids: From Their Origin to Application*. Pr. Mineral. (Mineralogical Transactions), 88, web.

Sheppard, S., Sohlenius, G., Omberg, L.G., Borgiel, M., Grolander, S., and Nordén, S. 2011. Solid/Liquid Partition Coefficients (K_d) and Plant/Soil Concentration Ratios (CR) for Selected

Soil, Tills, and Sediments at Forsmark. R-11-24. Swedish Nuclear Fuel and Waste Management Co. R-11-24. November.

Sheppard, S., Long, J., Sanipelli, B., and Sohlenius, G. 2009. Solid/Liquid Partition Coefficients (K_d) for Selected Soil and Sediments at Forsmark and Laxemar-Simpevarp. R-09-27. Swedish Nuclear Fuel and Waste Management Co. March.

United States Environmental Protection Agency (USEPA), 1994. Method 1312 – Synthetic Precipitation Leaching Procedure, Revision 0, September 1994, Final Update to the Third Edition of the Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA publication SW-846.

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

TABLES

Table 1: Summary of Key Cobalt Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant

Sample	Unit	Cobalt Concentration
Bottom Ash (Solid Material)	mg/kg	6.1
SPLP Leachate of Bottom Ash	mg/L	<0.01
EBAP Pond Water	mg/L	0.0024 J
AD-2 - Average	mg/L	0.0111
AD-31 - Average	mg/L	0.0107
AD-32 - Average	mg/L	0.0504

Notes:
mg/kg - milligram per kilogram
mg/L - milligram per liter
J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.
Average values were calculated using all cobalt data collected under 40 CFR 257 Subpart D, excluding any identified outliers.

Table 2: Soil Cobalt and Mineralogy Data
East Bottom Ash Pond - H.W. Pirkey Plant

Geosyntec Consultants, Inc.

Location ID	Sample Depth (ft bgs)	Cobalt (mg/kg)	Pyrite/Marcasite (%)
Bulk Soil Samples			
AD-17	7	3.10	2
	15	1.50	0
AD-18	8	3.60	1
	22	2.90	0
AD-30	7	1.00	3
	23	15.0	1
AD-31	12	1.90	2
	26	0.83	0
AD-32	11	1.70	--
	20-25	9.10	--
AD-41	15	< 1.0	--
	35	23.5	---
	95	1.90	---
B-2	10	2.36	---
	16	3.62	---
	71	10.30	---
	82	7.21	---
	87	3.11	---
B-3	10	1.30	---
	20	0.59	---
	97	1.11	---
Solid Material Retained After Filtration			
AD-32	13-33	5.4	--
B-2	38-48	4.3	--
B-3	29-34	12.0	--
	VAP 40-45	18.0	3

Notes:
'--' - analysis not completed
mg/kg- milligram per kilogram
ft bgs - feet below ground surface

For AD-XX locations, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-X locations were collected from cores removed from the borehole during well lithology logging.

Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

Table 3: X-Ray Diffraction Results
East Bottom Ash Pond - H. W. Pirkey Plant

Constituent	VAP-B3-(40-45)
Quartz	15
Plagioclase Feldspar	0.5
Orthoclase	ND
Calcite	ND
Dolomite	ND
Siderite	0.5
Goethite	ND
Hematite	2
Pyrite	3
Kaolinte	42
Chlorite	4
Illite/Mica	6
Smectite	12
Amorphous	15

Notes:

ND: Not detected

VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

Table 4: Soil Lithium Data *Geosyntec Consultants, Inc.*
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Sample Depth (ft bgs)	Lithium (mg/kg)
Bulk Soil Samples		
AD-32	11	0.53
	20-25	1.60
B-2	10	5.30
	16	3.97
	71	7.42
	87	13.10
B-3	10	3.64
	20	2.59
	97	11.10
Lignite	N/A	2.9 J
Solid Material Retained After Filtration		
AD-32	13-33	9.8 J
B-2	38-48	6.5 J
B-3	29-34	7.8 J
	VAP 40-45	13.0

Notes:
J - estimated value
mg/kg- milligram per kilogram
ft bgs - feet below ground surface
For AD-32, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-X locations were collected from cores removed from the borehole during well lithology logging.
Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.
VAP - vertical aquifer profiling

Table 5: Calculated Site-Specific Partition Coefficients
East Bottom Ash Pond - H. W. Pirkey Plant

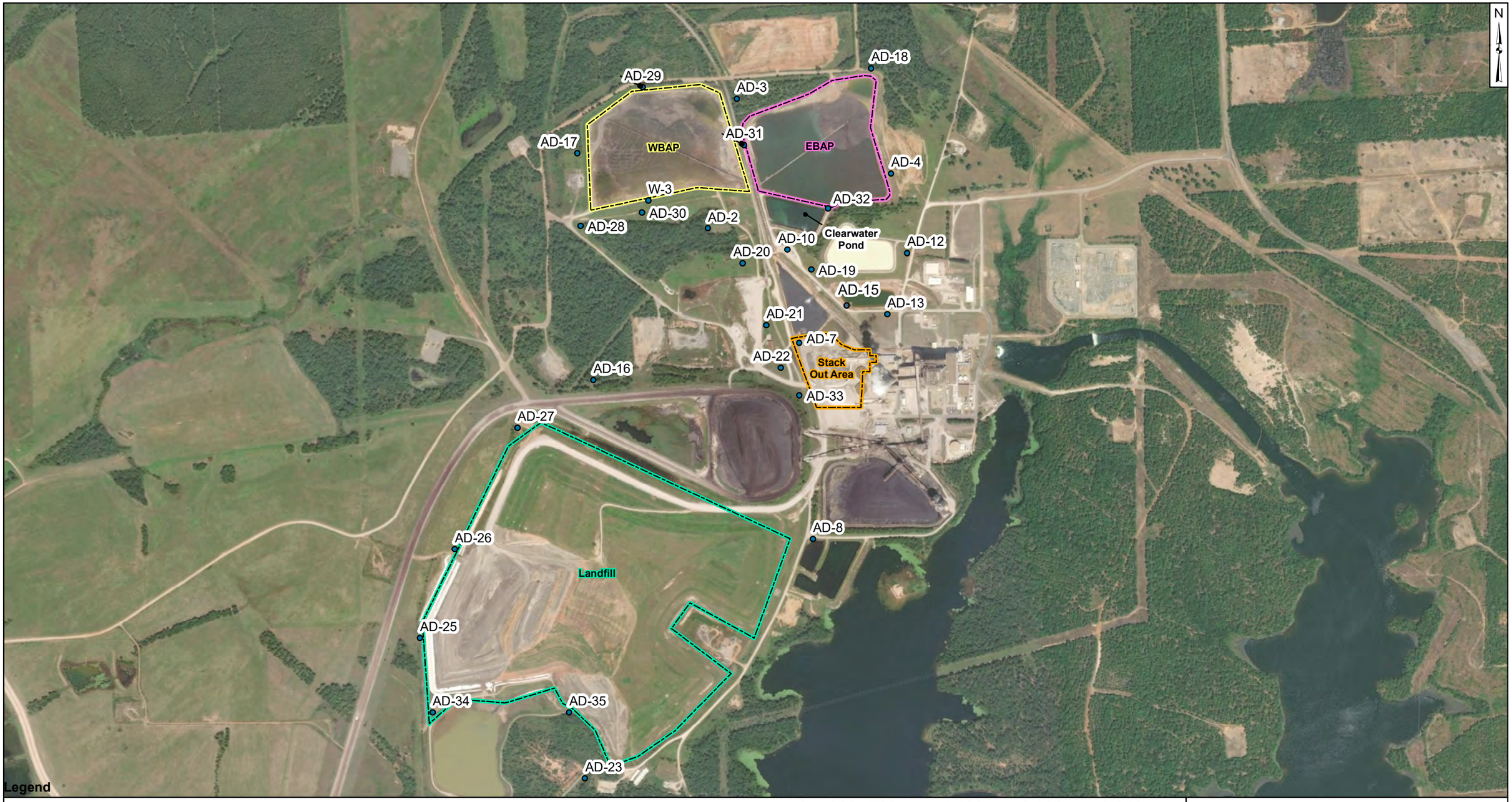
Source	B-2			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.081	6.5	80	43-370
K	2.6	1100	423	42-1200
Na	14	130	9	5.2-82

Source	B-3			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.097	7.8	80	43-370
K	2.9	1100	379	42-1200
Na	32	240	8	5.2-82

Source	AD-32			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.11	9.8	89	43-370
K	3.9	1800	462	42-1200
Na	57	220	4	5.2-82

Notes:
mg/L: milligrams per liter
mg/kg: milligrams per kilogram
L/kg: liters per kilogram
Kd: partition coefficient
Adsorbed values are total metals concentrations reported by USEPA Method 6010B.
Literature values represent maximum and minimum values for the parameter as reported in Sheppard et al, 2009 (Table 4-1, all sites) and Sheppard et al, 2011 (Table 3-3 cultivated peat and wetland peat only).

FIGURES



Legend

- AD-15
- Monitoring Wells

Location Boundaries

CCR Units

- EBAP
- Landfill
- Stack Out Area
- WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- AD-15 location is approximate.

0 380 760 1,520 2,280 3,040 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/03/25

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_20190322.mxd. HDuff. 3/25/2019. Project/Phase/Task.

Location	LCL (mg/L)
AD-31	0.0094

Location	Result (mg/L)
B-2	0.00814

Location	Result (mg/L)
AD-40	0.000799

Location	Result (mg/L)
AD-41	0.00801

Location	Result (mg/L)
B-3	0.0345

Location	LCL (mg/L)
AD-28	0.0132

Location	LCL (mg/L)
AD-2	0.010

Location	LCL (mg/L)
AD-32	0.033

AD-18
B-2
AD-29
WBAP
EBAP
AD-31
AD-40
AD-17
HPT-05
AD-4
AD-41
B-3
W-3
AD-32
AD-37
AD-30
AD-28
AD-2
AD-43
AD-42
AD-10
Clearwater Pond
AD-20
AD-12
AD-19
AD-44
AD-45
AD-15
HPT-09
AD-13
AD-38
AD-21
AD-7
Stack Out Area

N

Legend

- Out of Network
- EBAP
- WBAP
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- EBAP
- Stack Out Area
- WBAP

Notes
- Monitoring well coordinates, site features, and data provided by AEP.
- AD-15 location is approximated
- LCL: lower confidence limit
- Cobalt concentrations and LCL values displayed in milligrams per liter (mg/L).

400 200 0 400
Feet

Cobalt Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/09/17

Figure **2**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Pirkey_Cobalt_20190912.mxd. ARevezzo. 9/17/2019. Project/Phase/Task.

Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	B-2				
Depth (ft bgs)	10	16	71	82	87
Cobalt (mg/kg)	2.36	3.62	10.30	7.21	3.11
Pyrite/Marcasite (%)	-	-	-	-	-

Location	AD-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

Location	AD-41		
Depth (ft bgs)	15	35	95
Cobalt (mg/kg)	< 1.0	23.5	1.9
Pyrite/Marcasite (%)	-	-	-

Location	B-3		
Depth (ft bgs)	10	20	97
Cobalt (mg/kg)	1.30	0.59	1.11
Pyrite/Marcasite (%)	-	-	-

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

AD-29
AD-18
B-2
AD-40
AD-31
WBAP
EBAP
AD-17
HPT-05
AD-4
AD-41
B-3
W-3
AD-30
AD-37
AD-28
AD-2
AD-32
AD-10
Clearwater Pond
AD-12
AD-20
AD-19

N

Legend

- Monitoring Wells
- EBAP
- WBAP

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.

300 150 0 300
Feet

Soil Chemical and Mineralogical Analysis Results

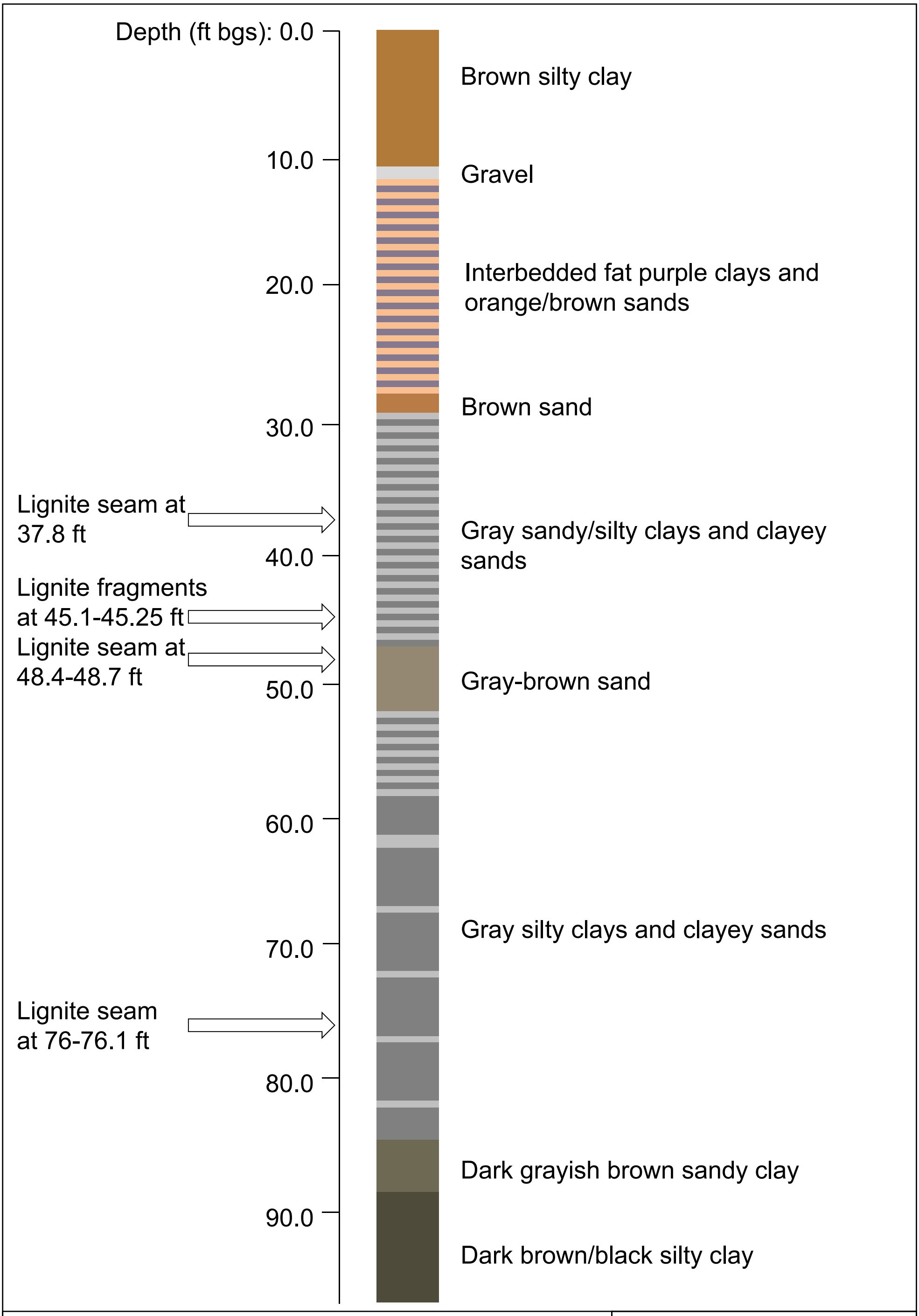
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/09/18

Figure 3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\Pirkey_SoilChem_minerals_March2019.mxd. hduff. 9/18/2019. Project/Phase/Task.



Notes:
- Ft = feet
- Bgs = below ground surface
- Boring completed May 2019
- Total depth of 97.5 ft bgs
- Well installed in offset boring screened at 29-34 ft bgs

Boring B-3 Visual Lithology Log

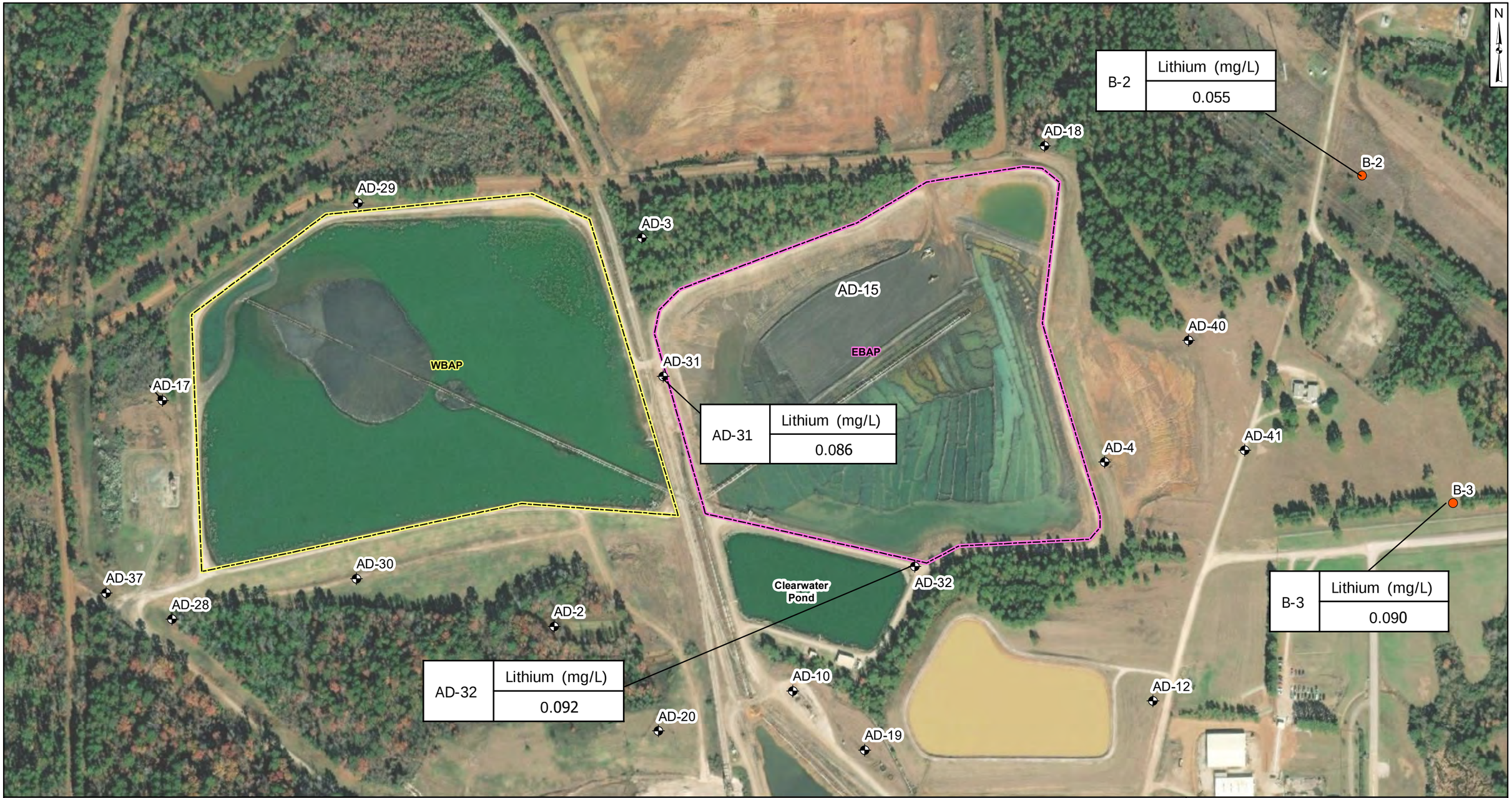
AEP Pirkey Powerplant
Hallsville, TX

Geosyntec consultants

CHA8462 | September 2019

Figure 4

\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-05 Field Investigation\Field Forms\Compiled Boring Logs\Visual boring logs



Legend

- Borehole
- Monitoring Well

Location Boundaries

- EBAP
- WBAP

Notes
- Lithium concentrations in micrograms per liter ug/L
- Monitoring well coordinates, site features, and data provided by AEP.
- AD-31 and AD-32 collected February 2019. B-2 and B-3 data from August 2019.

300 150 0 300
Feet

Lithium Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/09/18

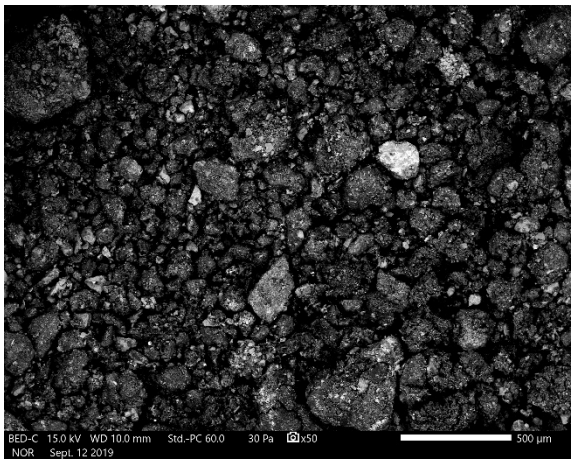
Figure **5**

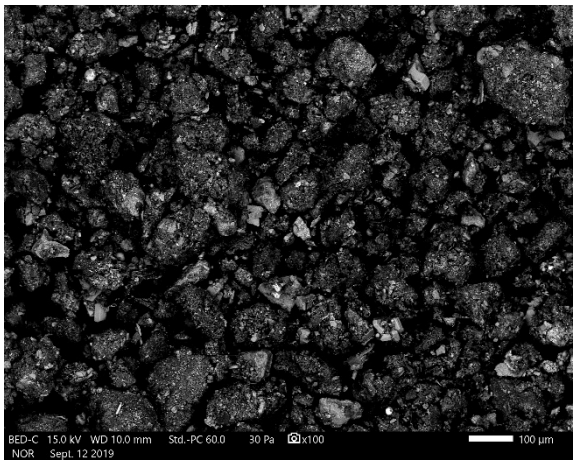
P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_Li_201909.mxd. hduff. 9/18/2019. CHA8462/12/02.

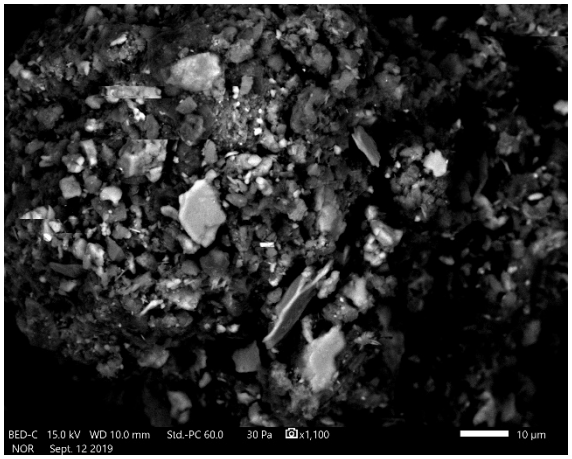
ATTACHMENT A
SEM/EDS Analysis

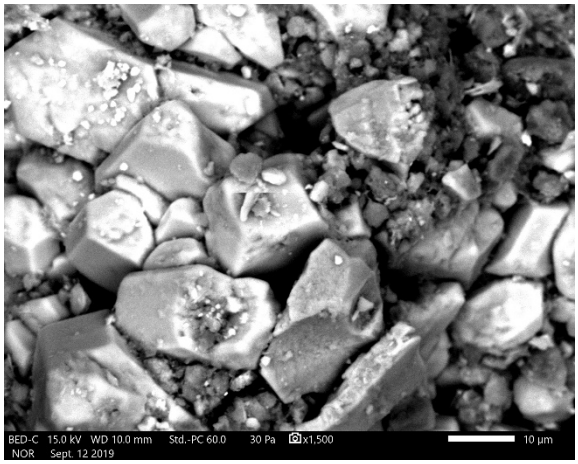
September 16, 2019

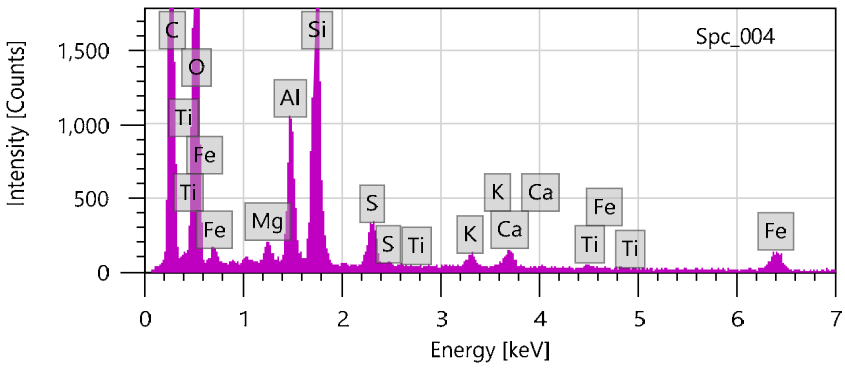
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221
via Email: BSass@geosyntec.com



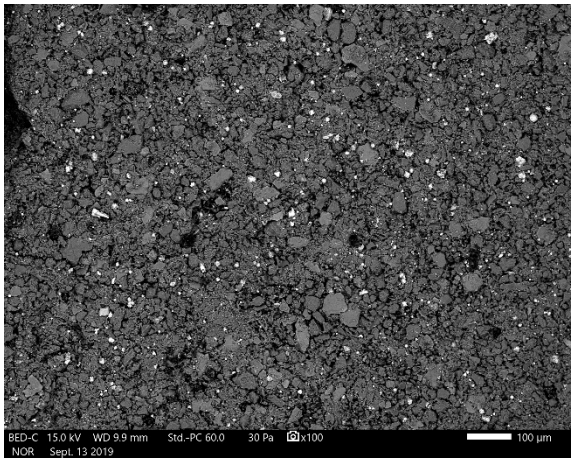


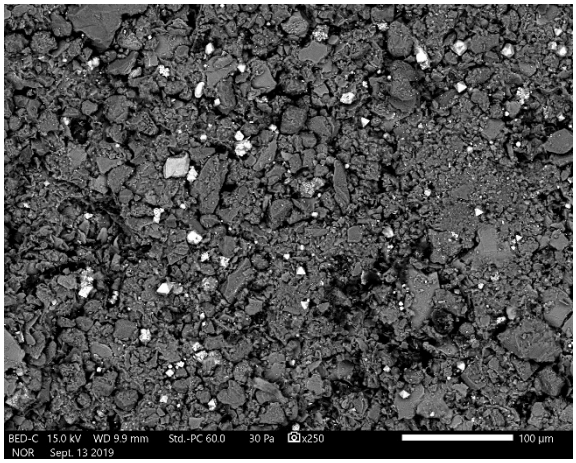


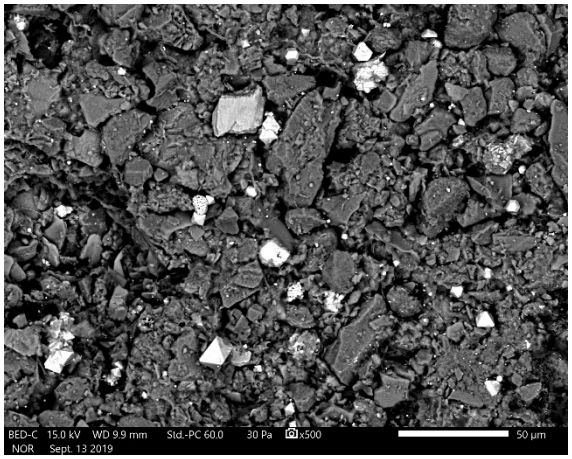


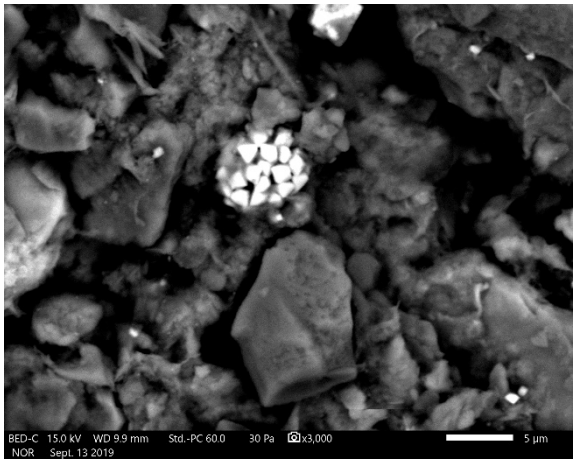


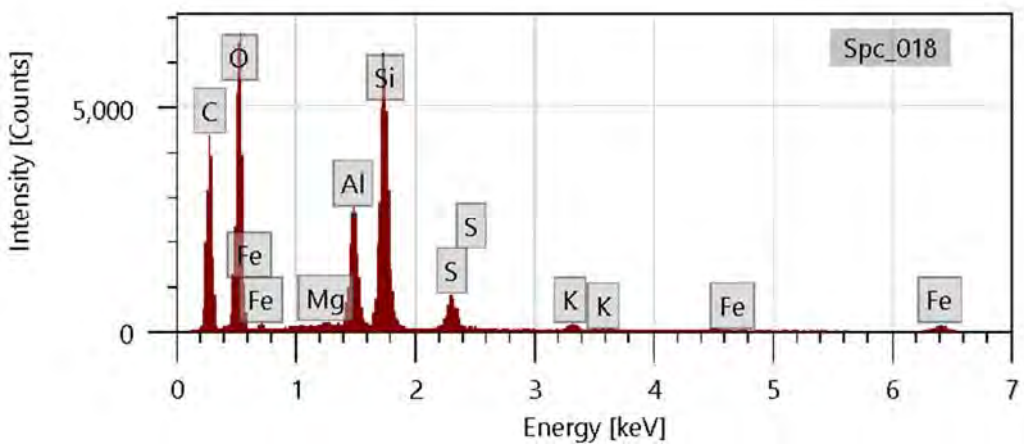
Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.





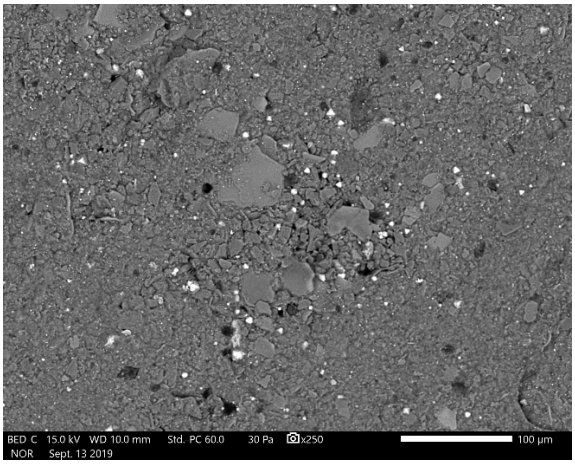


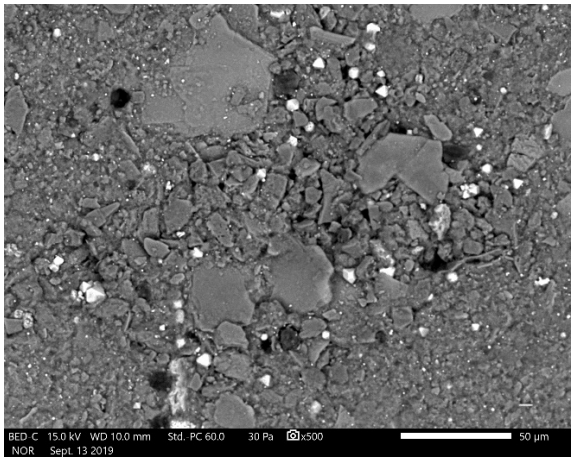


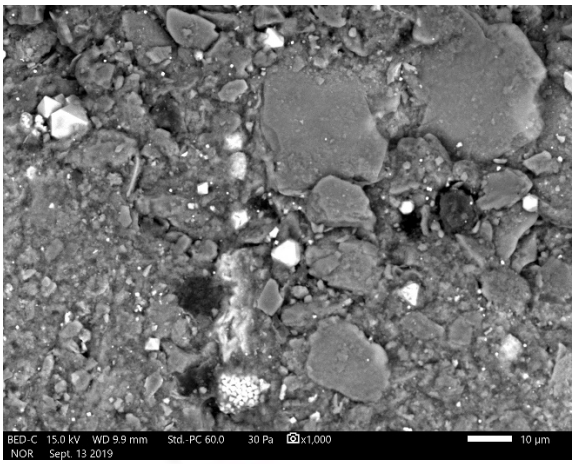


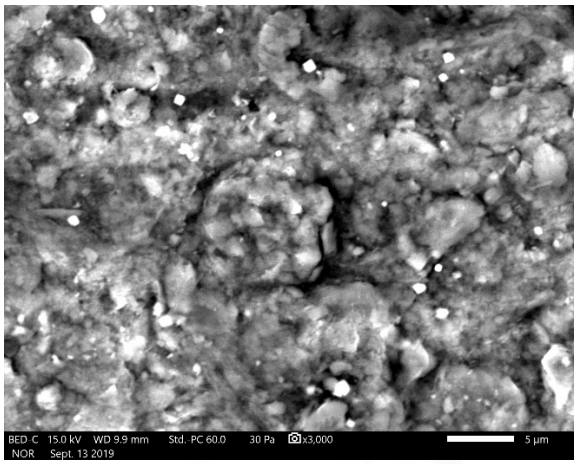
Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.

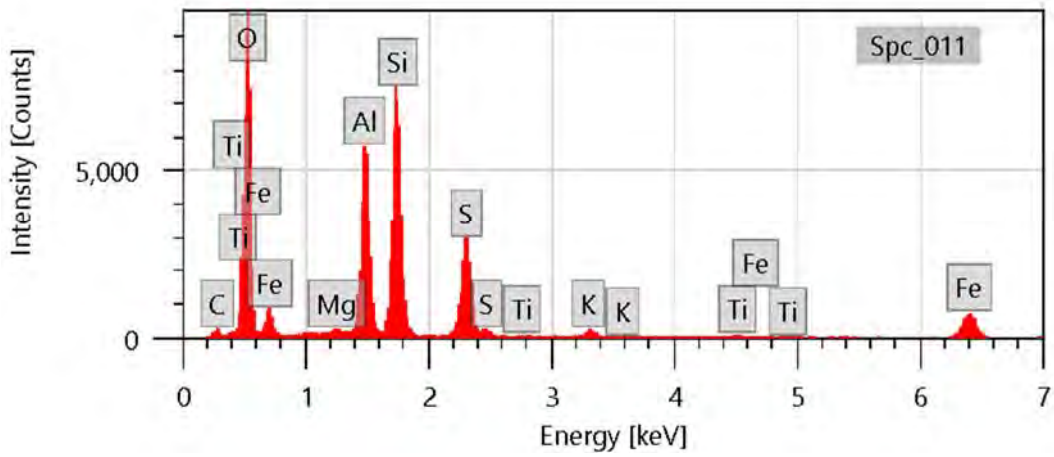
Geosyntec
CTLGroup 150350











Sample VAP B3 50-55. Backscattered electron micrographs show the sample at 250X, 500X, 1000X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 3000X. Bright particles are mostly pyrite (framboid in bottom left micrograph); occasional particles of Fe-Ti oxide are detected. Major peaks for oxygen, silicon, and aluminum suggest clay. Large blocky particles are mostly quartz, feldspar, and clay.

ATTACHMENT B
Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864	Texas	10/3/2019
License Number	Licensing State	Date

APPENDIX IV

Notices of groundwater monitoring program transitions are included in this appendix.

Pirkey Plant

Notice for Initiating an Assessment of Corrective Measures

CCR Unit – East Bottom Ash Pond

As required by 40 CFR 257.95(g)(5), this is a notification that an Assessment of Corrective Measures was initiated on March 26, 2019 for Pirkey Plant's East Bottom Ash Pond due to the statistically significant level detected above the established groundwater protection standard for lithium. This notification is being placed in the plant's operating record, as required by 40 CFR 257.105(h)(9).

APPENDIX V

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #506035

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.08" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 58.82" W**
Well County:	**Harrison**	Elevation:	**No Data**
			****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #185184**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/19/2019** Drilling End Date: **2/20/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**31**	**38**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

	Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Plug Information:	**SAND**	**50**	**60**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**clay brown**
1	**5**	**silty sand**
5	**9.5**	**clay**
9.5	**11**	**sand**
11	**32**	**clay**
32	**39**	**sand and clay**
39	**55**	**sand**
55	**60**	**fine sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**40**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**40**	**50**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS PLUGGING REPORT for Tracking #185184

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.08" N**
		Longitude:	**094° 29' 58.82" W**
	LOCATED ON OWNERS PROPERTY	Elevation:	**No Data**
Well County:	**Harrison**		

Well Type: **Monitor**

Drilling Information

Company: **Plains Environmental Services** Date Drilled: **2/20/2019**

Driller: **Jesse Kalvig** License Number: **5025**

Well Report Tracking #506035

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Plugging Information

Date Plugged: **2/21/2019** Plugger: **Jesse Kalvig**

Plug Method: **Pour in 3/8 bentonite chips when standing water in well is less than 100 feet depth, cement top 2 feet**

Casing Left in Well:

DIa (in.)	*Top (ft.)*	*Bottom (ft.)*
2	**15**	**50**

Plug(s) Placed in Well:

Top (ft.)	*Bottom (ft.)*	*Description (number of sacks & material)*
1	**40**	**Bentonite 10 Bags/Sacks**

Certification Data: The driller certified that the driller plugged this well (or the well was plugged under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the reports(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

STATE OF TEXAS WELL REPORT for Tracking #506039

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD37**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Latitude:	**32° 27' 56.32" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 41.78" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**17**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**10**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**8.5**	**CLAYS WITH SOME SAND**
8.5	**10.5**	**SAND**
10.5	**13**	**CLAY SOME SAND**
13	**15**	**SAND WITH SOME CLAYS**
15	**17**	**CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**12**	**17**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506038

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD38**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 46.12" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 43.34" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/21/2019** Drilling End Date: **2/21/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**CLAY RED**
5	**7**	**CLAY GRAY/RED**
7	**11.5**	**SAND/CLAY**
11.5	**17.5**	**SAND SOME CLAYS**
17.5	**18**	**CLAY SLITS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506037

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD39**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.05" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 58.84" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/20/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**12**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**5**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**CLAY**
1	**5**	**CLAY/SAND**
5	**9.5**	**CLAY**
9.5	**12**	**SAND/CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**7**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**7**	**12**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508688

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**AD-40 (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/10/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**40**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
27	**40**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**13**	**Cement**
13	**27**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**40**	**red and grey sand with occasional clay intervals**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**30**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**30**	**40**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508686

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB(MW)-01A**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/9/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**100**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
86	**100**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**86**	**Bentonite 17 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**85**	**red and grey sand with occasional clay intervals**
85	**88**	**grey clay**
88	**100**	**grey sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**90**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**90**	**100**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508703

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**22**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**22**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**3**	**Cement**
3	**8**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**22**	**red and grey sand w/occ. lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**12**	**22**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508695

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**80**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
56	**80**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**56**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**36**	**red and grey sand w/occ. lignite layers**
36	**41**	**red and tan clay**
41	**69**	**red and grey sand with occasional clay iand lignite layers**
69	**80**	**grey sandy clay with lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**59**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**59**	**69**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508712

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/24/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**25**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
12	**25**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**12**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**25**	**brown sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**15**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**15**	**25**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508708

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
45	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**45**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**28**	**brown sand**
28	**41**	**brown and grey silty clay**
41	**70**	**grey sand with occasional lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506040

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6S**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 30.34" N**
		Longitude:	**094° 29' 27.76" W**
	LOCAATED ON OWNERS PROPERTY	Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**18**	**SANDS AND CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506041

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6D**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 30.28" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 27.75" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**65**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**53**	**Bentonite 19 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**24**	**SANDS AND CLAYS**
24	**29**	**CLAYS**
29	**42.5**	**SANDS AND CLAYS**
42.5	**48.5**	**SANDS WITH SOME CLAY**
48.5	**56**	**CLAYS WITH SOME SAND**
56	**65**	**SILY SANDS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508722

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/3/2019** Drilling End Date: **3/3/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**45**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
32	**45**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**32**	**Bentonite 6 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**45**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**35**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**35**	**45**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508720

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
57	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**57**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**70**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**60**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**60**	**70**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508724

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**35**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**35**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**23**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**35**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**25**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**25**	**35**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508729

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 medium (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**65**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
52	**65**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**53**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**65**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508777

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/26/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**93**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
77	**93**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**77**	**Bentonite 15 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**90**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**
90	**93**	**gray clay (old pit base?)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**80**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**80**	**90**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508781

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/5/2019** Drilling End Date: **3/5/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**30**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
17	**30**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**17**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**30**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**20**	**30**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508779

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/4/2019** Drilling End Date: **3/4/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**60**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
48	**60**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**48**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**60**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508718

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/8/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**15**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**15**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement**
1	**3**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**5**	**15**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508717

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/7/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**43**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
30	**43**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**30**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**
18	**43**	**red and grey sand w/occ. clay layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**33**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**33**	**43**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #525309

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**B-2**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 54.7" N**
		Longitude:	**094° 28' 25.01" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **5/13/2019** Drilling End Date: **5/17/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**49**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
36	**49**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**32**	**Concrete 1 Bags/Sacks**
32	**36**	**Bentonite 1 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEST DRILLING SERVICES, INC.**

P.O. BOX 845
FRIENDSWOOD, TX 77549

Driller Name: **Ali Firouzbakht** License Number: **4997**

Apprentice Name: **Ramon Gutierrez** Apprentice Number: **56591**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**0.5**	**SILTY SAND, black**
0.5	**2**	**SAND, red/brown**
2	**5**	**SANDY CLAY, alternating layers red + brown**
5	**5.5**	**NO RECOVERY**
5.5	**6.7**	**SANDY CLAY, gray + brown/red**
6.7	**8**	**CLAY, gray**
8	**11**	**CLAY, gray with brown striations**
11	**11.5**	**CLAY, gray**
11.5	**12**	**CLAYEY, gray SAND, red-brown**
12	**14**	**NO RECOVERY**
14	**14.75**	**SANDY CLAY, reddish brown + gray**
14.75	**16**	**CLAY, gray + red & trace brown fine grained SAND**
16	**18.5**	**NO RECOVERY**
18.5	**18.75**	**CLAY, red & gray, trace SILT**
18.75	**18.95**	**SAND, tan**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**38**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**38**	**48**
2	**SUMP**	**New Plastic (PVC)**	**40**	**48**	**48.5**

18.95	20	CLAY, red/drk. gray
20	21.1	NO RECOVERY
21.1	21.8	SANDY CLAY, lt. brown + red
21.8	24	CLAY, red + drk. gray
24	24.5	SANDY CLAY, lt. brown
24.5	24.8	SANDY CLAY, red-brown
24.8	28	CLAY, purple + gray
28	29.9	CLAY, drk. purple
29.9	30.7	CLAY, black/drk. gray
30.7	32	SILTY CLAY, black/drk. gray
32	33.5	SILTY CLAY, drk. gray
33.5	36	SILTY CLAY, black
36	36.5	NO RECOVERY
36.5	38.1	SAND, drk. green
38.1	38.3	SILTY SAND, drk. brown
38.3	38.4	CLAYEY SAND, very drk. brown
38.4	38.5	SILTY SAND, drk. green
38.5	39	SILTY SAND, drk. brown
39	39.2	Laminated SANDY CLAY/CLAYEY SANDS, gray to drk. gray
39.2	43.1	NO RECOVERY
43.1	44.5	Fine graded SAND w/trace SILT, greenish gray
44.5	47	CLAYEY SAND/SANDY CLAY, drk. brown
47	48.1	NO RECOVERY
48.1	49	CLAYEY SAND/SANDY CLAY, drk. brown

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #525308

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**B-3**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 54.7" N**
		Longitude:	**094° 28' 25.01" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **5/15/2019** Drilling End Date: **5/15/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8	**0**	**35**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
26.9	**35**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**22**	**Concrete 1 Bags/Sacks**
22	**26.9**	**Bentonite 1 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEST DRILLING SERVICES, INC.**

P.O. BOX 845
FRIENDSWOOD, TX 77549

Driller Name: **Ali Firouzbakht** License Number: **4997**

Apprentice Name: **Ramon Gutierrez** Apprentice Number: **56591**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**2**	**CLAY, medium red-brown**
2	**3**	**CLAY, lt. brown**
3	**4**	**Organic CLAY, gray to lt. brown**
4	**4.5**	**Organic CLAY, lt. brown**
4.5	**5**	**Organic CLAY, lt. brown to reddish brown**
5	**9.5**	**Organic CLAY, lt. brown to reddish brown**
9.5	**10.5**	**SILTY CLAY, reddish-orange**
10.5	**11**	**Poorly graded gravel**
11	**13**	**CLAYEY SAND,**
13	**13.9**	**SANDY CLAY, brown to orange**
13.9	**15**	**SAND, orange**
15	**16**	**SANDY CLAY**
16	**18**	**SAND, orange**
18	**18.5**	**Fat CLAY, grayish purple**
18.5	**19.5**	**SAND, orange to grayish orange**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**29.2**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**29.2**	**34**
2	**SUMP**	**New Plastic (PVC)**	**40 0.010**	**34**	**34.5**

19.5	20	Fat CLAY, grayish purple
20	22.1	SAND, lt. brown to orange
22.1	22.3	Lenes of fat CLAY, drk. gray to purple
22.3	22.6	SAND, lt. brown to orange
22.6	23	Gravelly SAND
23	24	SANDY CLAY, grayish purple
24	25.6	SAND, tan to lt. brown
25.6	26.4	CLAY, purple and gray
26.4	26.8	CLAYEY SAND, tan to lt. brown
26.8	27.3	CLAY, purple
27.3	28	CLAY, drk. gray
28	28.6	NO RECOVERY
28.6	29.2	SAND, lt. brown
29.2	29.5	SILTY CLAY, drk. gray
29.5	32	CLAY, drk. gray to black
32	32.7	CLAY, drk. gray
32.7	33.1	CLAYEY SILT, drk. gray
33.1	35	SAND, drk. gray

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #525304

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**B-6**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 54.7" N**
		Longitude:	**094° 28' 25.01" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **5/20/2019** Drilling End Date: **5/20/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
4	**0**	**40**

Drilling Method: **Direct Push**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
27	**40**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**25**	**Concrete 1 Bags/Sacks**
25	**27**	**Bentonite 1 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEST DRILLING SERVICES, INC.**

P.O. BOX 845
FRIENDSWOOD, TX 77549

Driller Name: **Ali Firouzbakht** License Number: **4997**

Apprentice Name: **Ramon Gutierrez** Apprentice Number: **56591**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**0.4**	**Topsoil with vegetation, black SILT**
0.4	**1.8**	**SILT, brown**
1.8	**7**	**SILTY CLAY, red & lt. gray**
2.3	**23.5**	**SILT, drk. red**
7	**7.2**	**SILT, brown**
7.2	**7.6**	**SILTY CLAY, red & lt. gray**
7.6	**8**	**CLAY, lt. gray**
8	**9**	**CLAY, lt. gray & lt. red**
9	**9.3**	**SILTY CLAY, lt. gray & brown**
9.3	**9.8**	**CLAY, lt. gray**
9.8	**12**	**CLAY, reddish-brown**
12	**12.8**	**SILTY CLAY, red & brown**
12.8	**16**	**SILTY CLAY, drk. brown**
16	**18.1**	**CLAY, red & brown**
18.1	**18.8**	**SILTY CLAY, brown**
18.8	**18.9**	**CLAY, brown**
18.9	**19.1**	**SILT, lt. gray & brown**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**29**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**29**	**39**
2	**SUMP**	**New Plastic (PVC)**	**40**	**39**	**39.5**

19.1	19.4	SILTY CLAY, brown
19.4	20	CLAYEY SILT, lt. gray & brown
20	20.9	CLAY, red/brown
20.9	22.1	CLAYEY SILT, lt. brown
22.1	23.2	SILTY CLAY, lt. brown & gray
23.5	24	SILTY CLAY, lt. brown & gray
24	25.9	NO RECOVERY
25.9	26.1	CLAYEY SILT, lt. brown
26.1	26.3	SILTY CLAY, brown
26.3	28	SILTY CLAY, black & drk. green
28	28.7	Trace CLAY, brown SILT
28.7	29.6	SILTY CLAY, drk. brown & green
29.6	29.9	CLAY, drk. brown
29.9	30.3	CLAYEY SAND, drk. green & drk. brown
30.3	32	Fine grained SAND, drk. green
32	34.4	Fine grained SAND, gray & brown
34.4	34.5	SILT w/gravel, tan/brown
34.5	34.7	CLAY, drk. brown
34.7	35.1	Fine grained SAND, drk. green
35.1	36	Fine grained SANDY SILT, drk. green & black
36	37.4	Fine grained SAND, drk. brown
37.4	38.5	Fine grained SILTY SAND, drk. gray & drk. green
38.5	40	SANDY SILT, drk. green & black

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Annual Groundwater Monitoring Report

Southwestern Electric Power Company

H. W. Pirkey Power Plant

West Bottom Ash Pond CCR Management Unit

Hallsville, Texas

January 2020

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY

An AEP Company

BOUNDLESS ENERGY

Page

Table of Contents

I. Overview

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2019.

In general, the following activities were completed:

- Groundwater samples were collected for AD-3, AD-12, AD-17, AD-18, AD-28, and AD-30 in February, May, and August 2019 and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on December 26, 2018. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on March 26, 2019.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on July 10, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 23, 2019.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.
- The unit was in assessment monitoring and the beginning and the end of 2019.

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;

- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in Appendix I;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations (Appendix IV).
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

West Bottom Ash Pond Monitoring Wells	
Up Gradient	Down Gradient
AD-3	AD-17
AD-12	AD-28
AD-18	AD-30

III. Monitoring Wells Installed or Decommissioned

Several monitoring wells were installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry in mine spoils. Please see the list below. Well installation reports can be found in Appendix V.

Soil Boring ID	Monitor Well ID
	AD-37
	AD-38
	AD-39
	AD-40
SB-01A	AD-41
SB-04	AD-42
SB-04	AD-43
SB-05	AD-44
SB-05	AD-45
SB-06	AD-46
SB-06	AD-47
SB-07	AD-48
SB-07	AD-49
SB-08	AD-50
SB-08	AD-52
SB-08	AD-53
SB-09	AD-54
SB-09	AD-55
SB-11	AD-56
SB-11	AD-57

Three additional soil borings were installed to better understand the spatial variability of constituents at the site up gradient of the plant. Two monitor wells were installed at these boring locations B-2 and B-3. Well reports for soil boring B-2 and B-3 can also be found in Appendix V.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event also are shown in Appendix I, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., a one round of sampling in February in accordance with 40 CFR 257.95(d)(1). A May sampling event was conducted in accordance with 40 CFR 257.95(b) including all Appendix III parameters and those Appendix IV

constituents parameters followed by an August round of sampling in accordance with 40 CFR 257.95(d)(1). Assessment monitoring will continue in 2020.

V. Statistical Evaluation of 2019 Events

The two statistical analysis reports are included in Appendix II.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on July 10, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 23, 2019.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the west bottom ash pond SSLs above GWPSs. SSLs above the GWPS were determined for cobalt on December 26, 2018. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on March 26, 2019.

SSLs above the GWPS were determined for cobalt at wells AD-28 on July 10, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 23, 2019.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on January 3, 2020. An alternate source investigation will be conducted for these SSLs.

The supporting information are found in Appendix III.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

The unit transitioned from detection monitoring to assessment monitoring transition on April 3, 2018.

Assessment monitoring will continue in 2020.

Regarding defining an alternate monitoring frequency, no modification of the twice-per-year detection monitoring effort is needed.

VIII. Other Information Required

No other information applies at this time.

IX. Description of Any Problems Encountered in 2019 and Actions Taken

No significant problems were encountered.

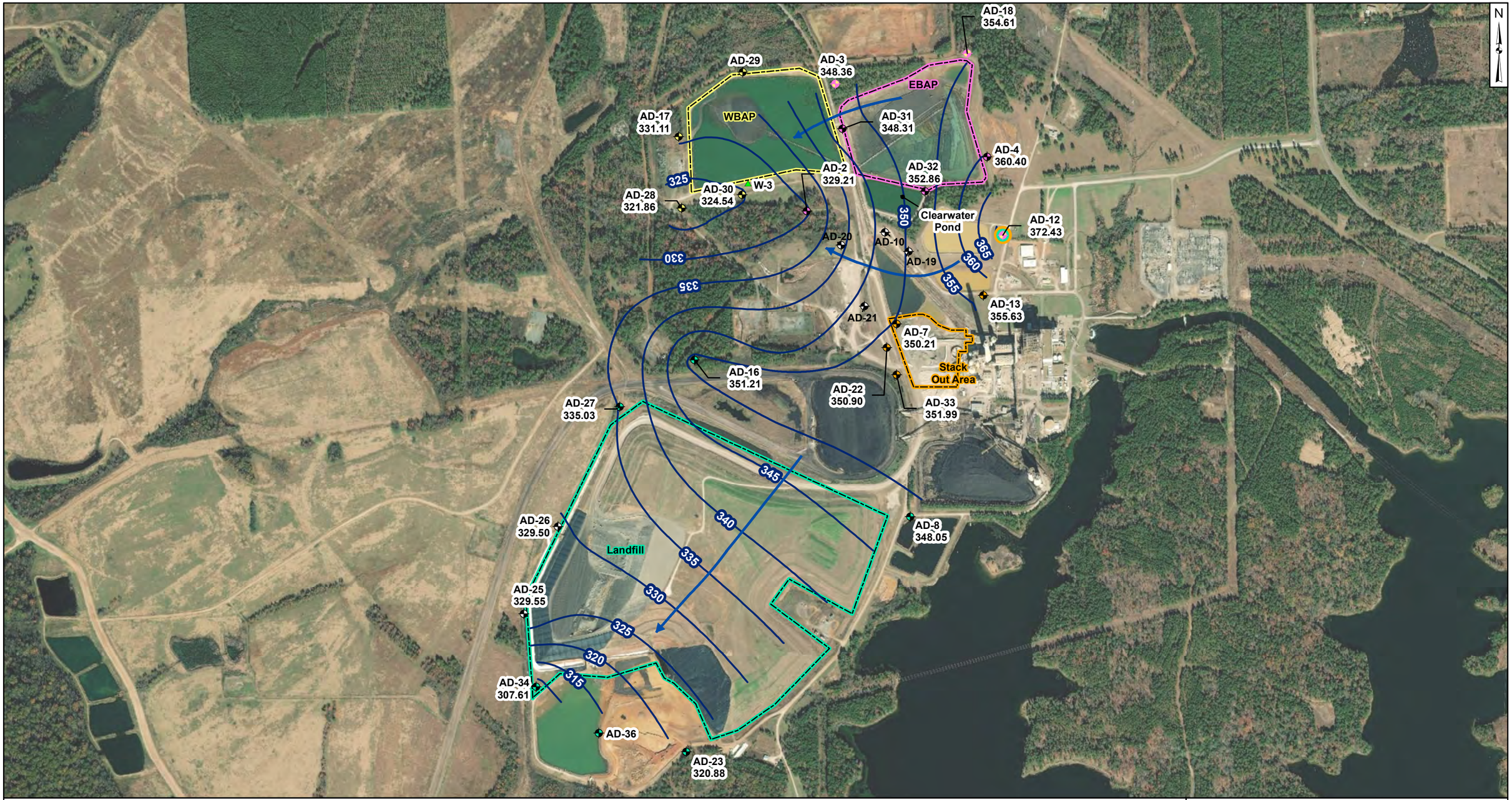
X. A Projection of Key Activities for the Upcoming Year

Key activities for 2020 include:

- Assessment monitoring sampling will be conducted;
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for any SSLs above GWPS;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the fourth annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on February 23-28, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in February 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer February 2019

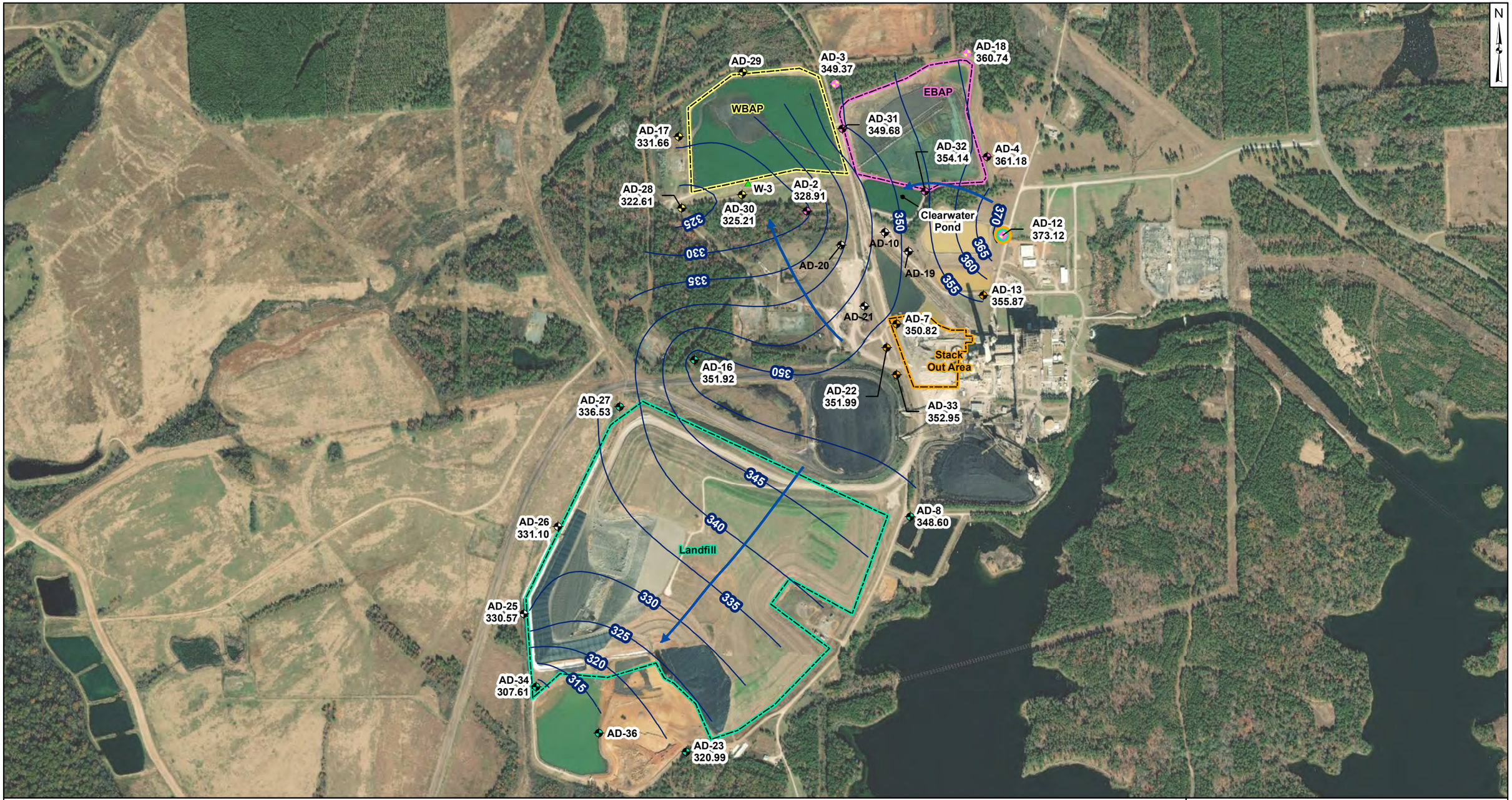
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201902-February.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 21-23, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in May 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer May 2019

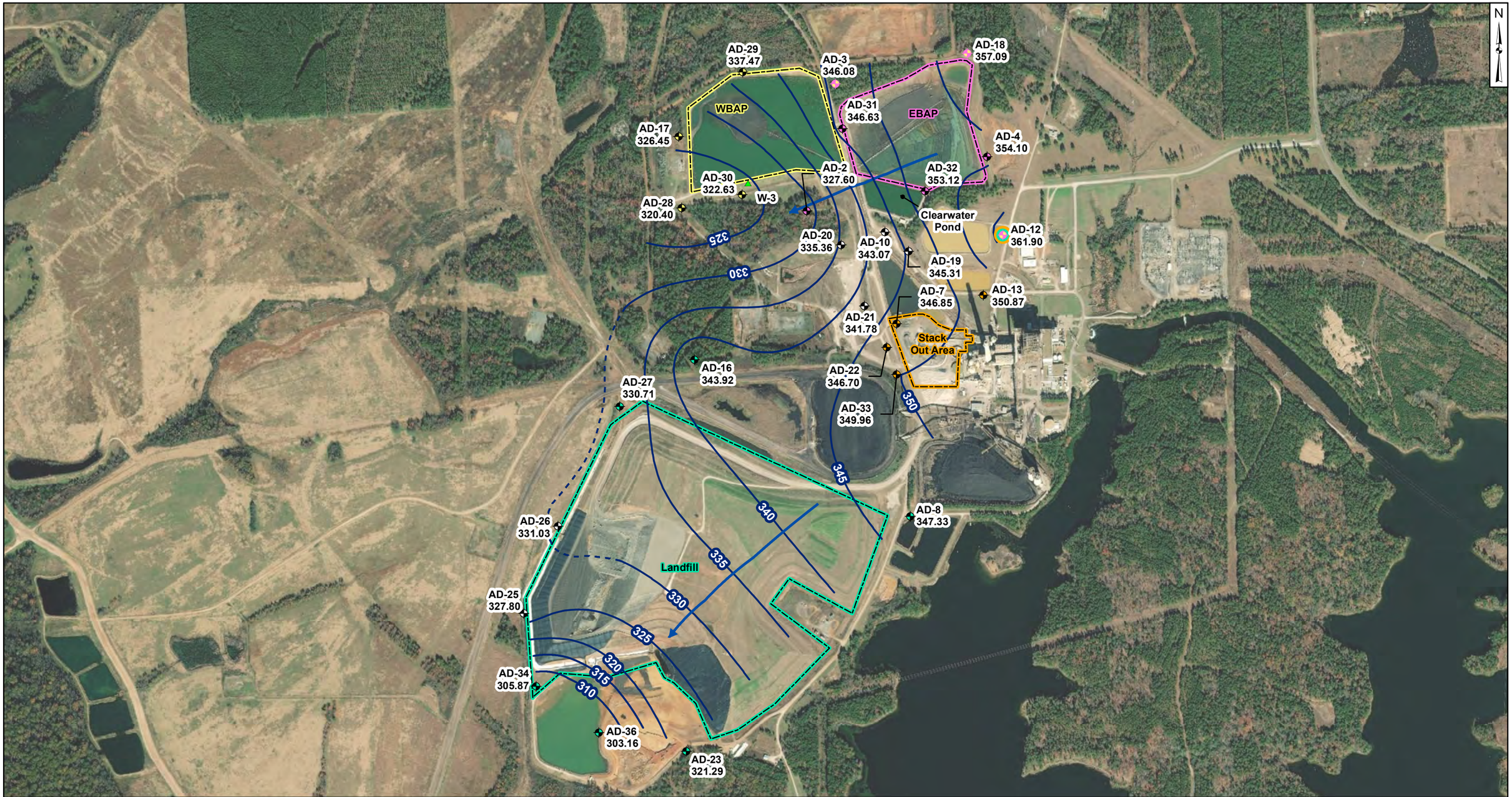
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure **2**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201905-May.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on August 12-16, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in August 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure 3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201908-August.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.

Table 1: Residence Time Calculation Summary
Pirkey West Bottom Ash Pond

Geosyntec Consultants, Inc.

CCR Management Unit	Monitoring Well	Well Diameter (inches)	2019-02		2019-05		2019-08	
			Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
West Bottom Ash Pond	AD-3 [1]	4.0	17.6	6.9	17.6	6.9	11.3	10.7
	AD-12 [1]	4.0	34.2	3.6	35.0	3.5	21.4	5.7
	AD-17 [2]	2.0	15.3	4.0	16.0	3.8	11.4	5.3
	AD-18 [1]	2.0	9.3	6.6	8.9	6.8	7.1	8.5
	AD-28 [2]	2.0	15.8	3.8	14.2	4.3	13.0	4.7
	AD-30 [2]	2.0	14.9	4.1	14.1	4.3	15.4	3.9

Notes:
[1] - Background Well
[2] - Downgradient Well

Table 1 - Groundwater Data Summary: AD-3
Pirkey - WBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.04	2.9	6	<0.083 U	4.9	136	18
7/14/2016	Background	0.06	4.67	6	<0.083 U	4.7	161	30
9/8/2016	Background	0.06	4.28	7	<0.083 U	4.5	145	28
10/13/2016	Background	0.05	4.93	8	<0.083 U	5.5	168	31
11/14/2016	Background	0.07	4.61	7	<0.083 U	5.4	170	29
1/12/2017	Background	0.05	3.81	7	<0.083 U	5.3	152	27
3/1/2017	Background	0.05	2.55	5	<0.083 U	5.1	124	16
4/10/2017	Background	0.06	2.6	10	<0.083 U	4.9	140	19
8/24/2017	Detection	0.08625	2.37	6	<0.083 U	5.6	68	17
3/22/2018	Assessment	0.05508	3.41	5	<0.083 U	5.3	140	26
8/21/2018	Assessment	0.055	4.79	9	<0.083 U	5.6	166	34
2/27/2019	Assessment	0.034	3.46	6.16	0.04 J	5.3	50	21.8
5/23/2019	Assessment	0.045	6.19	5.99	0.09	4.9	154	29.5
8/13/2019	Assessment	0.05 J	5.08	6.83	0.19	5.1	168	32.5

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-3
Pirkey - WBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	59	0.412956 J	0.0947139 J	0.724945 J	3.12937 J	1.059	<0.083 U	<0.68 U	0.025	0.00992 J	0.774997 J	3.29747 J	<0.86 U
7/14/2016	Background	<0.93 U	2.10876 J	70	0.583927 J	<0.07 U	1	7	1.69	<0.083 U	<0.68 U	0.095	0.025	1.16077 J	2.50173 J	<0.86 U
9/8/2016	Background	<0.93 U	<1.05 U	70	0.502486 J	<0.07 U	0.974129 J	7	1.491	<0.083 U	<0.68 U	0.087	0.00618 J	<0.29 U	<0.99 U	<0.86 U
10/13/2016	Background	<0.93 U	4.22879 J	82	0.591063 J	0.159178 J	2	9	3.42	<0.083 U	<0.68 U	0.991	0.0073 J	<0.29 U	1.92667 J	<0.86 U
11/14/2016	Background	<0.93 U	1.98138 J	64	0.310985 J	<0.07 U	0.42234 J	8	1.532	<0.083 U	<0.68 U	0.092	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	62	0.281878 J	<0.07 U	0.551806 J	4.96138 J	2.01	<0.083 U	<0.68 U	0.079	0.0057 J	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	62	0.279961 J	<0.07 U	<0.23 U	2.54266 J	0.862	<0.083 U	<0.68 U	0.046	<0.005 U	<0.29 U	1.78128 J	1.13014 J
4/10/2017	Background	<0.93 U	<1.05 U	61	0.284613 J	<0.07 U	0.250858 J	2.40319 J	0.991	<0.083 U	<0.68 U	0.046	<0.005 U	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	57.94	0.22 J	<0.07 U	0.86 J	3.74 J	0.739	<0.083 U	<0.68 U	0.06189	<0.005 U	<0.29 U	1.13 J	<0.86 U
8/21/2018	Assessment	<0.01 U	1.01	63.3	0.240	0.02 J	0.496	7.18	1.837	<0.083 U	0.355	0.0876	<0.005 U	0.1 J	0.1	0.057
2/27/2019	Assessment	0.04 J	0.13	54.2	<0.4 U	0.03 J	0.04 J	2.31	0.3144	0.04 J	0.05 J	0.0525	<0.005 U	<0.4 U	0.05 J	<0.1 U
5/23/2019	Assessment	<0.4 U	<0.6 U	61.8	<0.4 U	<0.2 U	<0.8 U	4.94	0.988	0.09	<0.4 U	0.0734	<0.005 U	<8 U	<0.6 U	<0.1 U
8/13/2019	Assessment	<0.02 U	2.41	58.3	0.196	0.02 J	0.206	6.55	1.378	0.19	0.417	0.108	<0.005 U	<0.4 U	0.1 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - WBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	<0.083 U	4.4	94	4
7/13/2016	Background	0.03	0.26	6	<0.083 U	3.1	75	4
9/7/2016	Background	0.04	0.343	6	<0.083 U	3.9	63	7
10/12/2016	Background	0.03	0.271	7	< 1 U	3.4	92	8
11/14/2016	Background	0.04	0.331	8	<0.083 U	2.6	80	6
1/11/2017	Background	0.03	0.315	7	<0.083 U	4.8	76	6
2/28/2017	Background	0.04	0.434	5	<0.083 U	3.6	50	4
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	72	7
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	52	6
3/21/2018	Assessment	0.01397	0.269	5	<0.083 U	4.2	<2 U	3
8/20/2018	Assessment	0.017	0.338	10	<0.083 U	4.4	94	4
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	36	3.6
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	80	4.0
8/12/2019	Assessment	<0.02 U	0.278	7.24	0.06 J	4.9	90	2.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - WBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	26	0.219521 J	<0.07 U	0.710981 J	1.58207 J	0.2073	<0.083 U	<0.68 U	<0.00013 U	<0.005 U	<0.29 U	1.73953 J	<0.86 U
7/13/2016	Background	<0.93 U	<1.05 U	23	0.190337 J	<0.07 U	0.68835 J	1.29444 J	2.909	<0.083 U	<0.68 U	0.008	<0.005 U	<0.29 U	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	30	0.232192 J	<0.07 U	0.353544 J	1.66591 J	0.881	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	<1.05 U	27	0.149553 J	<0.07 U	0.529033 J	1.56632 J	0.257	< 1 U	<0.68 U	0.012	<0.005 U	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	28	0.152375 J	<0.07 U	0.32826 J	1.47282 J	0.767	<0.083 U	<0.68 U	0.013	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	<1.05 U	23	0.126621 J	<0.07 U	0.650158 J	1.09495 J	1.536	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	<1.05 U	26	0.149219 J	<0.07 U	0.325811 J	1.29984 J	0.416	<0.083 U	<0.68 U	0.009	<0.005 U	<0.29 U	<0.99 U	0.994913 J
4/11/2017	Background	<0.93 U	<1.05 U	24	0.159412 J	<0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	<0.68 U	0.008	0.01364 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	25.82	0.16 J	<0.07 U	1.05	1.49 J	0.784	<0.083 U	<0.68 U	0.00722	<0.005 U	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	<0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	<0.083 U	0.089	0.0143	<0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	<0.4 U	<0.6 U	22.5	<0.4 U	<0.2 U	<0.8 U	1.37	0.225	0.09	<0.4 U	0.00688	<0.005 U	<8 U	<0.6 U	<2 U
5/21/2019	Assessment	<0.4 U	<0.6 U	21.7	<0.4 U	<0.2 U	<0.8 U	1.15	0.201	0.09	<0.4 U	0.00576	<0.005 U	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.07 J	23.8	0.154	<0.01 U	0.204	1.3	0.237	0.06 J	0.08 J	0.00829	<0.005 U	<0.4 U	0.2 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-17
Pirkey - WBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.02	0.648	12	<0.083 U	4.3	68	4
7/14/2016	Background	0.03	1.28	34	<0.083 U	3.3	96	4
9/8/2016	Background	0.03	1.19	29	<0.083 U	3.9	88	6
10/13/2016	Background	0.03	1.34	32	0.393 J	3.6	96	6
11/15/2016	Background	0.03	1.3	30	0.3446 J	3.7	88	6
1/12/2017	Background	0.03	1.08	26	<0.083 U	4.4	90	6
3/1/2017	Background	0.04	0.57	19	<0.083 U	4.0	80	5
4/10/2017	Background	0.03	0.395	20	<0.083 U	4.2	88	9
8/24/2017	Detection	0.04495	1.06	25	0.245 J	4.6	98	6
12/21/2017	Detection	- -	- -	26	<0.083 U	- -	76	8
3/22/2018	Assessment	0.03113	0.0981	13	<0.083 U	4.4	44	5
8/21/2018	Assessment	0.044	0.997	35	<0.083 U	3.9	98	7
2/28/2019	Assessment	0.03 J	0.2 J	10.2	0.12	3.7	68	2.4
5/23/2019	Assessment	0.019	0.2 J	10.3	0.13	4.0	58	2.4
8/13/2019	Assessment	0.03 J	0.777	26.3	0.24	4.8	88	1.8

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-17
Pirkey - WBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	1.21333 J	143	0.507354 J	0.0868344 J	1	5	2.082	<0.083 U	<0.68 U	<0.00013 U	0.06	<0.29 U	2.55378 J	<0.86 U
7/14/2016	Background	<0.93 U	1.3096 J	334	0.85295 J	0.0833036 J	2	14	3.12	<0.083 U	<0.68 U	0.027	0.138	0.485824 J	<0.99 U	<0.86 U
9/8/2016	Background	<0.93 U	1.76675 J	327	0.948023 J	<0.07 U	5	14	4.473	<0.083 U	<0.68 U	0.028	0.142	<0.29 U	<0.99 U	1.0754 J
10/13/2016	Background	<0.93 U	<1.05 U	324	0.753919 J	<0.07 U	0.542006 J	14	6.64	0.393 J	<0.68 U	0.026	0.05	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	290	0.708598 J	<0.07 U	0.448238 J	13	7.94	0.3446 J	<0.68 U	0.026	0.078	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	234	0.541302 J	<0.07 U	0.723126 J	10	9.6	<0.083 U	<0.68 U	0.023	0.055	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	176	0.499114 J	<0.07 U	0.359001 J	8	2.31	<0.083 U	<0.68 U	0.019	0.084	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	140	0.511666 J	<0.07 U	0.689417 J	7	3.67	<0.083 U	<0.68 U	0.016	0.069	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	94.77	0.38 J	<0.07 U	1.21	4.57 J	1.669	<0.083 U	<0.68 U	0.01186	0.125	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	<0.01 U	0.41	223	0.588	0.04	0.367	10.9	2.505	<0.083 U	0.181	0.0234	0.216	<0.02 U	0.5	0.051
2/28/2019	Assessment	<0.4 U	<0.6 U	71.4	<0.4 U	<0.2 U	<0.8 U	2.93	0.772	0.12	<0.4 U	0.00912	0.107	<8 U	<0.6 U	<2 U
5/23/2019	Assessment	<0.4 U	<0.6 U	82.9	<0.4 U	<0.2 U	0.9 J	3.15	1.62	0.13	<0.4 U	0.00911	0.103	<8 U	<0.6 U	<0.1 U
8/13/2019	Assessment	<0.02 U	0.40	216	0.554	0.04 J	0.732	9.03	6.40	0.24	0.2 J	0.0193	0.447	<0.4 U	0.3	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-18
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.01	0.548	8	<0.083 U	4.5	108	7
7/14/2016	Background	0.01	0.409	8	<0.083 U	4.7	116	7
9/8/2016	Background	0.01	0.343	8	<0.083 U	4.7	110	8
10/13/2016	Background	0.02	0.56	7	<0.083 U	4.1	124	10
11/15/2016	Background	0.02	0.59	7	<0.083 U	4.4	134	7
1/12/2017	Background	0.01	0.415	7	<0.083 U	4.7	128	10
3/1/2017	Background	0.01	0.224	6	<0.083 U	4.1	108	7
4/10/2017	Background	0.01	0.304	7	<0.083 U	4.1	102	8
8/24/2017	Detection	0.0278	0.435	8	<0.083 U	4.9	68	8
3/22/2018	Assessment	0.01642	0.292	6	<0.083 U	5.4	100	6
8/21/2018	Assessment	0.012	0.321	10	<0.083 U	5.1	118	8
2/28/2019	Assessment	<0.02 U	0.490	8.19	0.02 J	5.0	84	6.1
5/23/2019	Assessment	0.013	0.684	8.82	0.02 J	5.2	104	10.6
8/13/2019	Assessment	<0.02 U	0.647	8.49	0.01 J	5.2	90	6.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-18
Pirkey - WBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	<0.93 U	<1.05 U	157	0.262755 J	0.109247 J	1	1.82932 J	0.847	<0.083 U	<0.68 U	0.004	0.01536 J	<0.29 U	1.71074 J	<0.86 U
7/14/2016	Background	<0.93 U	3.77261 J	139	0.243326 J	<0.07 U	3	2.16037 J	3.264	<0.083 U	<0.68 U	0.02	0.064	0.41347 J	2.45009 J	<0.86 U
9/8/2016	Background	<0.93 U	<1.05 U	115	0.226343 J	<0.07 U	0.779959 J	1.09947 J	1.105	<0.083 U	<0.68 U	0.019	0.03	<0.29 U	<0.99 U	<0.86 U
10/13/2016	Background	<0.93 U	<1.05 U	112	0.192611 J	<0.07 U	0.631027 J	2.24885 J	1.161	<0.083 U	<0.68 U	0.026	0.01416 J	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	94	0.107171 J	<0.07 U	0.724569 J	1.66054 J	1.486	<0.083 U	<0.68 U	0.017	0.029	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	99	0.169196 J	<0.07 U	0.411433 J	1.62881 J	0.976	<0.083 U	<0.68 U	0.026	0.01887 J	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	99	0.105337 J	<0.07 U	0.572874 J	0.976724 J	0.468	<0.083 U	<0.68 U	0.017	0.01086 J	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	105	0.130316 J	<0.07 U	0.967681 J	0.98157 J	0.648	<0.083 U	<0.68 U	0.019	0.0096 J	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	97.75	0.09 J	<0.07 U	<0.23 U	0.97 J	0.942	<0.083 U	<0.68 U	0.01647	0.006 J	<0.29 U	1.53 J	<0.86 U
8/21/2018	Assessment	0.02 J	1.01	99.8	0.129	0.02 J	0.809	1.18	1.108	<0.083 U	0.280	0.0175	0.014 J	0.08 J	0.2	0.060
2/28/2019	Assessment	<0.4 U	<0.6 U	106	<0.4 U	<0.2 U	<0.8 U	1.11	0.615	0.02 J	0.7 J	0.0177	0.009 J	<8 U	<0.6 U	<2 U
5/23/2019	Assessment	<0.4 U	<0.6 U	131	<0.4 U	<0.2 U	<0.8 U	1.47	0.492	0.02 J	<0.4 U	0.0209	0.009 J	<8 U	<0.6 U	<0.1 U
8/13/2019	Assessment	<0.02 U	0.45	100	0.118	0.02 J	0.212	1.25	0.473	0.01 J	0.2 J	0.0183	0.023 J	<0.4 U	0.09 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-28
Pirkey - WBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.277	2.16	6	0.9005 J	4.7	106	18
7/14/2016	Background	0.301	1.69	6	0.4478 J	5.1	96	17
9/7/2016	Background	0.332	1.25	6	0.3966 J	4.1	94	19
10/13/2016	Background	0.23	3.21	6	0.532 J	5.3	124	19
11/15/2016	Background	0.32	1.64	8	0.9199 J	4.2	112	16
1/12/2017	Background	0.285	1.22	7	0.7158 J	4.1	84	17
3/1/2017	Background	0.293	1.25	5	<0.083 U	3.4	96	18
4/10/2017	Background	0.293	1.2	7	0.6732 J	4.1	104	20
8/24/2017	Detection	0.281	1.22	6	0.557 J	5.1	96	18
12/21/2017	Detection	0.277	1.14	- -	- -	- -	- -	- -
3/22/2018	Assessment	0.254	1.4	5	0.6327 J	5.2	100	23
8/21/2018	Assessment	0.330	1.39	9	0.4982 J	5.0	96	22
2/27/2019	Assessment	0.458	1.65	6.29	0.81	5.0	32	19.6
5/22/2019	Assessment	0.313	1.24	4.48	0.69	4.6	100	20.1
8/12/2019	Assessment	0.366	1.72	6.04	0.65	4.7	128	22.5

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-28
Pirkey - WBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	1.58838 J	2.49885 J	223	0.968775 J	<0.07 U	1	18	1.212	0.9005 J	<0.68 U	0.004	0.146	<0.29 U	1.10335 J	<0.86 U
7/14/2016	Background	<0.93 U	1.52986 J	170	0.663081 J	<0.07 U	0.982579 J	15	2.29	0.4478 J	<0.68 U	0.034	0.162	<0.29 U	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	168	0.728735 J	<0.07 U	0.605543 J	14	1.44	0.3966 J	<0.68 U	0.03	0.069	<0.29 U	<0.99 U	1.24745 J
10/13/2016	Background	<0.93 U	6	152	0.42032 J	<0.07 U	6	18	2.547	0.532 J	<0.68 U	0.066	0.085	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	1.40867 J	148	0.520895 J	<0.07 U	0.638766 J	13	3.35	0.9199 J	<0.68 U	0.032	0.029	0.294156 J	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	154	0.475597 J	<0.07 U	<0.23 U	12	2.67	0.7158 J	<0.68 U	0.031	0.025	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	163	0.576508 J	<0.07 U	0.968975 J	14	2.082	<0.083 U	<0.68 U	0.031	0.025	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	162	0.654819 J	<0.07 U	0.324151 J	15	2.331	0.6732 J	<0.68 U	0.03	0.026	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	166	0.95 J	<0.07 U	<0.23 U	14.36	1.288	0.6327 J	<0.68 U	0.02561	0.046	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	0.03 J	0.64	143	0.598	0.05	0.688	14.4	2.028	0.4982 J	0.266	0.0307	0.028	0.05 J	0.3	0.03 J
2/27/2019	Assessment	<0.4 U	<0.6 U	154	0.9 J	<0.2 U	<0.8 U	14.3	2.318	0.81	<0.4 U	0.0266	0.061	<8 U	<0.6 U	<2 U
5/22/2019	Assessment	<0.4 U	<0.6 U	148	0.5 J	<0.2 U	<0.8 U	13.8	1.948	0.69	<0.4 U	0.0227	0.028	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	0.02 J	0.64	113	0.473	0.04 J	0.416	12.8	2.381	0.65	0.1 J	0.0380	0.092	<0.4 U	0.2 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-30
Pirkey - WBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.258	0.591	18	<0.083 U	4.7	112	14
7/14/2016	Background	0.384	0.499	22	<0.083 U	4.8	118	14
9/7/2016	Background	0.515	0.27	24	<0.083 U	4.4	110	15
10/13/2016	Background	0.625	0.373	24	<0.083 U	4.2	140	18
11/15/2016	Background	0.701	0.326	25	<0.083 U	4.3	132	19
1/12/2017	Background	0.697	0.286	26	<0.083 U	5.2	136	22
3/1/2017	Background	0.824	0.273	22	<0.083 U	4.8	136	25
4/11/2017	Background	0.837	0.242	24	<0.083 U	4.2	124	27
8/24/2017	Detection	1.39	0.294	25	<0.083 U	5.2	176	46
12/21/2017	Detection	1.27	0.363	26	<0.083 U	- -	152	48
3/22/2018	Assessment	0.937	0.345	17	<0.083 U	5.2	140	44
8/21/2018	Assessment	1.57	0.716	29	<0.083 U	4.8	188	66
2/28/2019	Assessment	0.491	0.3 J	14.6	<0.04 U	4.2	- -	31.5
4/3/2019	Assessment	- -	- -	- -	- -	- -	135	- -
5/23/2019	Assessment	0.520	1.74	18.8	0.04 J	4.9	112	29.2
8/12/2019	Assessment	1.25	0.302	28.1	0.03 J	4.9	160	39.8

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-30
Pirkey - WBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	1.71137 J	1.92931 J	54	0.155441 J	<0.07 U	3	2.21375 J	1.057	<0.083 U	<0.68 U	<0.00013 U	0.278	<0.29 U	<0.99 U	<0.86 U
7/14/2016	Background	<0.93 U	<1.05 U	54	0.126875 J	<0.07 U	0.994219 J	2.13856 J	4.701	<0.083 U	<0.68 U	0.01	0.649	1.14165 J	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	52	0.153878 J	<0.07 U	0.769517 J	1.83325 J	0.312	<0.083 U	<0.68 U	0.009	0.214	<0.29 U	<0.99 U	1.34697 J
10/13/2016	Background	<0.93 U	<1.05 U	56	0.0606961 J	<0.07 U	0.543859 J	2.26228 J	2.27	<0.083 U	<0.68 U	0.01	0.709	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	52	0.0603858 J	<0.07 U	<0.23 U	1.91681 J	4.07	<0.083 U	<0.68 U	0.009	0.584	<0.29 U	1.2068 J	0.959001 J
1/12/2017	Background	<0.93 U	<1.05 U	51	0.0580655 J	<0.07 U	0.504125 J	1.76108 J	0.355	<0.083 U	<0.68 U	0.009	1.588	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	0.997045 J	<1.05 U	55	0.0632093 J	<0.07 U	0.740184 J	1.69598 J	0.354	<0.083 U	<0.68 U	0.008	2.59	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	<1.05 U	55	0.0611 J	<0.07 U	0.535696 J	1.80383 J	1.861	<0.083 U	<0.68 U	0.008	1.207	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	56.42	0.09 J	<0.07 U	1.47	2.6 J	1.108	<0.083 U	<0.68 U	0.00837	0.104	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	<100 U	0.77	62.9	0.07 J	<0.05 U	1.22	2.93	0.987	<0.083 U	0.2 J	0.0118	1.123	<0.2 U	0.4 J	0.1 J
2/28/2019	Assessment	<0.4 U	<0.6 U	43.3	<0.4 U	<0.2 U	4 J	1.67	1.144	<0.04 U	<0.4 U	0.00707	0.461	<8 U	<0.6 U	<2 U
5/23/2019	Assessment	<0.4 U	0.6 J	59.2	<0.4 U	<0.2 U	1 J	3.26	1.089	0.04 J	<0.4 U	0.00841	0.165	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.21	58.0	0.07 J	<0.01 U	0.374	2.10	1.217	0.03 J	0.06 J	0.00804	0.345	<0.4 U	0.2 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
WEST BOTTOM ASH POND
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

July 10, 2019

CHA8473

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
WBAP	West Bottom Ash Pond

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the West Bottom Ash Pond (WBAP), an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, chloride, and sulfate at the WBAP. An alternative source was not identified at the time, so two assessment monitoring events were conducted at the WBAP in 2018, in accordance with 40 CFR 257.95. An SSL for cobalt was identified at well AD-28. An ASD was successfully completed (Geosyntec, 2019); thus, the unit remained in assessment monitoring.

A semi-annual assessment monitoring event was completed in February 2019, with the results of the February 2019 event documented in this report. Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The February 2019 monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. An SSL was identified for cobalt. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, one set of samples was collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(d)(1). Although antimony, arsenic, cadmium, lead, molybdenum, and thallium were not detected during the March 2018 screening event, samples from the February 2019 semi-annual sampling event were analyzed for all Appendix III and Appendix IV parameters. A summary of data collected during this assessment monitoring event may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.14 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the WBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained to meet the requirements of 40 CFR 257.95(d)(1) were screened for potential outliers. Thallium was not detected at any wells and was replaced with the reporting limit of 0.01 mg/L. Because this was higher than previous reporting limits, these values were flagged as outliers. However, the removal of these values as outliers did not affect the statistical evaluation of this event, as thallium was not detected during the March 2018 screening event.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine

background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for cobalt, mercury, and selenium due to apparent non-normal distributions and for antimony, arsenic, cadmium, fluoride, lead, molybdenum, and selenium due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey WBAP:

- The LCL for cobalt exceeded the GWPS of 0.009 mg/L at AD-28 (0.0132 mg/L).

As a result, the Pirkey WBAP will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring

2.2.3 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations. Prediction limits were calculated for the Appendix III parameters to represent background values. As described in the January 2018 *Statistical Analysis Summary* report (Geosyntec, 2018), intrawell tests were used to evaluate potential SSIs for calcium, pH, sulfate and TDS, whereas interwell tests were used to evaluate potential SSIs for boron, chloride and fluoride.

Prediction limits for the interwell tests were recalculated using data collected during the February 2019 assessment monitoring event. Three data points (i.e., one sample from three background wells) were added to the background dataset for each interwell test. New data were tested for outliers prior to being added to the background dataset. The updated prediction limits were calculated for a one-of-two retesting procedure, as during detection monitoring. The values of the updated prediction limits were similar to the values of the prediction limits calculated during detection monitoring. The revised interwell prediction limits were used to evaluate potential SSIs for boron, chloride, and fluoride.

For the intrawell tests, limited data made it possible to add only one data point (i.e., one sample from each compliance well) to each background dataset. Because one sample result is insufficient to compare against the existing background dataset, the prediction limits were not updated for the intrawell tests at this time. The intrawell prediction limits calculated during detection monitoring were used to evaluate potential SSIs for calcium, pH, sulfate, and TDS.

Data collected during the February 2019 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0700 mg/L at AD-28 (0.330 mg/L) and AD-30 (1.57 mg/L).
- The calcium concentration exceeded the intrawell UPL of 0.664 mg/L at AD-30 (0.716 mg/L).
- Chloride exceeded the interwell background value of 9.61 mg/L at AD-17 (35.0 mg/L) and AD-30 (29.0 mg/L).
- The sulfate concentration exceeded the intrawell background value of 155 mg/L at AD-30 (188 mg/L)
- TDS concentrations exceeded the intrawell UPL of 21.2 mg/L at AD-28 (22.0 mg/L) and the intrawell UPL of 31.6 mg/L at AD-30 (66.0 mg/L).

While the prediction limits were calculated assuming a 1-of-2 testing procedure, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the UPL based on previous results. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey WBAP during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the February 2019 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. An SSL was identified for cobalt. Appendix III parameters were also evaluated, with exceedances identified for boron, calcium, chloride, sulfate, and TDS.

Based on this evaluation, the Pirkey WBAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – Pirkey Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – West Bottom Ash Pond, H.W. Pirkey Power Plant, Hallsville, Texas. January 3, 2018.

Geosyntec. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant - West Bottom Ash Pond. March.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - West Bottom Ash Pond

Geosyntec Consultants

Parameter	Unit	AD-3	AD-12	AD-17	AD-18	AD-28	AD-30	
		2/27/2019	2/27/2019	2/28/2019	2/28/2019	2/27/2019	2/28/2019	4/3/2019
Antimony	µg/L	0.0400 J	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	-
Arsenic	µg/L	0.130	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	-
Barium	µg/L	54.2	22.5	71.4	106	154	43.3	-
Beryllium	µg/L	2.00 U	2.00 U	2.00 U	2.00 U	0.900 J	2.00 U	-
Boron	mg/L	0.0340	0.0300 J	0.0300 J	0.100 U	0.458	0.491	-
Cadmium	µg/L	0.0300 J	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	-
Calcium	mg/L	3.46	0.400 J	0.200 J	0.490	1.65	0.300 J	-
Chloride	mg/L	6.16	6.08	10.2	8.19	6.29	14.6	-
Chromium	µg/L	0.0400 J	4.00 U	4.00 U	4.00 U	4.00 U	4.00 J	-
Cobalt	µg/L	2.31	1.37	2.93	1.11	14.3	1.67	-
Combined Radium	pCi/L	0.314	0.225	0.772	0.615	2.32	1.14	-
Fluoride	mg/L	0.0400 J	0.0900	0.120	0.0200 J	0.810	0.200 U	-
Lead	µg/L	0.0500 J	2.00 U	2.00 U	0.700 J	2.00 U	2.00 U	-
Lithium	mg/L	0.0525	0.00688	0.00912	0.0177	0.0266	0.00707	-
Mercury	mg/L	0.0000250 U	0.0000250 U	0.000107	0.00000900 J	0.0000610	0.000461	-
Molybdenum	µg/L	2.00 U	40.0 U	40.0 U	40.0 U	40.0 U	40.0 U	-
Selenium	µg/L	0.0500 J	4.00 U	4.00 U	4.00 U	4.00 U	4.00 U	-
Total Dissolved Solids	mg/L	50.0	36.0	68.0	84.0	32.0	-	135
Sulfate	mg/L	21.8	3.60	2.40	6.10	19.6	31.5	-
Thallium	µg/L	0.500 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	-
pH	SU	5.31	5.17	3.70	5.02	4.99	4.20	-

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.
J: Estimated value. Parameter was detected in concentrations below the reporting limit.
-: Not sampled

Table 2: Groundwater Protection Standards
Pirkey Plant - West Bottom Ash Pond

Geosyntec Consultants, Inc.

Constituent Name	MCL	CCR Rule-Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.002
Arsenic, Total (mg/L)	0.01		0.0042
Barium, Total (mg/L)	2		0.16
Beryllium, Total (mg/L)	0.004		0.0012
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.0029
Cobalt, Total (mg/L)	n/a	0.006	0.009
Combined Radium, Total (pCi/L)	5		3.57
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.002
Lithium, Total (mg/L)	n/a	0.04	0.14
Mercury, Total (mg/L)	0.002		0.000064
Molybdenum, Total (mg/L)	n/a	0.1	0.04
Selenium, Total (mg/L)	0.05		0.004
Thallium, Total (mg/L)	0.002		0.002

Notes:
Grey cell indicates calculated UTL is higher than MCL.
MCL = Maximum Contaminant Level
RSL = Regional Screening Level
Calculated UTL (Upper Tolerance Limit) represents site-specific background values.
The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3: Appendix III Data Summary
Pirkey - West Bottom Ash Pond

Geosyntec Consultants, Inc.

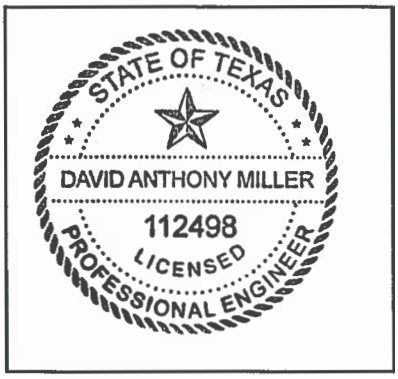
Parameter	Units	Description	AD-17	AD-28	AD-30
			8/21/2018	8/21/2018	8/21/2018
Boron	mg/L	Interwell Background Value (UPL)	0.0700		
		Detection Monitoring Data	0.0440	**0.330**	**1.57**
Calcium	mg/L	Intrawell Background Value (UPL)	1.90	3.41	0.664
		Detection Monitoring Data	0.997	1.39	**0.716**
Chloride	mg/L	Interwell Background Value (UPL)	9.61		
		Detection Monitoring Data	**35.0**	9.00	**29.0**
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
		Detection Monitoring Data	0.0830	0.498	0.0830
pH	SU	Intrawell Background Value (UPL)	4.8	5.9	5.4
		Intrawell Background Value (LPL)	3.0	2.8	3.7
		Detection Monitoring Data	3.9	5.0	4.8
TDS	mg/L	Intrawell Background Value (UPL)	109	132	155
		Detection Monitoring Data	98.0	96.0	**188**
Sulfate	mg/L	Intrawell Background Value (UPL)	9.64	21.2	31.6
		Detection Monitoring Data	7.00	**22.0**	**66.0**

Notes
UPL: Upper prediction limit
LPL: Lower prediction limit
TDS: Total dissolved solids
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A
Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.



DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

112498	TEXAS	07.10.19
License Number	Licensing State	Date

ATTACHMENT B
Statistical Analysis Output

GROUNDWATER STATS CONSULTING

July 10, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey WBAP
Assessment Monitoring Event – February 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis of groundwater data for the February 2019 sample event for American Electric Power Inc.'s Pirkey West Bottom Ash Pond. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-3, AD-12, and AD-18; and
- **Downgradient wells:** AD-17, AD-28, and AD-30.

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS;

- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Values previously flagged during the screening as outliers may be seen in a lighter font and disconnected symbol on the time series graphs, and a summary of those values follows this letter (Figure B).

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, chloride and fluoride; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for calcium, pH, sulfate and TDS for the February 2019 data (Figures C & D, respectively). The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data are screened for any newly suspected outliers or obvious trending patterns using time series plots. All values flagged as outliers may be seen on the Outlier Summary report following this letter. No obvious trending patterns were observed in the upgradient wells.

Intrawell prediction limits utilize the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the background data set will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

Note that the reporting limit for fluoride for the February 2019 event at well AD-30 was <0.2 mg/L whereas all historical reporting limits for all wells is <1.0 mg/L. Therefore, <1.0 mg/L was substituted for all nondetects which is less than the Groundwater Protection Standard of 4 mg/L. Additionally, in the case of TDS at well AD-30, the April 2019 sample was compared against background.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant

increase (SSI) is identified, and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. Prediction limit exceedances were noted for boron at wells AD-28 and AD-30, and chloride at wells AD-17 and AD-30. The results of those findings may be found in the Prediction Limit Summary tables following this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable (Figure E). Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site. Such patterns are an indication of natural variability in groundwater unrelated to practices at the site.

No statistically significant increasing or decreasing trends were found for any of the downgradient well/parameter pairs with prediction limit exceedances, except for a statistically significant increasing trend for boron in well AD-30.

Evaluation of Appendix IV Parameters

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure F). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure G).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of the MCL, CCR-Rule specified level or ACL as discussed above (Figure H). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. Note that the reporting limit for thallium for this event was <0.01 mg/L which is higher than the historical reporting limit of <0.002 mg/L and higher than the GWPS. Since the <0.01 mg/L

values do not provide any useful information regarding whether the observations exceed the GWPS, they are flagged as outliers.

No confidence interval exceedances were found except for cobalt in well AD-28. A summary of the confidence interval results follows this letter.

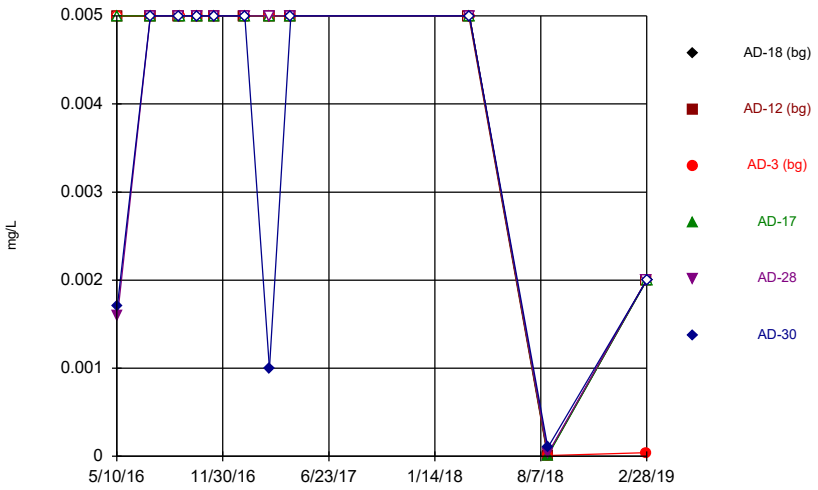
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey West Bottom Ash Pond. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

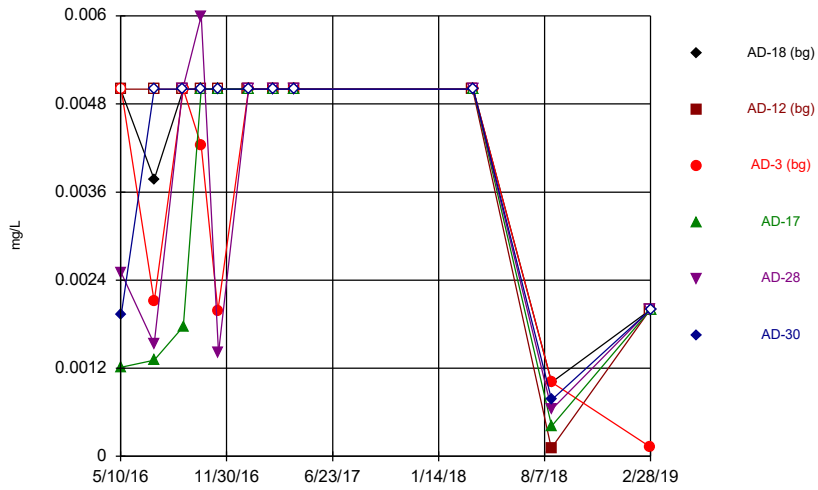
Time Series



Constituent: Antimony, total Analysis Run 7/9/2019 1:50 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

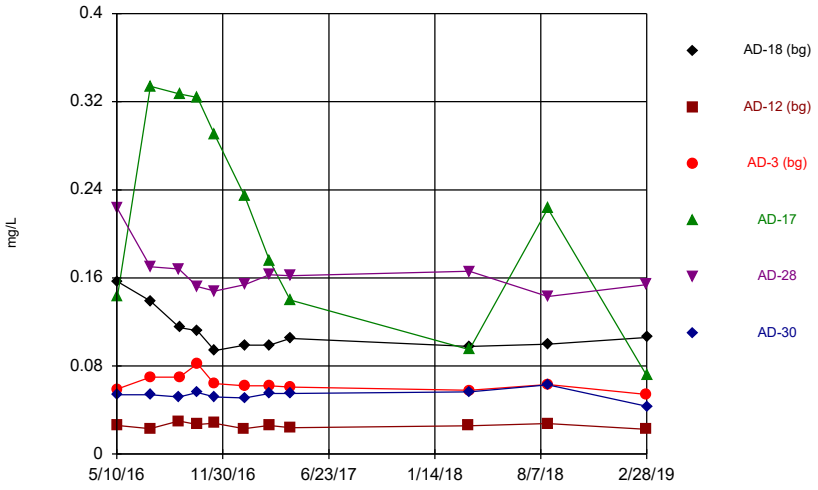
Time Series



Constituent: Arsenic, total Analysis Run 7/9/2019 1:50 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

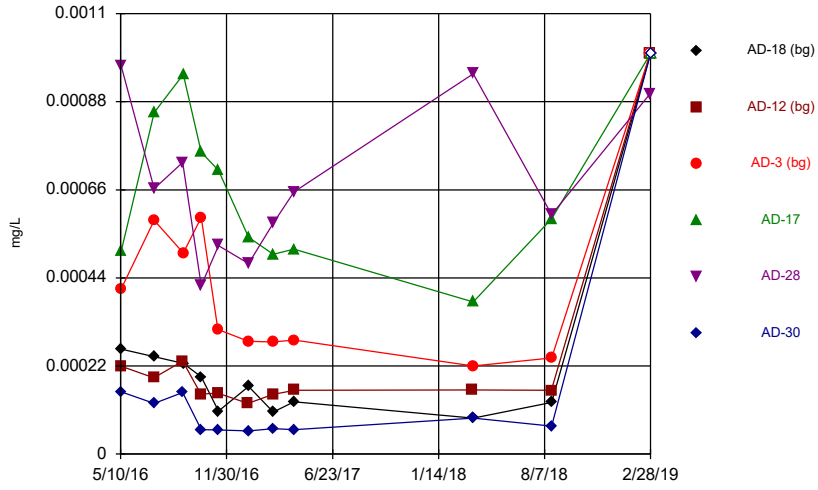
Time Series



Constituent: Barium, total Analysis Run 7/9/2019 1:50 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

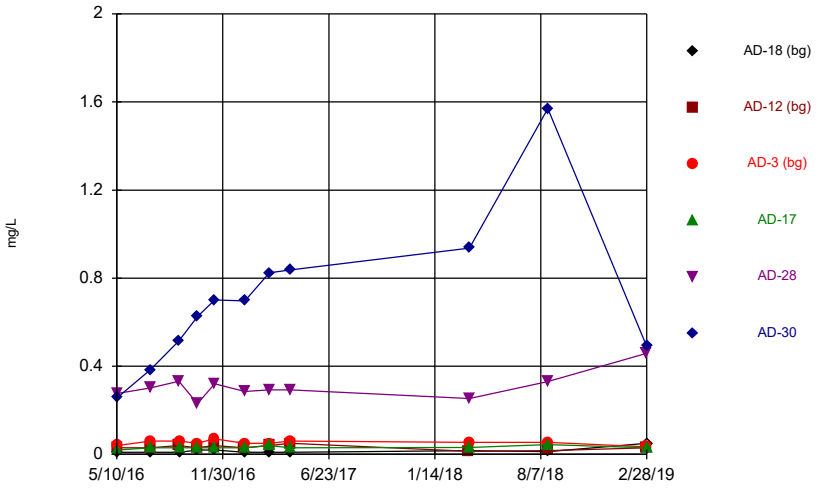
Time Series



Constituent: Beryllium, total Analysis Run 7/9/2019 1:50 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

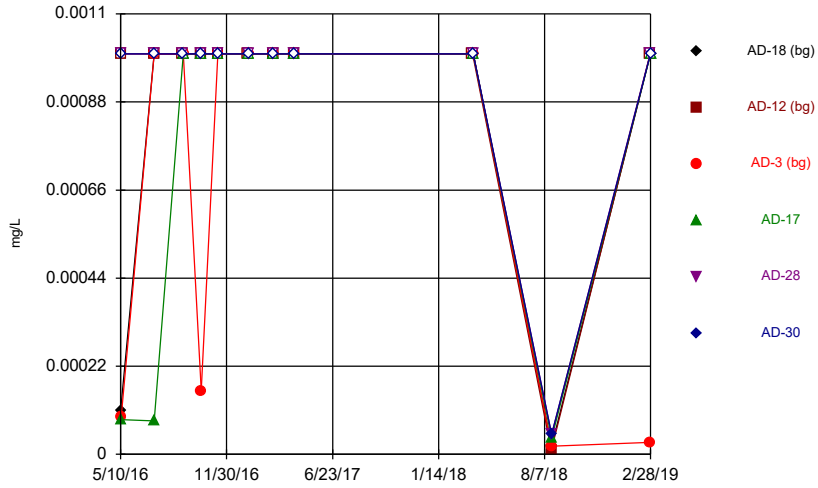
Time Series



Constituent: Boron, total Analysis Run 7/9/2019 1:50 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

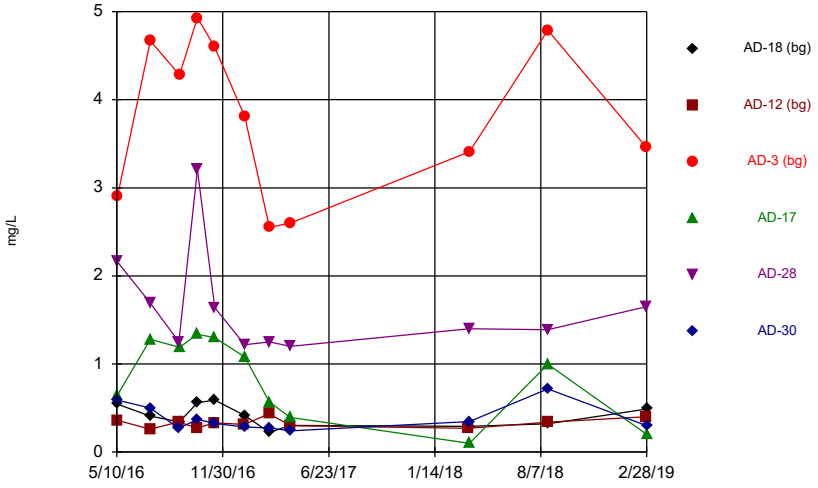
Time Series



Constituent: Cadmium, total Analysis Run 7/9/2019 1:50 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

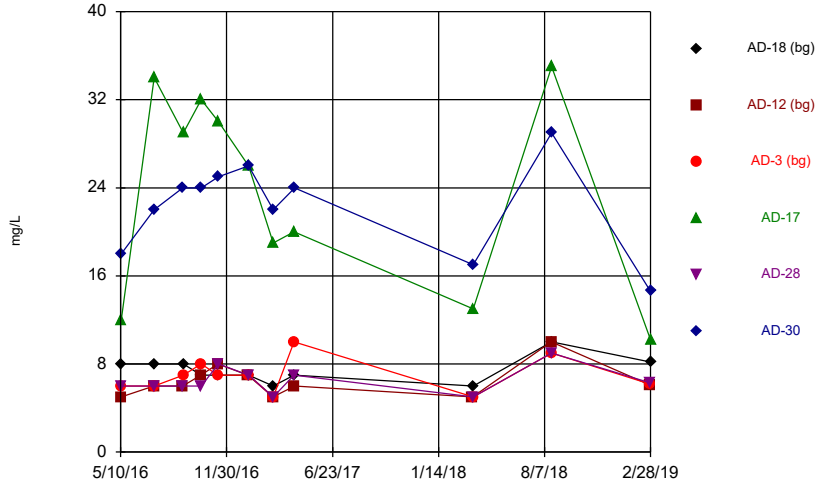
Time Series



Constituent: Calcium, total Analysis Run 7/9/2019 1:50 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

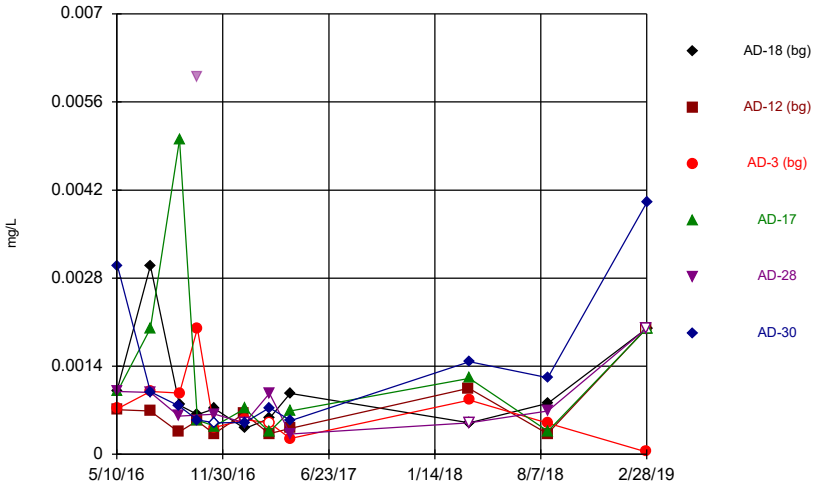
Time Series



Constituent: Chloride, total Analysis Run 7/9/2019 1:50 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

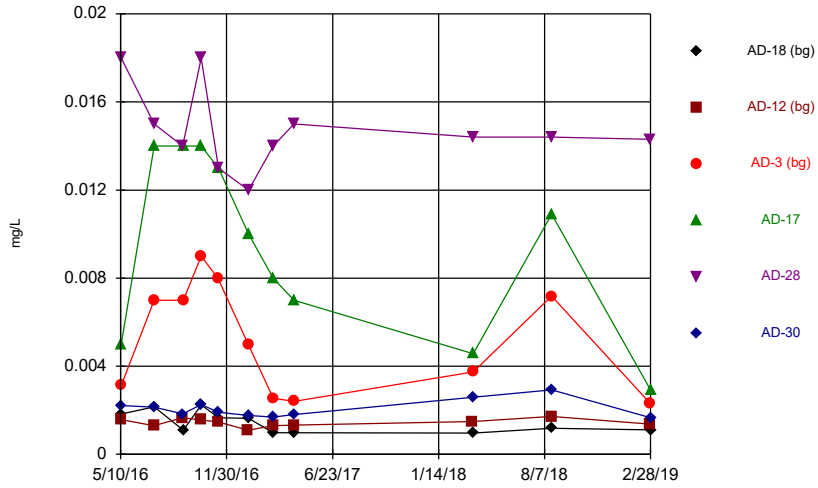
Time Series



Constituent: Chromium, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

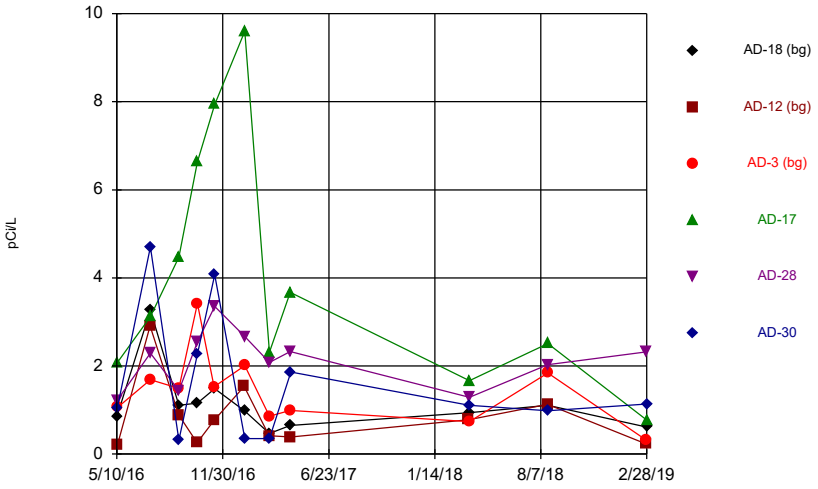
Time Series



Constituent: Cobalt, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

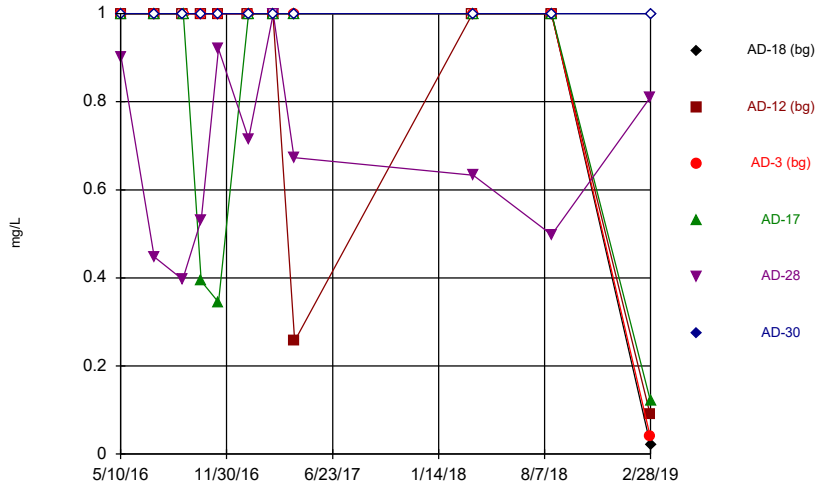
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

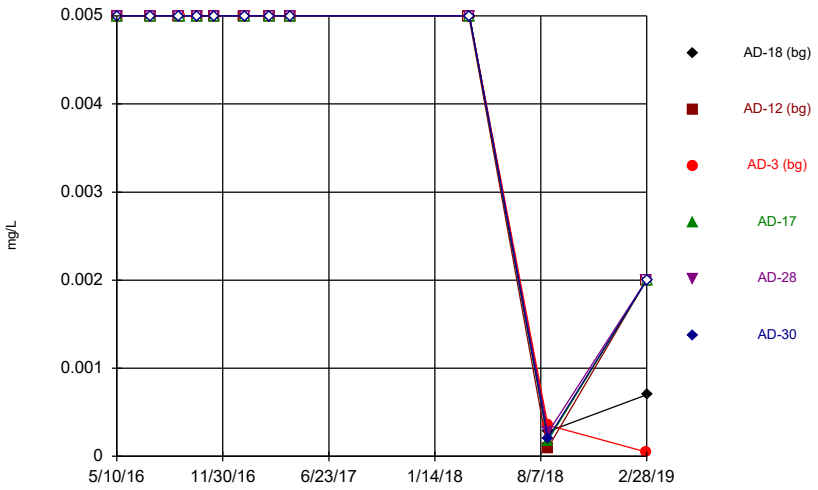
Time Series



Constituent: Fluoride, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

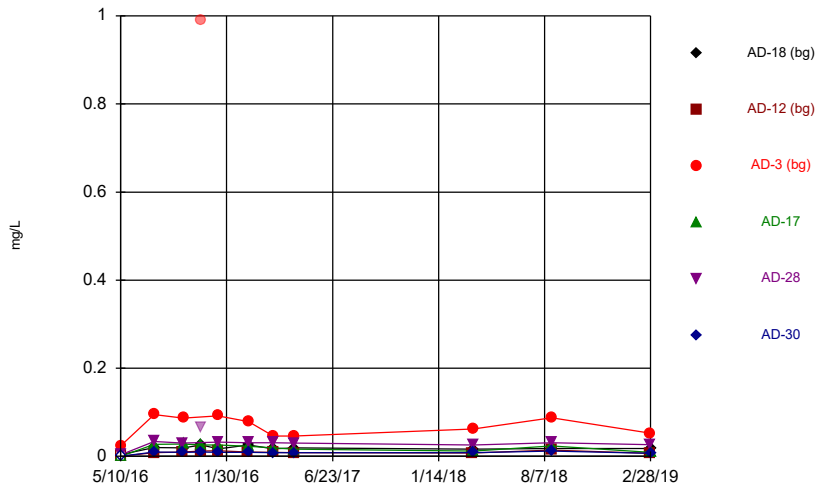
Time Series



Constituent: Lead, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

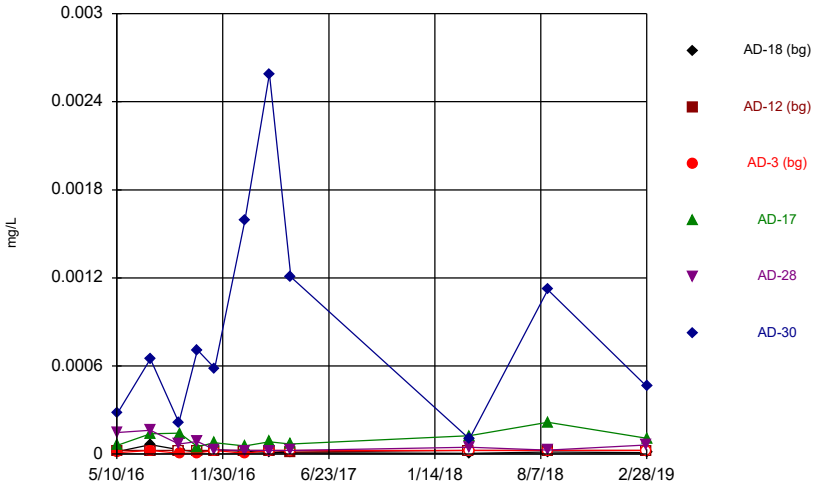
Time Series



Constituent: Lithium, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

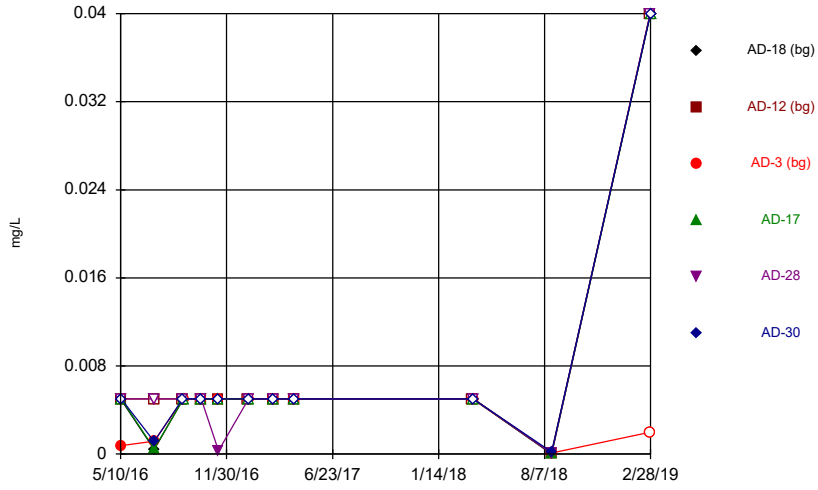
Time Series



Constituent: Mercury, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

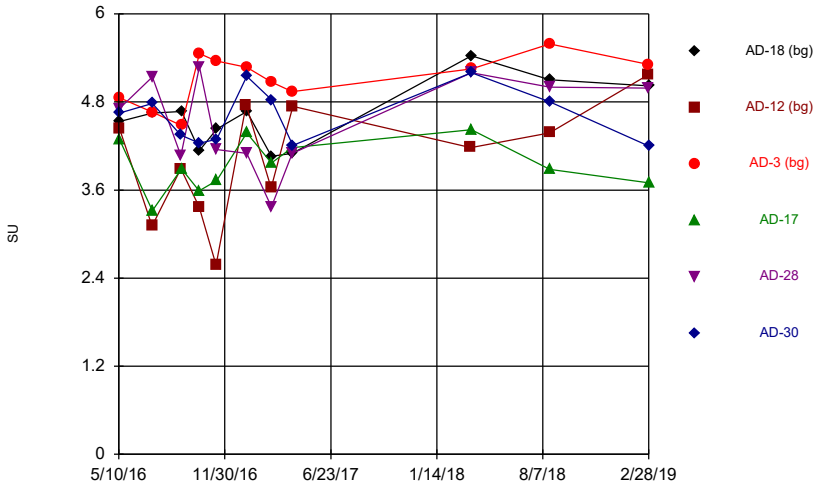
Time Series



Constituent: Molybdenum, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

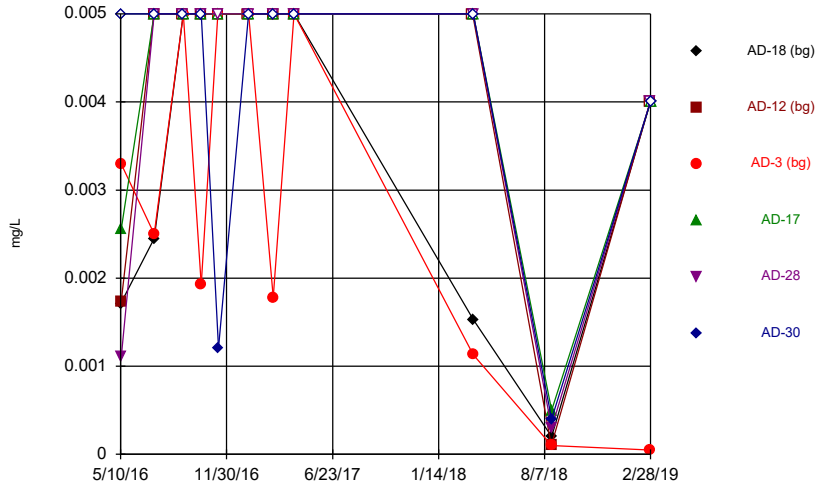
Time Series



Constituent: pH, field Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

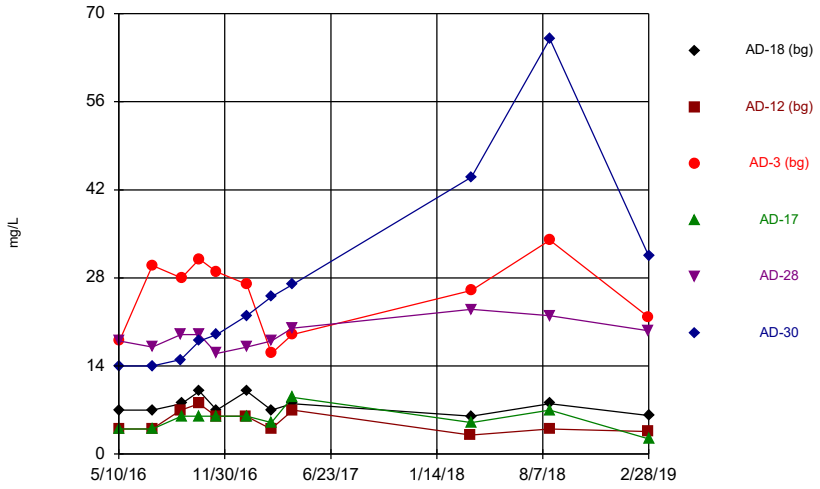
Time Series



Constituent: Selenium, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

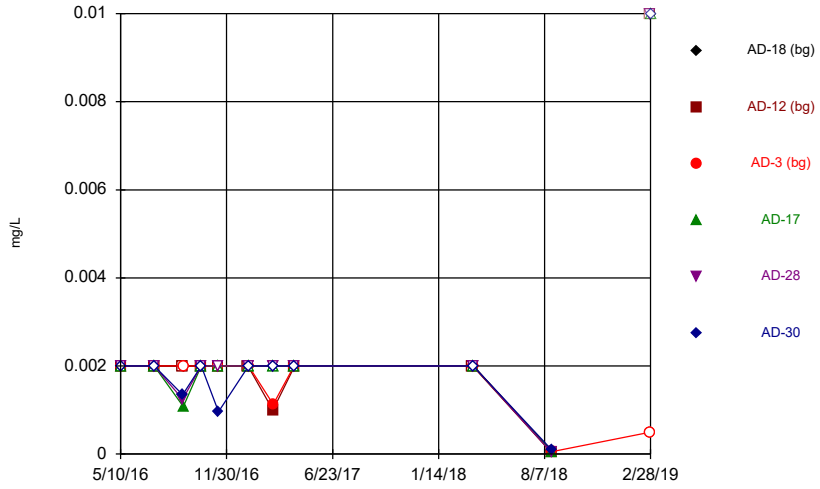
Time Series



Constituent: Sulfate, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

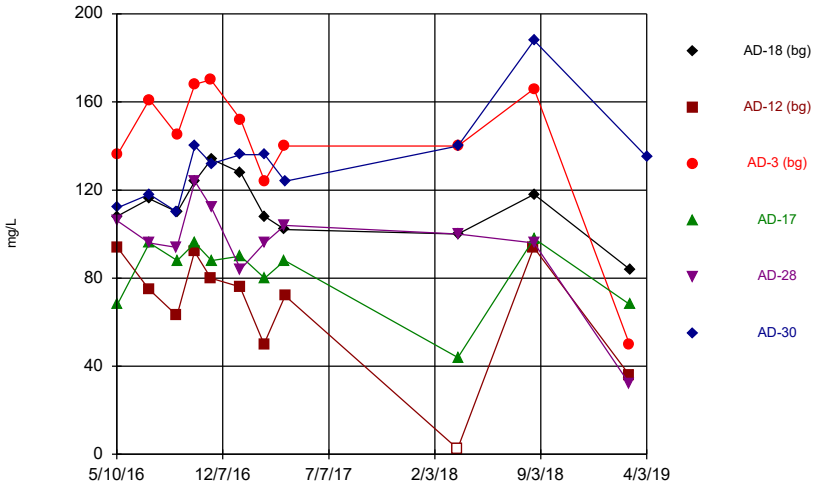
Time Series



Constituent: Thallium, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Total Dissolved Solids [TDS] Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Outlier Summary

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/9/2019, 2:03 PM

	AD-28 Chromium, total (mg/L)	AD-3 Lithium, total (mg/L)	AD-28 Lithium, total (mg/L)	AD-18 Thallium, total (mg/L)	AD-12 Thallium, total (mg/L)	AD-17 Thallium, total (mg/L)	AD-28 Thallium, total (mg/L)	AD-30 Thallium, total (mg/L)
10/13/2016	0.006 (o)	0.991 (o)	0.066 (o)					
2/27/2019					<0.01 (o)		<0.01 (o)	
2/28/2019				<0.01 (o)		<0.01 (o)		<0.01 (o)

Interwell Prediction Limit Summary - Significant Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/7/2019, 8:01 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-28**	**0.0668**	**n/a**	**2/27/2019**	**0.458**	**Yes**	**33**	**0.03374**	**0.01858**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-30**	**0.0668**	**n/a**	**2/28/2019**	**0.491**	**Yes**	**33**	**0.03374**	**0.01858**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-17**	**9.608**	**n/a**	**2/28/2019**	**10.2**	**Yes**	**33**	**2.624**	**0.2676**	**0**	**None**	**sqrt(x)**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-30**	**9.608**	**n/a**	**2/28/2019**	**14.6**	**Yes**	**33**	**2.624**	**0.2676**	**0**	**None**	**sqrt(x)**	**0.002505**	**Param Inter 1 of 2**

Interwell Prediction Limit Summary - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/7/2019, 8:01 PM

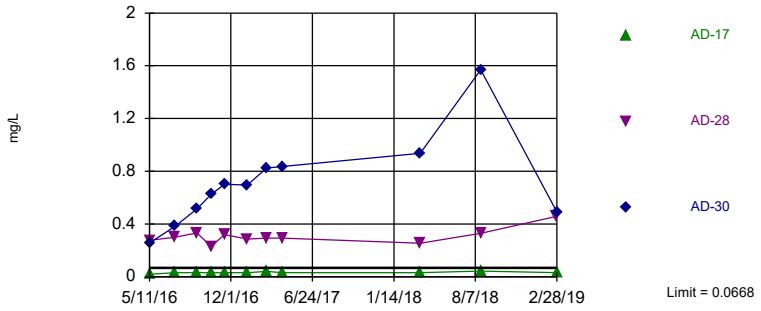
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-17	0.0668	n/a	2/28/2019	0.03	No	33	0.03374	0.01858	3.03	None	No	0.002505	Param Inter 1 of 2
Boron, total (mg/L)	**AD-28**	**0.0668**	**n/a**	**2/27/2019**	**0.458**	**Yes**	**33**	**0.03374**	**0.01858**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-30**	**0.0668**	**n/a**	**2/28/2019**	**0.491**	**Yes**	**33**	**0.03374**	**0.01858**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-17**	**9.608**	**n/a**	**2/28/2019**	**10.2**	**Yes**	**33**	**2.624**	**0.2676**	**0**	**None**	**sqrt(x)**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	AD-28	9.608	n/a	2/27/2019	6.29	No	33	2.624	0.2676	0	None	sqrt(x)	0.002505	Param Inter 1 of 2
Chloride, total (mg/L)	**AD-30**	**9.608**	**n/a**	**2/28/2019**	**14.6**	**Yes**	**33**	**2.624**	**0.2676**	**0**	**None**	**sqrt(x)**	**0.002505**	**Param Inter 1 of 2**
Fluoride, total (mg/L)	AD-17	1	n/a	2/28/2019	0.12	No	33	n/a	n/a	87.88	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-28	1	n/a	2/27/2019	0.81	No	33	n/a	n/a	87.88	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-30	1	n/a	2/28/2019	1ND	No	33	n/a	n/a	87.88	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-28, AD-30

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=0.03374, Std. Dev.=0.01858, n=33, 3.03% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9114, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

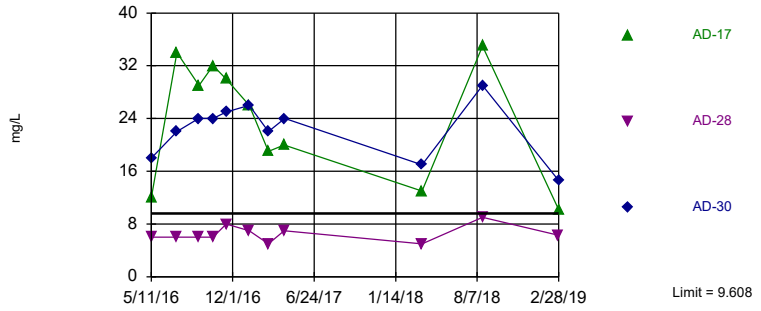
Constituent: Boron, total Analysis Run 7/7/2019 8:00 PM View: PLs - Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-17, AD-30

Prediction Limit

Interwell Parametric



Background Data Summary (based on square root transformation): Mean=2.624, Std. Dev.=0.2676, n=33. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9176, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

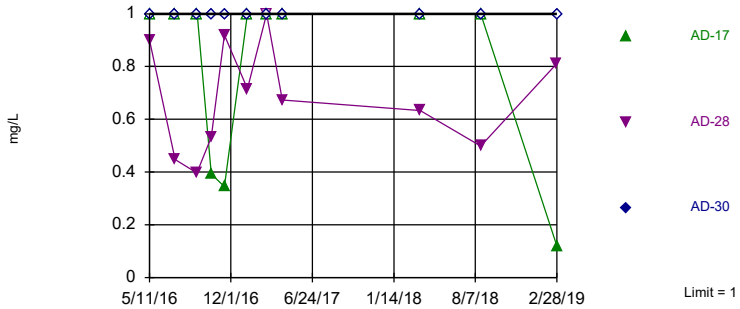
Constituent: Chloride, total Analysis Run 7/7/2019 8:00 PM View: PLs - Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 33 background values. 87.88% NDs. Annual per-constituent alpha = 0.009997. Individual comparison alpha = 0.001673 (1 of 2). Comparing 3 points to limit.

Constituent: Fluoride, total Analysis Run 7/7/2019 8:00 PM View: PLs - Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Intrawell Prediction Limit Summary - All Results (No Significant)

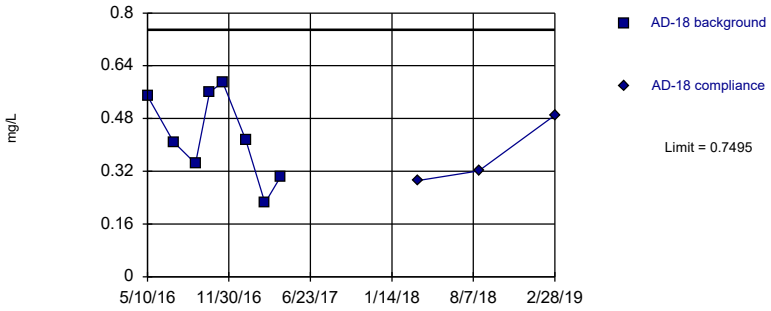
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/7/2019, 8:07 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-18	0.7495	n/a	2/28/2019	0.49	No	8	0.4241	0.1324	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-12	0.4631	n/a	2/27/2019	0.4	No	8	0.3269	0.05542	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-3	6.204	n/a	2/27/2019	3.46	No	8	3.794	0.9807	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-17	1.903	n/a	2/28/2019	0.2	No	8	0.9754	0.3773	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-28	3.411	n/a	2/27/2019	1.65	No	8	1.703	0.695	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-30	0.6643	n/a	2/28/2019	0.3	No	8	0.3575	0.1248	0	None	No	0.002505	Param Intra 1 of 2
pH, field (SU)	AD-18	5.063	3.75	2/28/2019	5.02	No	8	4.406	0.267	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-12	5.764	1.866	2/27/2019	5.17	No	8	3.815	0.7928	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-3	5.857	4.168	2/27/2019	5.31	No	8	5.013	0.3437	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-17	4.812	3.025	2/28/2019	3.7	No	8	3.919	0.3634	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-28	5.925	2.805	2/27/2019	4.99	No	8	4.365	0.6348	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-30	5.403	3.722	2/28/2019	4.2	No	8	4.563	0.3421	0	None	No	0.001253	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-18	11.39	n/a	2/28/2019	6.1	No	8	2.821	0.2255	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-12	9.636	n/a	2/27/2019	3.6	No	8	5.75	1.581	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-3	39.6	n/a	2/27/2019	21.8	No	8	24.75	6.042	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-17	9.636	n/a	2/28/2019	2.4	No	8	5.75	1.581	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-28	21.22	n/a	2/27/2019	19.6	No	8	18	1.309	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-30	31.56	n/a	2/28/2019	31.5	No	8	19.25	5.007	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-18	144	n/a	2/28/2019	84	No	8	116.3	11.29	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	110.7	n/a	2/27/2019	36	No	8	75.25	14.41	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-3	189.4	n/a	2/27/2019	50	No	8	149.5	16.23	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-17	109.2	n/a	2/28/2019	68	No	8	86.75	9.13	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-28	132.3	n/a	2/27/2019	32	No	8	102	12.33	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-30	154.7	n/a	4/3/2019	135	No	8	126	11.66	0	None	No	0.002505	Param Intra 1 of 2

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.4241, Std. Dev.=0.1324, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9343, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

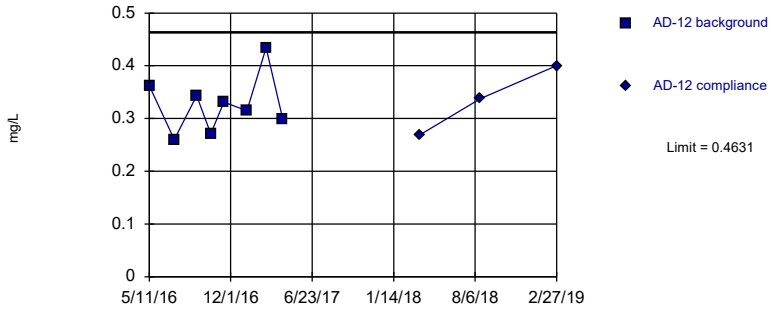
Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.3269, Std. Dev.=0.05542, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9467, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

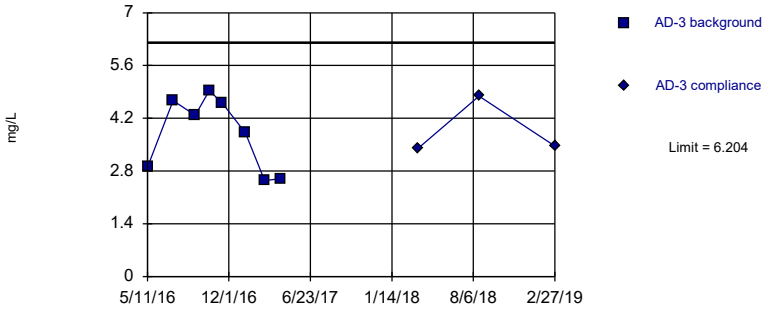
Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.794, Std. Dev.=0.9807, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8697, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

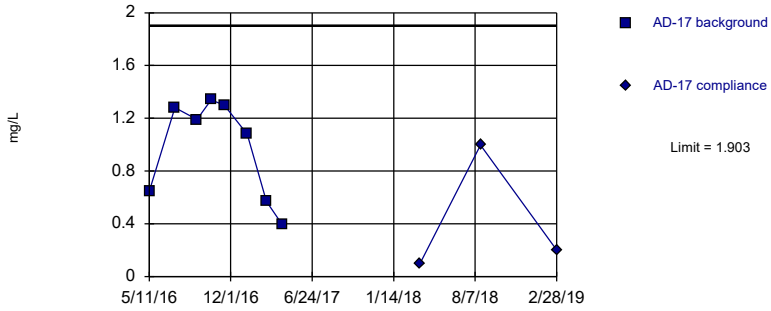
Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.9754, Std. Dev.=0.3773, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8479, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

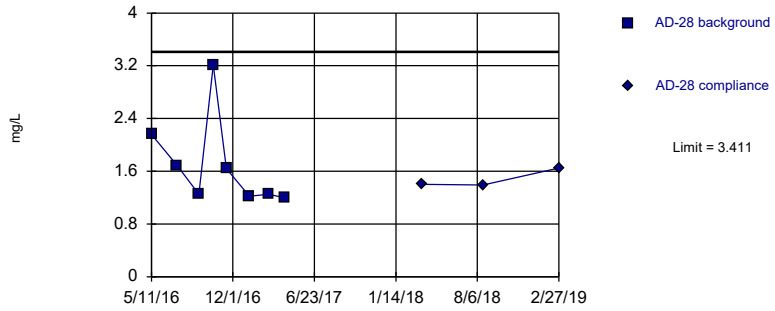
Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1.703, Std. Dev.=0.695, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.769, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

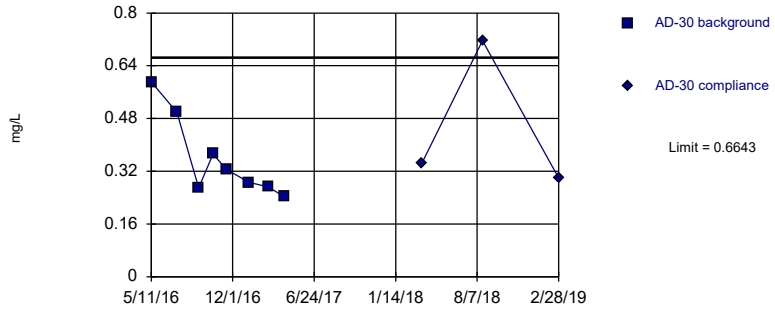
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.3575, Std. Dev.=0.1248, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.844, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

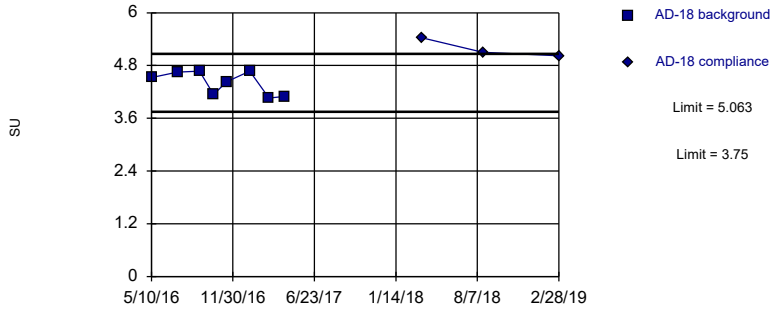
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.406, Std. Dev.=0.267, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8312, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

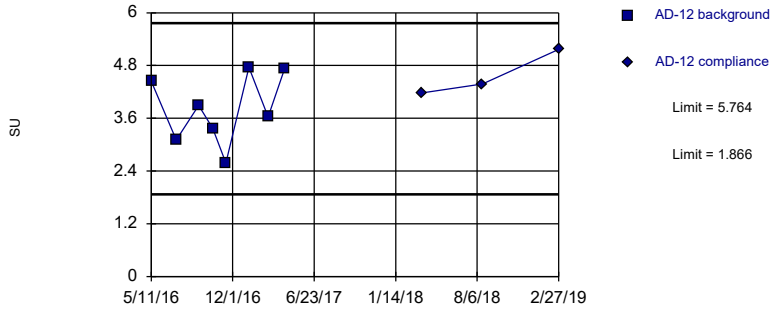
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.815, Std. Dev.=0.7928, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

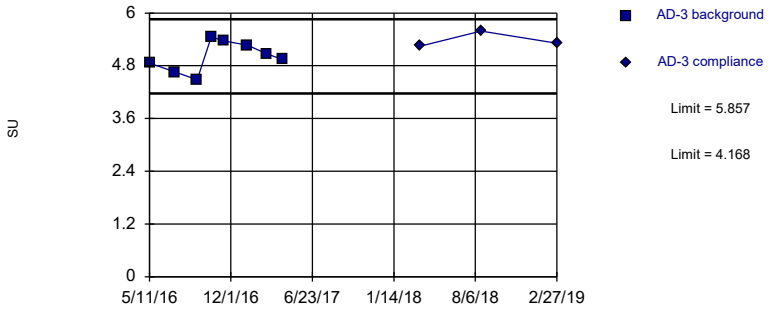
Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.013, Std. Dev.=0.3437, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.965, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

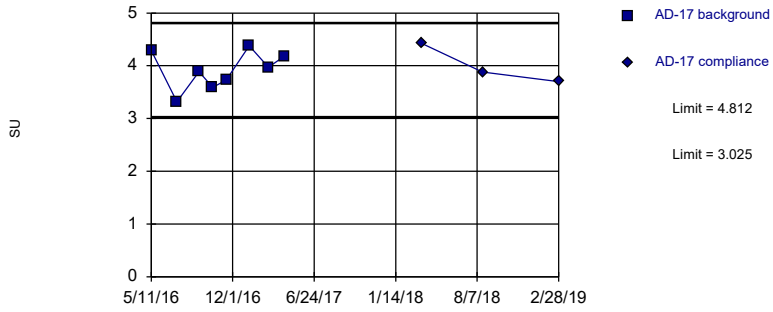
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.919, Std. Dev.=0.3634, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9678, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

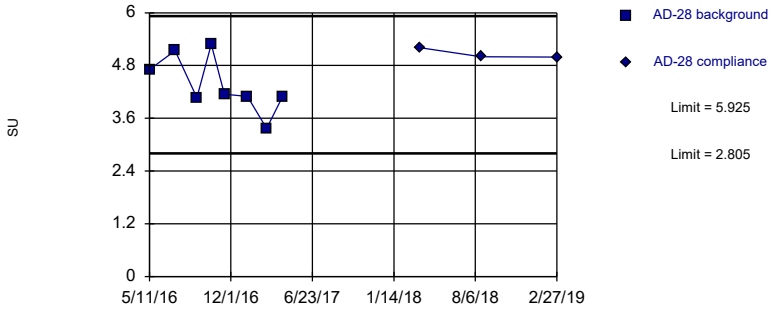
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.365, Std. Dev.=0.6348, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9117, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

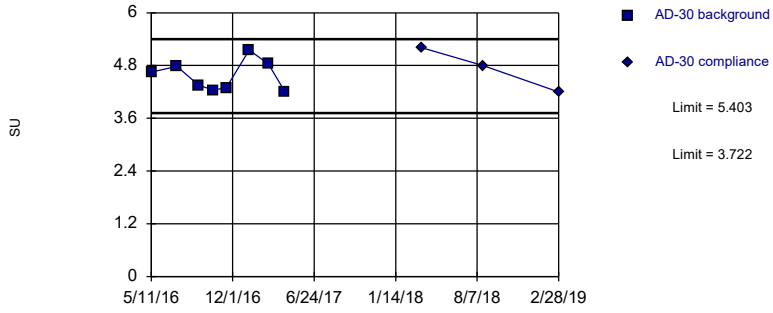
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.563, Std. Dev.=0.3421, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8981, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

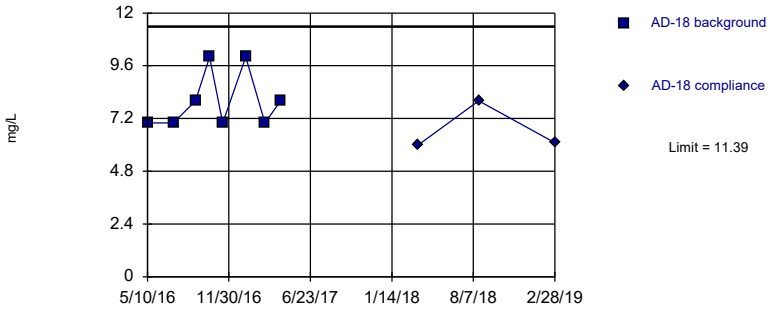
Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square root transformation): Mean=2.821, Std. Dev.=0.2255, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7543, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

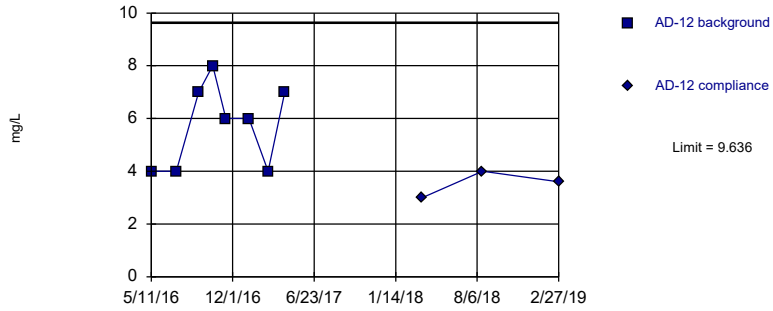
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.75, Std. Dev.=1.581, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.866, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

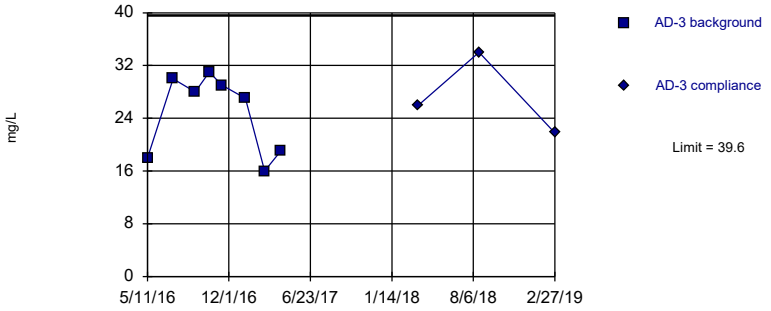
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=24.75, Std. Dev.=6.042, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8428, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

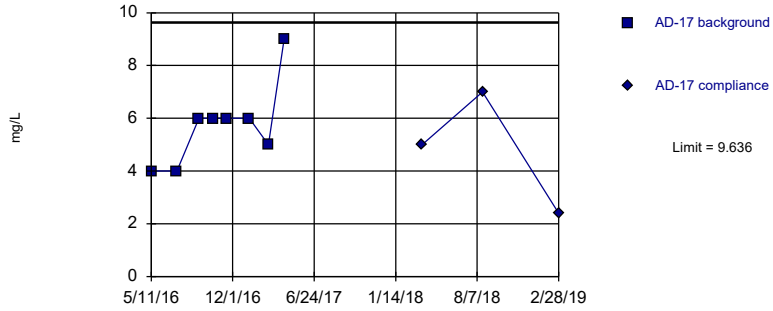
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.75, Std. Dev.=1.581, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8396, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

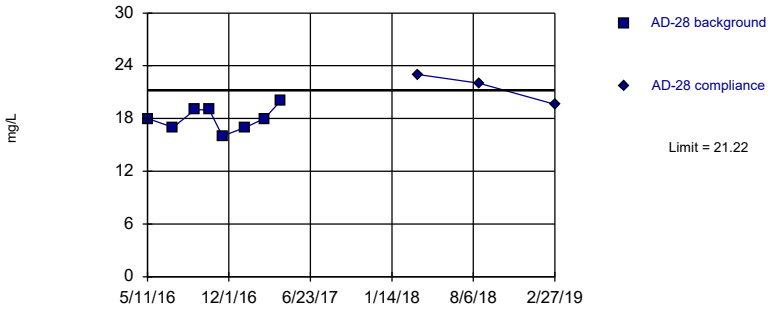
Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=18, Std. Dev.=1.309, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9646, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

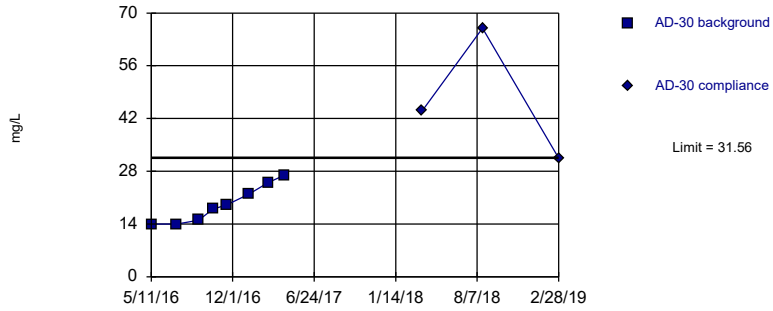
Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=19.25, Std. Dev.=5.007, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9081, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

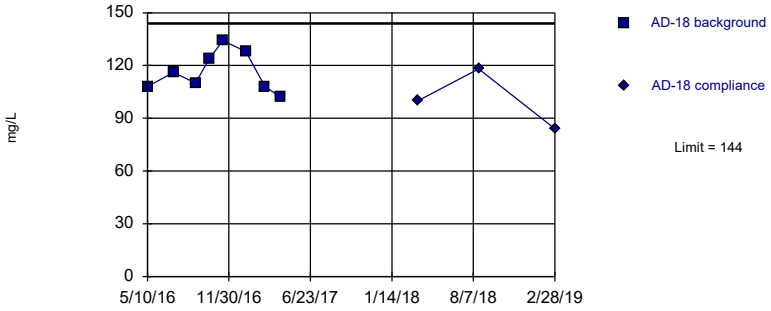
Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=116.3, Std. Dev.=11.29, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9317, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

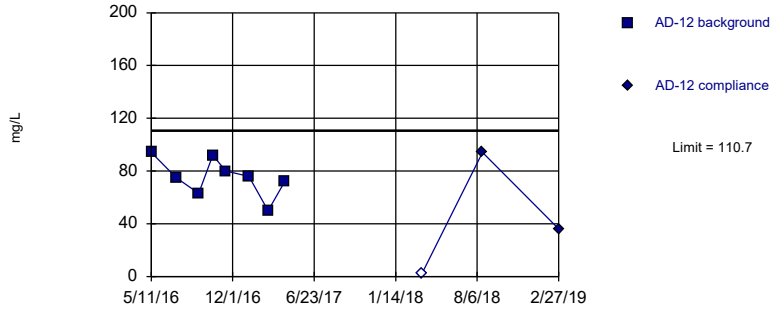
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=75.25, Std. Dev.=14.41, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9549, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

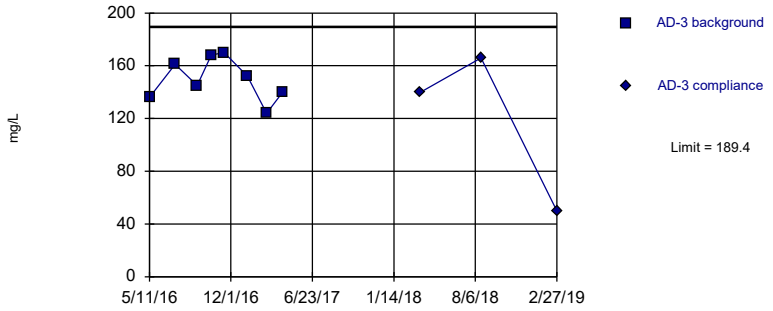
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=149.5, Std. Dev.=16.23, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9574, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

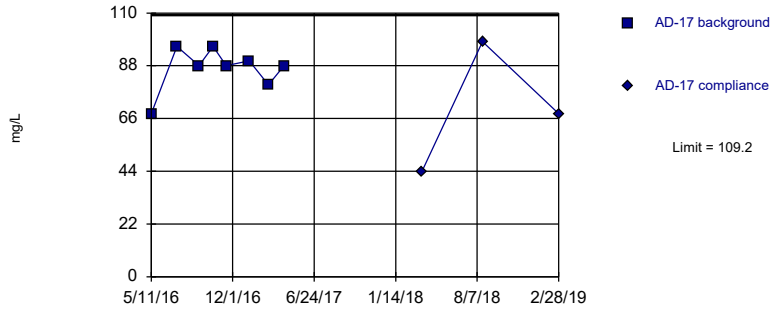
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=86.75, Std. Dev.=9.13, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8566, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

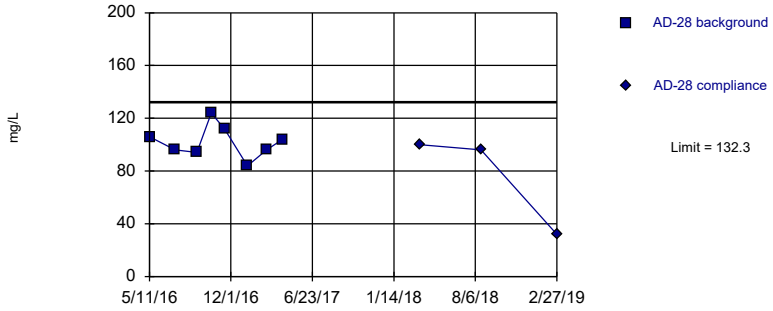
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=102, Std. Dev.=12.33, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9681, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

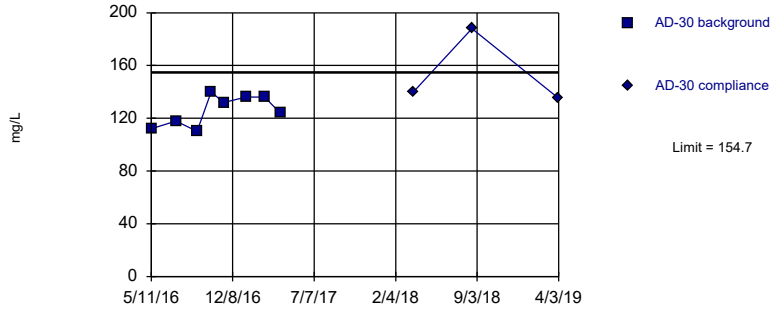
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=126, Std. Dev.=11.66, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.904, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Trend Test Summary Table - Significant Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/7/2019, 8:20 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	**AD-30**	**0.5226**	**37**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**

Trend Test Summary Table - All Results

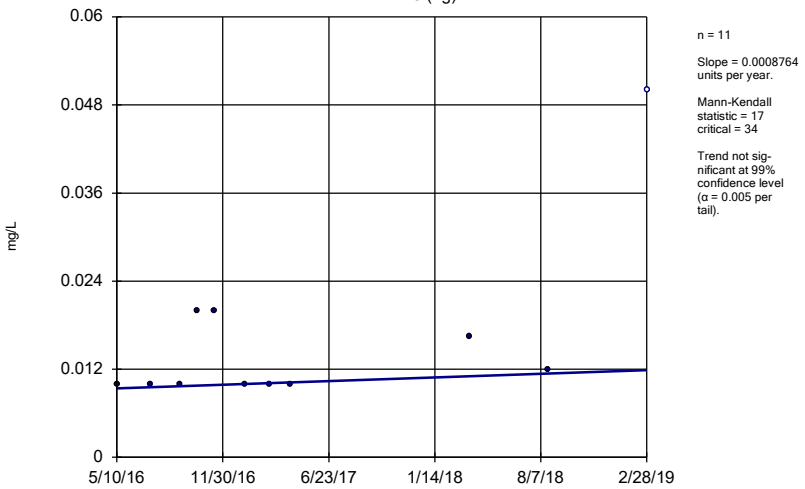
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/7/2019, 8:20 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-18 (bg)	0.0008764	17	34	No	11	9.091	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0	-4	-34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-3 (bg)	-0.0002401	-7	-34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-28	0.01986	12	34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	**AD-30**	**0.5226**	**37**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride, total (mg/L)	AD-18 (bg)	0	-7	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.03234	10	34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-3 (bg)	0.05714	6	34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-17	-7.599	-15	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-30	0	3	34	No	11	0	n/a	n/a	0.01	NP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = 0.0008764 units per year.

Mann-Kendall statistic = 17
critical = 34

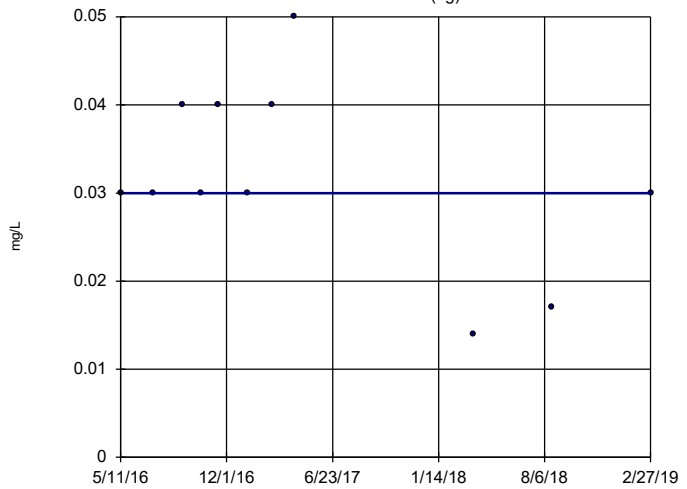
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -4
critical = -34

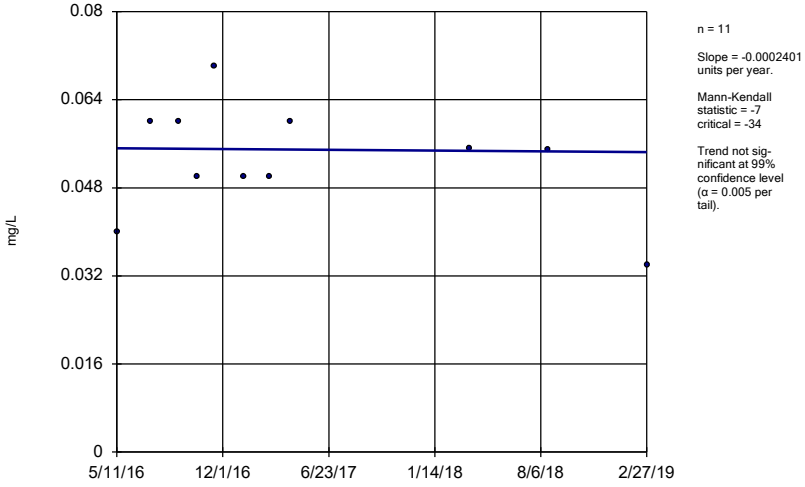
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-3 (bg)



n = 11

Slope = -0.0002401 units per year.

Mann-Kendall statistic = -7
critical = -34

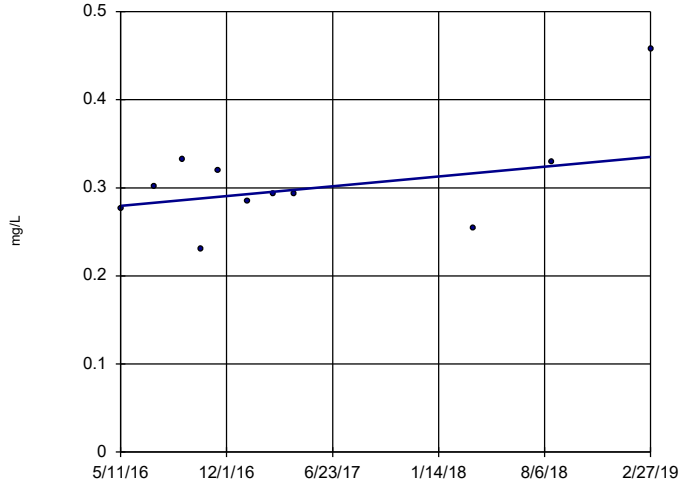
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-28



n = 11

Slope = 0.01986 units per year.

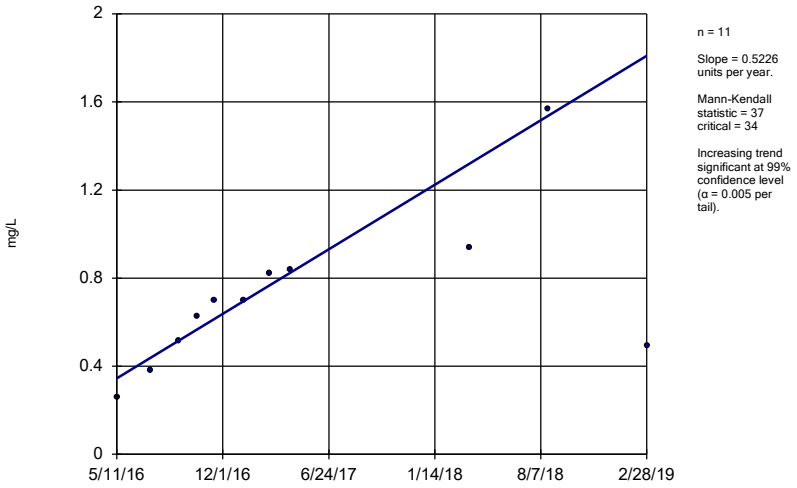
Mann-Kendall statistic = 12
critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-30



n = 11

Slope = 0.5226 units per year.

Mann-Kendall statistic = 37 critical = 34

Increasing trend significant at 99% confidence level (α = 0.005 per tail).

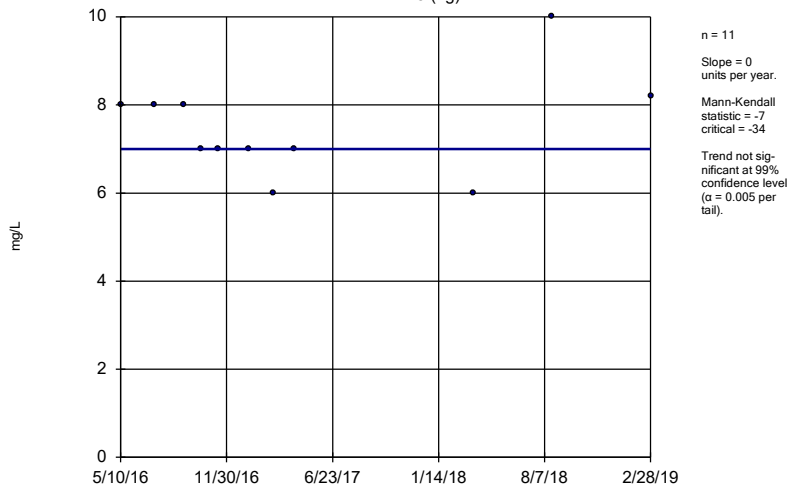
Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -7 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

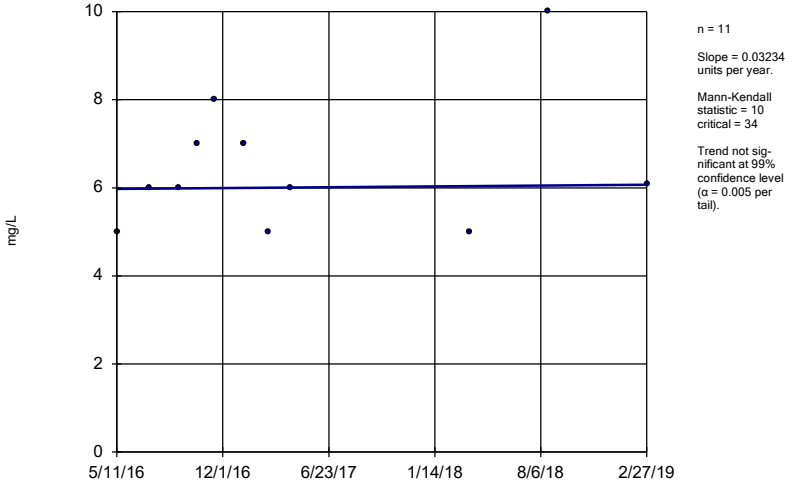
Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.03234 units per year.

Mann-Kendall statistic = 10 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

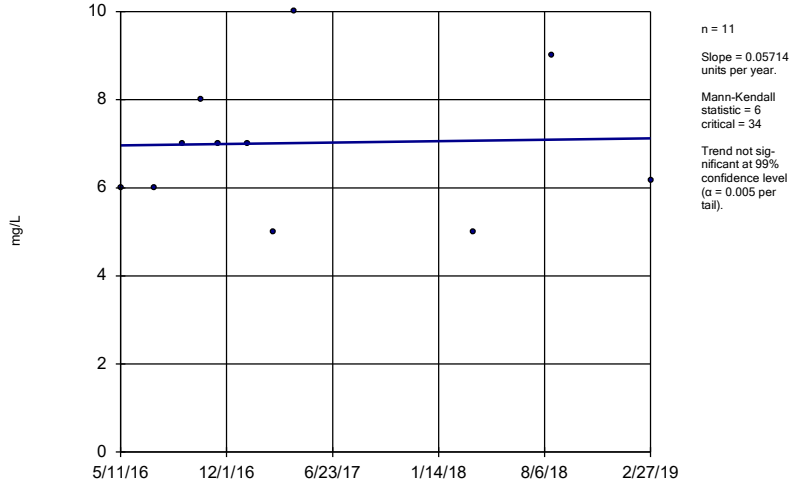
Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-3 (bg)



n = 11

Slope = 0.05714 units per year.

Mann-Kendall statistic = 6 critical = 34

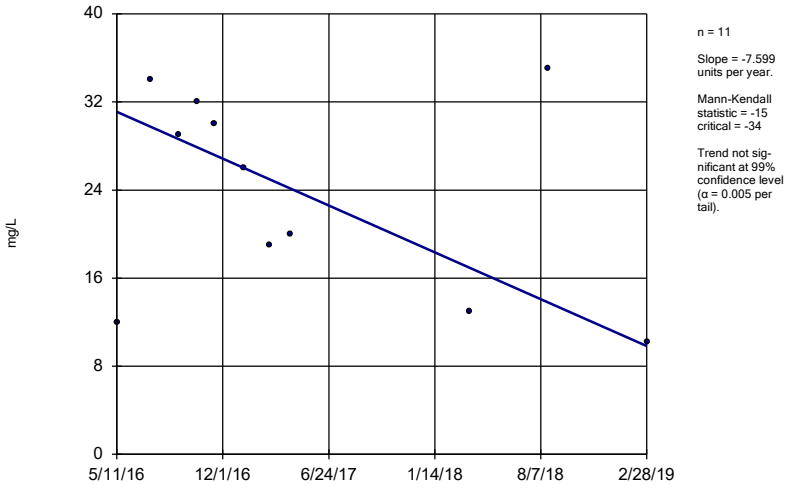
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-17



n = 11

Slope = -7.599 units per year.

Mann-Kendall statistic = -15 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

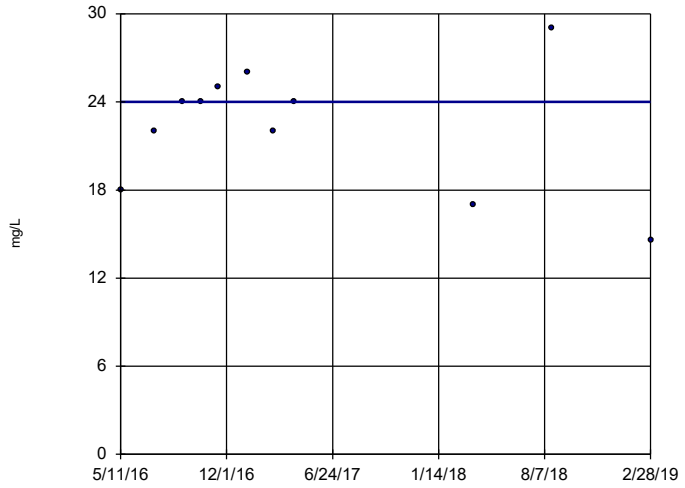
Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-30



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = 3 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Tolerance Limit Summary Table

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/8/2019, 5:28 AM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.002	33	n/a	n/a	87.88	n/a	n/a	0.184	NP Inter(NDs)
Arsenic, total (mg/L)	n/a	0.004229	33	n/a	n/a	75.76	n/a	n/a	0.184	NP Inter(NDs)
Barium, total (mg/L)	n/a	0.1593	33	0.06703	0.03743	0	None	No	0.01	Inter
Beryllium, total (mg/L)	n/a	0.001196	33	-8.334	0.6511	9.091	None	ln(x)	0.01	Inter
Cadmium, total (mg/L)	n/a	0.001	33	n/a	n/a	78.79	n/a	n/a	0.184	NP Inter(NDs)
Chromium, total (mg/L)	n/a	0.002894	33	0.02814	0.01041	12.12	None	sqrt(x)	0.01	Inter
Cobalt, total (mg/L)	n/a	0.009	33	n/a	n/a	0	n/a	n/a	0.184	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	n/a	3.565	33	1.016	0.3538	0	None	sqrt(x)	0.01	Inter
Fluoride, total (mg/L)	n/a	1	33	n/a	n/a	87.88	n/a	n/a	0.184	NP Inter(NDs)
Lead, total (mg/L)	n/a	0.002	33	n/a	n/a	84.85	n/a	n/a	0.184	NP Inter(NDs)
Lithium, total (mg/L)	n/a	0.1387	32	0.283	0.09452	3.125	None	x^(1/3)	0.01	Inter
Mercury, total (mg/L)	n/a	0.000064	33	n/a	n/a	48.48	n/a	n/a	0.184	NP Inter(normality)
Molybdenum, total (mg/L)	n/a	0.04	33	n/a	n/a	81.82	n/a	n/a	0.184	NP Inter(NDs)
Selenium, total (mg/L)	n/a	0.004	33	n/a	n/a	60.61	n/a	n/a	0.184	NP Inter(normality)
Thallium, total (mg/L)	n/a	0.002	33	n/a	n/a	84.85	n/a	n/a	0.184	NP Inter(NDs)

Confidence Interval Summary Table - Significant Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/9/2019, 12:58 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-28**	**0.01626**	**0.01321**	**0.009**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**

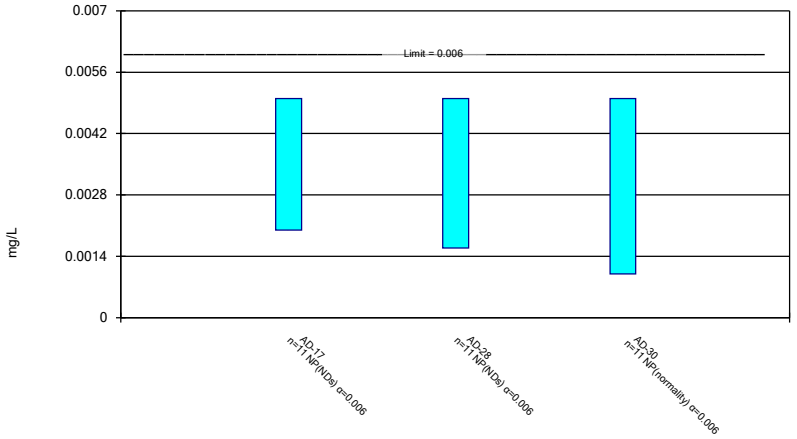
Confidence Interval Summary Table - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/9/2019, 12:58 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-17	0.005	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-28	0.005	0.001588	0.006	n/a	No	11	81.82	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-30	0.005	0.000997	0.006	n/a	No	11	72.73	No	0.006	NP (normality)
Arsenic, total (mg/L)	AD-17	0.005	0.001213	0.01	n/a	No	11	63.64	No	0.006	NP (normality)
Arsenic, total (mg/L)	AD-28	0.005	0.001409	0.01	n/a	No	11	54.55	No	0.006	NP (normality)
Arsenic, total (mg/L)	AD-30	0.005	0.001929	0.01	n/a	No	11	81.82	No	0.006	NP (NDs)
Barium, total (mg/L)	AD-17	0.2942	0.1343	2	n/a	No	11	0	No	0.01	Param.
Barium, total (mg/L)	AD-28	0.17	0.148	2	n/a	No	11	0	No	0.006	NP (normality)
Barium, total (mg/L)	AD-30	0.05771	0.04986	2	n/a	No	11	0	No	0.01	Param.
Beryllium, total (mg/L)	AD-17	0.0008327	0.0004929	0.004	n/a	No	11	9.091	No	0.01	Param.
Beryllium, total (mg/L)	AD-28	0.000836	0.0005198	0.004	n/a	No	11	0	No	0.01	Param.
Beryllium, total (mg/L)	AD-30	0.0001554	0.0000604	0.004	n/a	No	11	9.091	No	0.006	NP (normality)
Cadmium, total (mg/L)	AD-17	0.001	0.0000833	0.005	n/a	No	11	72.73	No	0.006	NP (normality)
Cadmium, total (mg/L)	AD-28	0.001	0.001	0.005	n/a	No	11	90.91	No	0.006	NP (NDs)
Cadmium, total (mg/L)	AD-30	0.001	0.001	0.005	n/a	No	11	90.91	No	0.006	NP (NDs)
Chromium, total (mg/L)	AD-17	0.002321	0.0004231	0.1	n/a	No	11	9.091	x^(1/3)	0.01	Param.
Chromium, total (mg/L)	AD-28	0.001	0.0006055	0.1	n/a	No	10	30	No	0.011	NP (normality)
Chromium, total (mg/L)	AD-30	0.001864	0.0005964	0.1	n/a	No	11	9.091	ln(x)	0.01	Param.
Cobalt, total (mg/L)	AD-17	0.01285	0.005951	0.009	n/a	No	11	0	No	0.01	Param.
Cobalt, total (mg/L)	**AD-28**	**0.01626**	**0.01321**	**0.009**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Cobalt, total (mg/L)	AD-30	0.002411	0.001739	0.009	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-17	6.421	1.722	5	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-28	2.675	1.609	5	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-30	2.662	0.5223	5	n/a	No	11	0	sqrt(x)	0.01	Param.
Fluoride, total (mg/L)	AD-17	1	0.3446	4	n/a	No	11	72.73	No	0.006	NP (normality)
Fluoride, total (mg/L)	AD-28	0.8546	0.5139	4	n/a	No	11	9.091	No	0.01	Param.
Fluoride, total (mg/L)	AD-30	1	1	4	n/a	No	11	100	No	0.006	NP (NDs)
Lead, total (mg/L)	AD-17	0.005	0.002	0.015	n/a	No	11	90.91	No	0.006	NP (NDs)
Lead, total (mg/L)	AD-28	0.005	0.002	0.015	n/a	No	11	90.91	No	0.006	NP (NDs)
Lead, total (mg/L)	AD-30	0.005	0.002	0.015	n/a	No	11	90.91	No	0.006	NP (NDs)
Lithium, total (mg/L)	AD-17	0.02643	0.01174	0.14	n/a	No	11	9.091	No	0.01	Param.
Lithium, total (mg/L)	AD-28	0.03262	0.02484	0.14	n/a	No	10	0	x^3	0.01	Param.
Lithium, total (mg/L)	AD-30	0.01021	0.006832	0.14	n/a	No	11	9.091	x^2	0.01	Param.
Mercury, total (mg/L)	AD-17	0.0001439	0.00006042	0.002	n/a	No	11	0	No	0.01	Param.
Mercury, total (mg/L)	AD-28	0.00009517	0.00002722	0.002	n/a	No	11	0	x^(1/3)	0.01	Param.
Mercury, total (mg/L)	AD-30	0.001473	0.000255	0.002	n/a	No	11	0	No	0.01	Param.
Molybdenum, total (mg/L)	AD-17	0.005	0.0004858	0.1	n/a	No	11	81.82	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-28	0.005	0.0002942	0.1	n/a	No	11	81.82	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-30	0.005	0.001142	0.1	n/a	No	11	81.82	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-17	0.005	0.002554	0.05	n/a	No	11	81.82	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-28	0.005	0.001103	0.05	n/a	No	11	81.82	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-30	0.005	0.001207	0.05	n/a	No	11	81.82	No	0.006	NP (NDs)
Thallium, total (mg/L)	AD-17	0.002	0.001075	0.002	n/a	No	10	80	No	0.011	NP (NDs)
Thallium, total (mg/L)	AD-28	0.002	0.001247	0.002	n/a	No	10	80	No	0.011	NP (NDs)
Thallium, total (mg/L)	AD-30	0.002	0.000959	0.002	n/a	No	10	70	No	0.011	NP (normality)

Non-Parametric Confidence Interval

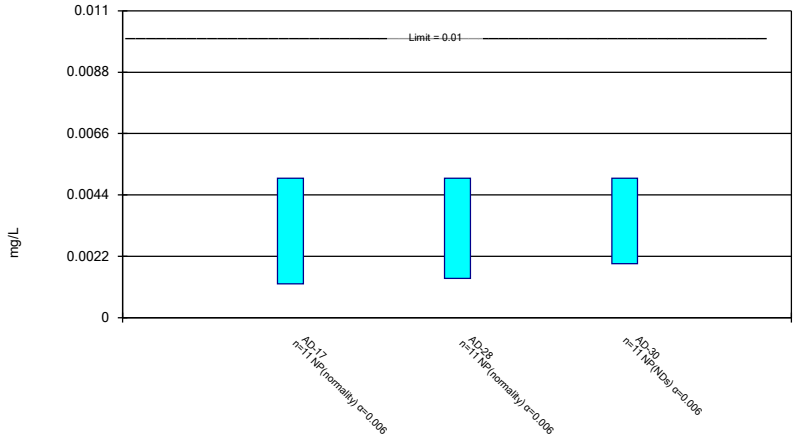
Compliance Limit is not exceeded.



Constituent: Antimony, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

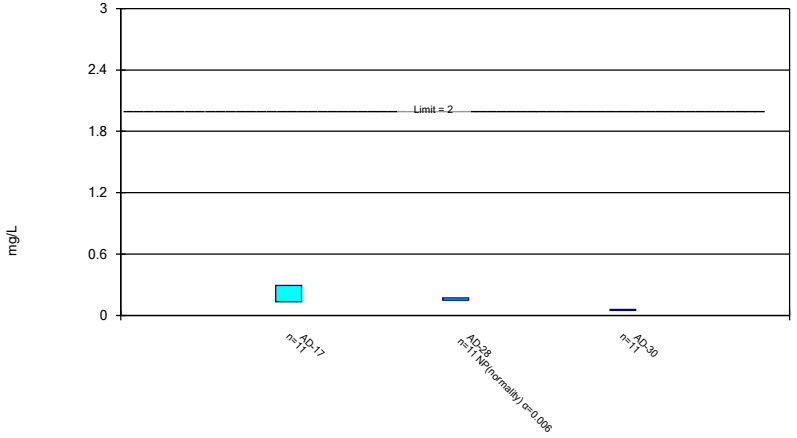
Compliance Limit is not exceeded.



Constituent: Arsenic, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

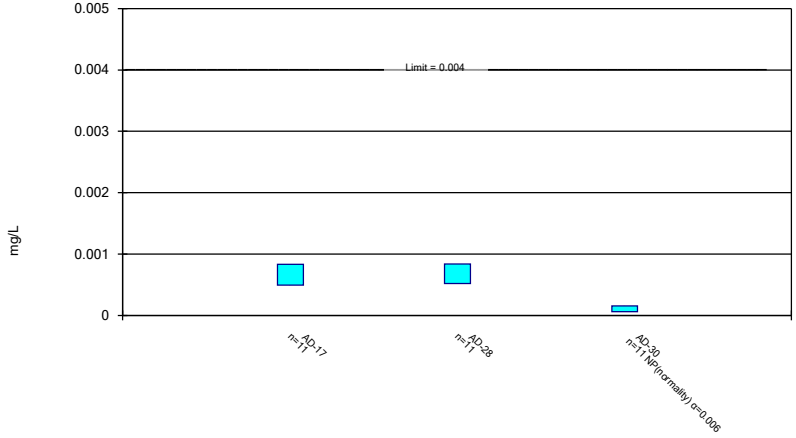
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Barium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

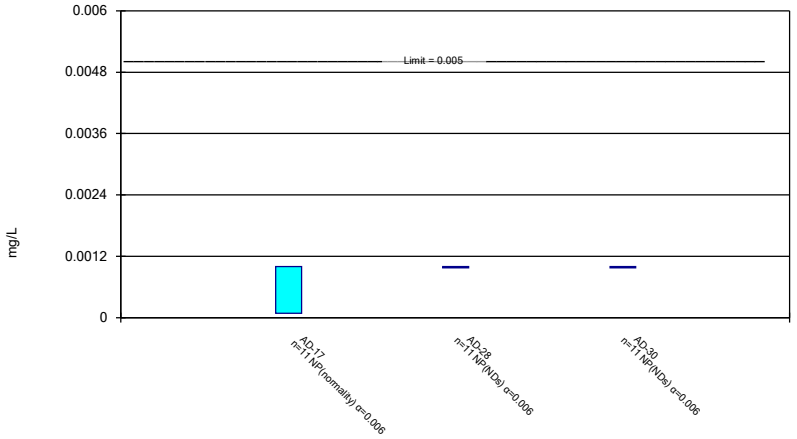
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Beryllium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

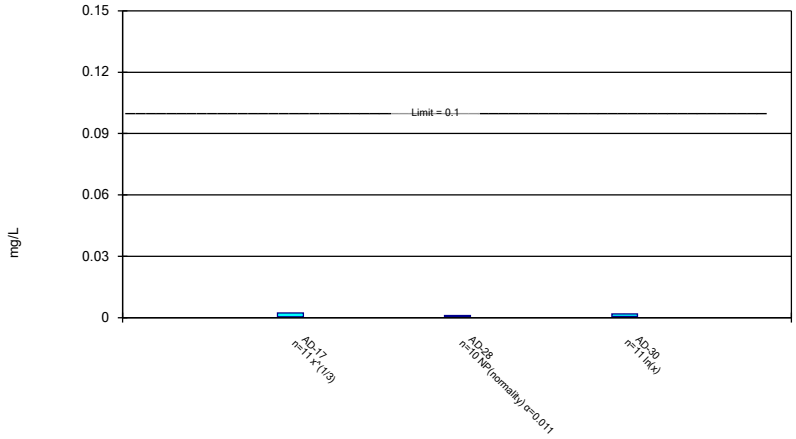
Compliance Limit is not exceeded.



Constituent: Cadmium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

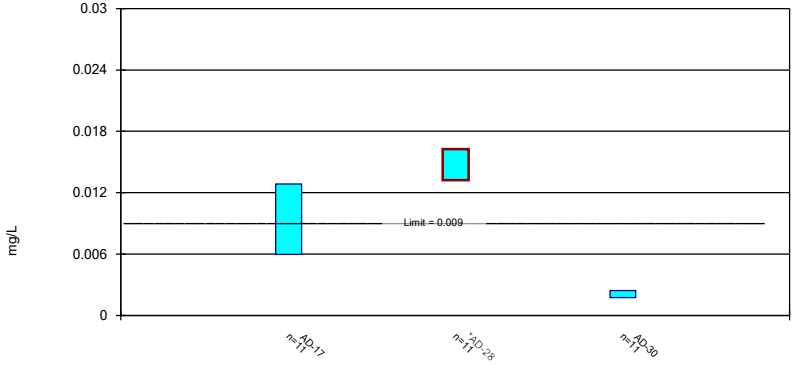
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chromium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

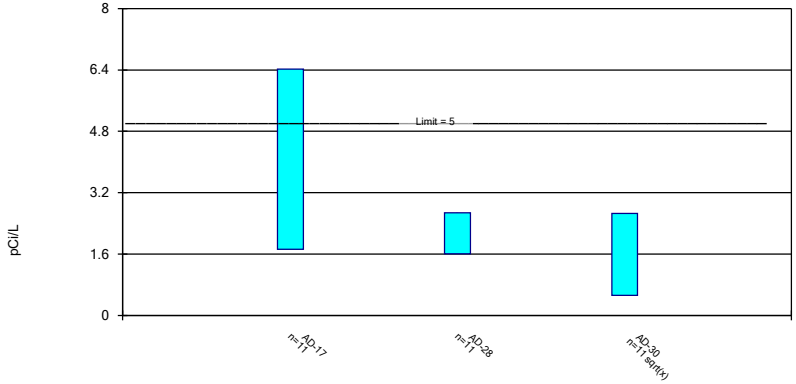
Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cobalt, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

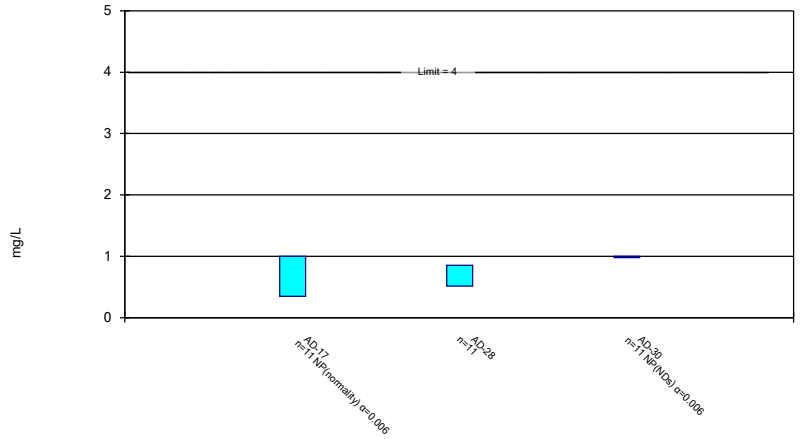
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals -
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

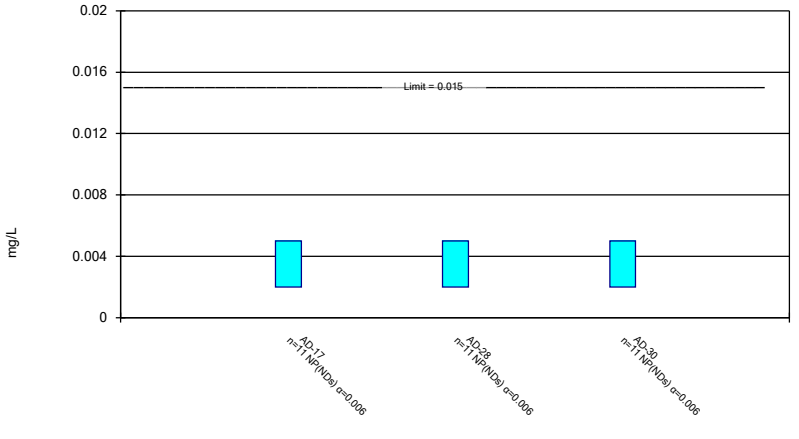
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Fluoride, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

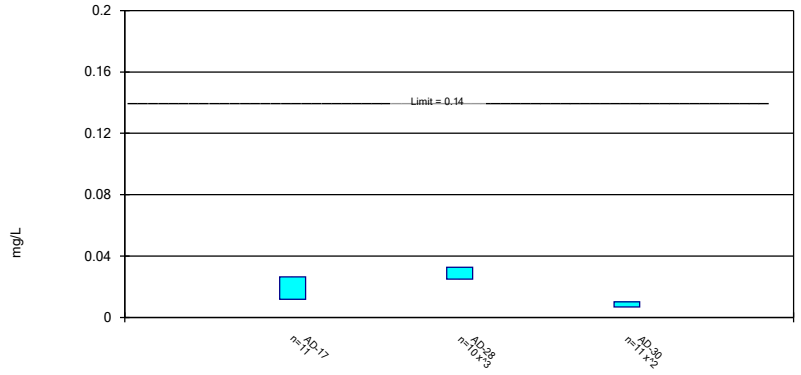
Compliance Limit is not exceeded.



Constituent: Lead, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

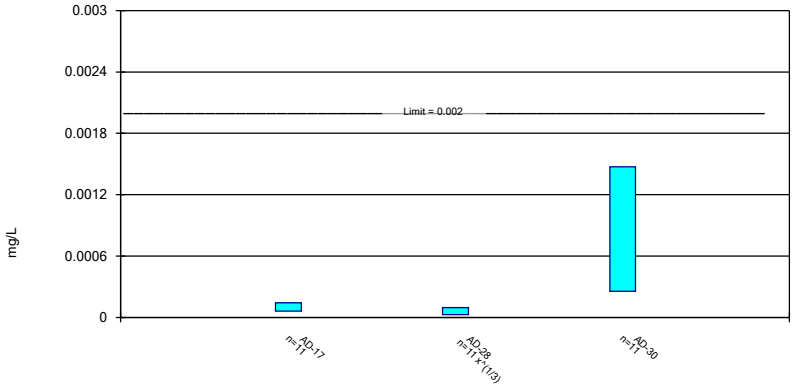
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Lithium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

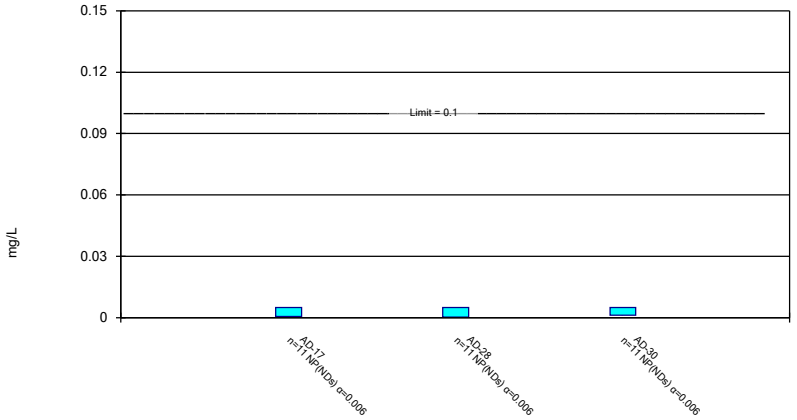
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Mercury, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



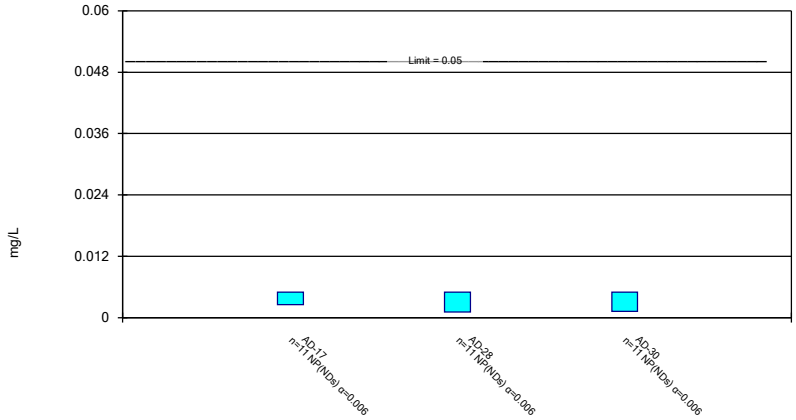
Constituent: Molybdenum, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



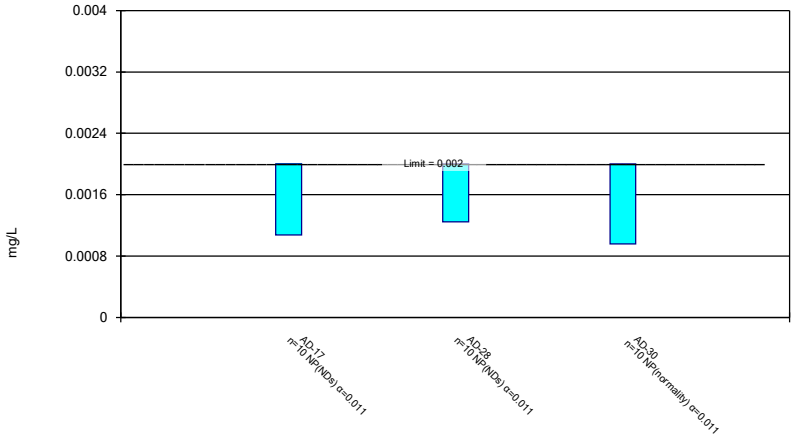
Constituent: Selenium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



Constituent: Thallium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

STATISTICAL ANALYSIS SUMMARY
WEST BOTTOM ASH POND
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

December 26, 2019

CHA8473

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
SU	Standard Units
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
WBAP	West Bottom Ash Pond

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the West Bottom Ash Pond (WBAP), an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, chloride, and sulfate at the WBAP. An alternative source was not identified at the time, so the WBAP has been in assessment monitoring since. During the most recent assessment monitoring event, completed in February 2019, an SSL for cobalt was identified at well AD-28. An ASD was successfully completed (Geosyntec, 2019); thus, the unit remained in assessment monitoring. Two assessment monitoring events were conducted at the WBAP in May and August 2019, in accordance with 40 CFR 257.95. The results of these events are documented in this report.

Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. An SSL was identified for cobalt. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

WEST BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, two sets of samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) (May 2019) and 257.95(d)(1) (August 2019). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during these assessment monitoring events may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.23 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the WBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained in May and August 2019 were screened for potential outliers. No outliers were identified.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for arsenic, barium, beryllium,

cobalt, fluoride, mercury, and selenium due to apparent non-normal distributions and for antimony, cadmium, lead, molybdenum, and thallium due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSL was identified at the Pirkey WBAP:

- The LCL for cobalt exceeded the GWPS of 0.009 mg/L at AD-28 (0.0132 mg/L).

As a result, the Pirkey WBAP will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Establishment of Appendix III Prediction Limits

Upper prediction limits (UPL) were previously established for all Appendix III parameters following the background monitoring period (Geosyntec, 2018). Intrawell tests were used to evaluate potential SSIs for calcium, pH, sulfate and TDS, whereas interwell tests were used to evaluate potential SSIs for boron, chloride and fluoride. While interwell prediction limits have been updated periodically during the assessment monitoring period as sufficient data became available, this represents the first update to the background dataset for parameters evaluated using intrawell tests.

Mann-Whitney (Wilcoxon rank-sum) tests were performed to determine whether the newer data are affected by a release from the WBAP. Because the interwell Appendix III limits and the Appendix IV GWPSs are based on data from upgradient wells which we would not expect to have been impacted by a release, these tests were used for intrawell Appendix III tests only. Mann-Whitney tests were used to compare the medians of historical data (May 2016 - April 2017) to the new compliance samples (August 2017 – February 2019) for calcium, pH, sulfate and TDS. Results were evaluated to determine if the medians of the two groups were similar at the 99% confidence level. Where no significant difference was found, the new compliance data were added to the background dataset. Where a statistically significant difference was found between the medians of the two groups, the data were reviewed to evaluate the cause of the difference and to determine if adding newer data to the background dataset, replacing the background dataset with the newer data, or continuing to use the existing background dataset was most appropriate. If the differences appeared to have been caused by a release, then the previous background dataset would have continued to be used.

The complete Mann-Whitney test results and a summary of the significant findings can be found in Attachment B. Significant differences were found between the two groups for pH in upgradient well AD-18 and for sulfate in downgradient well AD-30. Typically, when the test concludes that the medians of the two groups are significantly different, particularly in the downgradient wells, the background are not updated to include the newer data but will be reconsidered in the future. In the case of pH in upgradient well AD-18, the more recent reported measurements are slightly higher than those reported historically; therefore, this record was updated so that only the most recent eight samples are used to construct the prediction limits and, thus, better represent the groundwater quality upgradient of the facility. At downgradient well AD-30, the dataset was not updated, and the previously calculated prediction limit was used to more conservatively evaluate possible exceedances for sulfate.

After the revised background set was established, a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., "J-flagged" data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets (either transformed or untransformed) that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or non-parametric) and transformation (where applicable) for each background dataset are shown in Attachment B.

UPLs were updated using all the historical data through February 2019 to represent background values. LPLs were also updated for pH. The updated prediction limits are summarized in Table 3. Intrawell tests continued to be used to evaluate potential SSIs for calcium, pH, sulfate and TDS, whereas interwell tests continued to be used to evaluate potential SSIs for boron, chloride and fluoride. The intrawell UPLs were calculated for a one-of-two retesting procedure; i.e., if at least one sample in a series of two does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, where the initial result did not exceed the UPL, a second sample was not collected. The retesting procedures allowed achieving an acceptably high statistical power to detect changes at downgradient wells for constituents evaluated using intrawell prediction limits.

2.2.4 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations.

Data collected during the May and August 2019 assessment monitoring events from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 4. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0768 at AD-28 (0.313 mg/L and 0.366 mg/L) and AD-30 (0.520 mg/L and 1.25 mg/L).

- Chloride concentrations exceeded the interwell UPL of 9.50 mg/L at AD-17 (10.3 mg/L and 26.3 mg/L) and AD-30 (18.8 mg/L and 28.1 mg/L).

- Sulfate concentrations exceeded the intrawell UPL of 31.6 mg/L at AD-30 (39.8 mg/L).

Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey WBAP during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the May and August 2019 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. An SSL was identified for cobalt. Appendix III parameters were compared to recalculated prediction limits, with exceedances identified for boron, chloride, and sulfate.

Based on this evaluation, the Pirkey WBAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – West Bottom Ash Pond, H.W. Pirkey Power Plant, Hallsville, Texas. January 15, 2018.

Geosyntec. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant - West Bottom Ash Pond. September.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - West Bottom Ash Pond

Geosyntec Consultants, Inc.

Component	Unit	AD-3		AD-12		AD-17		AD-18		AD-28		AD-30	
		8/13/2019	5/23/2019	5/21/2019	8/12/2019	5/23/2019	8/13/2019	5/22/2019	8/12/2019	5/22/2019	8/12/2019	5/23/2019	8/12/2019
Antimony	µg/L	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.0200 J	2.00 U	0.100 U
Arsenic	µg/L	2.00 U	2.41	2.00 U	0.0700 J	2.00 U	0.400	2.00 U	0.450	2.00 U	0.640	0.600 J	0.210
Barium	µg/L	61.8	58.3	21.7	23.8	82.9	216	131	100	148	113	59.2	58.0
Beryllium	µg/L	2.00 U	0.196	2.00 U	0.154	2.00 U	0.554	2.00 U	0.118	0.500 J	0.473	2.00 U	0.0700 J
Boron	mg/L	0.0450	0.0500 J	0.0200	0.0500 U	0.0190	0.0300 J	0.0130	0.0500 U	0.313	0.366	0.520	1.25
Cadmium	µg/L	1.00 U	0.0200 J	1.00 U	0.0500 U	1.00 U	0.0400 J	1.00 U	0.0200 J	1.00 U	0.0400 J	1.00 U	0.0500 U
Calcium	mg/L	6.19	5.08	0.300 J	0.278	0.200 J	0.777	0.684	0.647	1.24	1.72	1.74	0.302
Chloride	mg/L	5.99	6.83	6.30	7.24	10.3	26.3	8.82	8.49	4.48	6.04	18.8	28.1
Chromium	µg/L	4.00 U	0.206	4.00 U	0.204	0.900 J	0.732	4.00 U	0.212	4.00 U	0.416	1.00 J	0.374
Cobalt	µg/L	4.94	6.55	1.15	1.30	3.15	9.03	1.47	1.25	13.8	12.8	3.26	2.10
Combined Radium	pCi/L	0.988	1.38	0.201	0.237	1.62	6.40	0.492	0.473	1.95	2.38	1.09	1.22
Fluoride	mg/L	0.0900	0.190	0.0900	0.0600 J	0.130	0.240	0.0200 J	0.0100 J	0.690	0.650	0.0400 J	0.0300 J
Lead	µg/L	2.00 U	0.417	2.00 U	0.0800 J	2.00 U	0.200 J	2.00 U	0.200 J	2.00 U	0.100 J	2.00 U	0.0600 J
Lithium	mg/L	0.0734	0.108	0.00576	0.00829	0.00911	0.0193	0.0209	0.0183	0.0227	0.0380	0.00841	0.00804
Mercury	mg/L	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.000103	0.000447	0.00000900 J	0.0000230 J	0.0000280	0.0000920	0.000165	0.000345
Molybdenum	µg/L	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U
Selenium	µg/L	4.00 U	0.100 J	4.00 U	0.200 J	4.00 U	0.300	4.00 U	0.0900 J	4.00 U	0.200 J	4.00 U	0.200 J
Total Dissolved Solids	mg/L	154	168	80.0	90.0	58.0	88.0	104	90.0	100	128	112	160
Sulfate	mg/L	29.5	32.5	4.00	2.60	2.40	1.80	10.6	6.60	20.1	22.5	29.2	39.8
Thallium	µg/L	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U
pH	SU	4.90	5.12	4.09	4.94	3.96	4.75	5.20	5.22	4.62	4.66	4.86	4.87

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above the method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit

Table 2: Groundwater Protection Standards
Pirkey Plant - West Bottom Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL
Antimony, Total (mg/L)	0.006		0.005
Arsenic, Total (mg/L)	0.01		0.005
Barium, Total (mg/L)	2		0.16
Beryllium, Total (mg/L)	0.004		0.002
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.0032
Cobalt, Total (mg/L)	n/a	0.006	0.009
Combined Radium, Total (pCi/L)	5		3.31
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	0.015		0.005
Lithium, Total (mg/L)	n/a	0.04	0.14
Mercury, Total (mg/L)	0.002		0.000064
Molybdenum, Total (mg/L)	n/a	0.1	0.01
Selenium, Total (mg/L)	0.05		0.005
Thallium, Total (mg/L)	0.002		0.002

Notes:
Grey cell indicates calculated UTL is higher than MCL or CCR Rule-specified value.
MCL = Maximum Contaminant Level
Calculated UTL (Upper Tolerance Limit) represents site-specific background values.
The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3: Revised Prediction Limits
Pirkey - West Bottom Ash Pond

Parameter	Unit	Description	AD-17	AD-28	AD-30
Boron	mg/L	Interwell Background Value (UPL)	0.0768		
Calcium	mg/L	Intrawell Background Value (UPL)	1.79	2.76	0.680
Chloride	mg/L	Interwell Background Value (UPL)	9.50		
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
pH	SU	Intrawell Background Value (UPL)	4.8	5.9	5.5
		Intrawell Background Value (LPL)	3.2	3.3	3.8
Sulfate	mg/L	Intrawell Background Value (UPL)	9.32	23.2	31.6
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	115	129	189

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

Table 4: Appendix III Data Summary
Pirkey - West Bottom Ash Pond

Geosyntec Consultants, Inc.

Parameter	Unit	Description	AD-17		AD-28		AD-30	
			5/23/2019	8/13/2019	5/22/2019	8/12/2019	5/23/2019	8/12/2019
Boron	mg/L	Interwell Background Value (UPL)	0.0768					
		Detection Monitoring Result	0.0190	0.0300	**0.313**	**0.366**	**0.520**	**1.25**
Calcium	mg/L	Intrawell Background Value (UPL)	1.79		2.76		0.680	
		Detection Monitoring Result	0.200	0.777	1.24	1.72	1.74	0.302
Chloride	mg/L	Interwell Background Value (UPL)	9.50					
		Detection Monitoring Result	**10.3**	**26.3**	4.48	6.04	**18.8**	**28.1**
Fluoride	mg/L	Interwell Background Value (UPL)	1.00					
		Detection Monitoring Result	0.130	0.240	0.690	0.650	0.0400	0.0300
pH	SU	Intrawell Background Value (UPL)	4.8		5.9		5.5	
		Intrawell Background Value (LPL)	3.2		3.3		3.8	
		Detection Monitoring Result	4.0	4.8	4.6	4.7	4.9	4.9
Sulfate	mg/L	Intrawell Background Value (UPL)	9.32		23.2		31.6	
		Detection Monitoring Result	2.40	1.80	20.1	22.5	29.2	**39.8**
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	115		129		189	
		Detection Monitoring Result	58.0	88.0	100	128	112	160

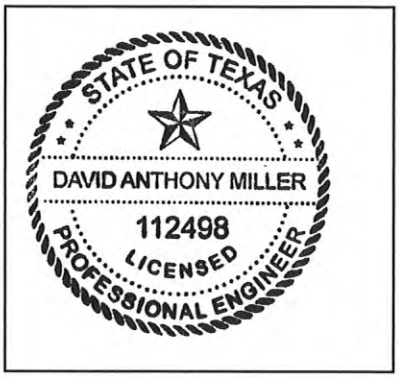
Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.



DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

112498	TEXAS	01.03.20
License Number	Licensing State	Date

ATTACHMENT B
Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

December 10, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey WBAP
Background Update – 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the background update of groundwater data for American Electric Power Inc.'s Pirkey West Bottom Ash Pond. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-3, AD-12, and AD-18
- **Downgradient wells:** AD-17, AD-28, and AD-30

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis report was reviewed by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to Groundwater Stats Consulting. The analysis was prepared according to the background screening conducted in December 2017 that was approved by Dr. Kirk Cameron.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS;

- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series and box plots for both Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figures A and B, respectively). Values flagged as outliers from this screening may be seen in a lighter font and disconnected symbol on the time series graphs, and a summary of those values follows this letter (Figure C).

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for calcium and pH, sulfate, and TDS;
2) Interwell prediction limits combined with a 1-of-2 resample plan for boron, chloride, and fluoride.

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, the reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory and there is no replacement of historical reporting limits with the most recent reporting limit. It was noted that the more recent reporting limits are significantly lower than those reported historically.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric prediction limits are used on data containing greater than 50% nondetects.

Historical Summary - Evaluation of Appendix III Parameters – December 2017

Outlier Evaluation

Time series plots were used to identify suspected outliers, or extreme values that would result in limits that are not conservative from a regulatory perspective, in proposed background data. Suspected outliers at all wells for Appendix III parameters were formally tested using Tukey's box plot method and, when identified, flagged in the computer database with "o" and deselected prior to construction of statistical limits.

During the previous background screening, no values were flagged as outliers for Appendix III parameters. The current assumption is that changes in concentrations are reflective of natural variation upgradient of the facility; however, a separate study and hydrogeological investigation would be required to fully understand the geochemical conditions and expected groundwater quality for the region. That study and assessment is beyond the scope of services provided by Groundwater Stats Consulting.

Statistical Limits

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, chloride and fluoride; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for calcium, pH, sulfate, and TDS for the February 2019 data. The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data were screened for any newly suspected outliers or obvious trending patterns using time series plots. Intrawell prediction limits utilized the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the set background data will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

Note that the reporting limit for fluoride for the February 2019 event at well AD-30 was <0.2 mg/L whereas all historical reporting limits for all wells at that time was <1.0 mg/L. Therefore, <1.0 mg/L was substituted for all nondetects which is less than the Groundwater Protection Standard of 4 mg/L. Additionally, in the case of TDS at well AD-30, the April 2019 sample was compared against background.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified, and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. Prediction limit exceedances were noted for boron at wells AD-28 and AD-30, and chloride at wells AD-17 and AD-30.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable. Upgradient wells were included in the trend analyses to identify whether similar patterns exist upgradient of the site. Such patterns are an indication of natural variability in groundwater unrelated to practices at the site.

No statistically significant increasing or decreasing trends were found for any of the downgradient well/parameter pairs with prediction limit exceedances, except for a statistically significant increasing trend for boron in well AD-30.

Appendix III Background Update – November 2019

Prior to updating background data, samples are re-evaluated for all wells for intrawell parameters and all upgradient wells for interwell parameters using Tukey's outlier test and visual screening with the February 2019 samples. Samples during August and December 2017 that were previously absent were also incorporated into this analysis. No values were noted or flagged as outliers for Appendix III parameters. As mentioned above, any flagged data are displayed in a lighter font and as a disconnected symbol on the time series reports, as well as in a lighter font on the accompanying data pages. An updated summary of Tukey's test results and flagged outliers follows this letter.

For constituents requiring intrawell prediction limits, the Mann-Whitney (Wilcoxon Rank Sum) test was used to compare the medians of historical data through April 2017 to the new compliance samples at each well through February 2019 to evaluate whether the groups are statistically different at the 99% confidence level, in which case background data may be updated with compliance data (Figure D). Statistically significant differences were found between the two groups for pH in upgradient well AD-18, and sulfate in downgradient well AD-30.

Typically, when the test concludes that the medians of the two groups are significantly different, particularly in the downgradient wells, the background are not updated to include the newer data but will be reconsidered in the future. Although the differences for pH in well AD-18 occurred in an upgradient well, more recent data are fairly similar to background, thus better representing the groundwater quality upgradient of the facility. As a result, the background for well AD-18 was updated to be the most recent 8 samples rather than the data set as a whole.

Regarding downgradient well AD-30 for sulfate, more recent concentrations exhibited substantial increases and exceeded median compliance values of all other wells and, therefore, the background will not be updated at this time. A summary of these results follows this letter and the test results are included with the Mann Whitney test section at the end of this report. Additionally, summaries of well/constituent pairs using a truncated portion of their data follow this letter (Figure E).

Intrawell prediction limits using all historical data through February 2019, except in the cases mentioned above, combined with a 1-of-2 resample plan, were constructed and a summary of the updated limits follows this letter (Figure F).

For parameters tested using interwell analyses, the Sen's Slope/Mann-Kendall trend test was used on upgradient wells to determine whether concentrations are statistically increasing, decreasing or stable (Figure G). No statistically significant increasing or decreasing trends were noted. A summary of those results is included with the trend tests.

Interwell prediction limits, combined with a 1-of-2 resample plan, were updated using all available data from upgradient wells through February 2019 for boron, chloride, and fluoride (Figure H). Interwell prediction limits pool upgradient well data to establish a background limit for an individual constituent. A summary table of the updated limits may be found following this letter in the Prediction Limit Summary Tables.

Evaluation of Appendix IV Parameters – November 2019

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure I).
Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Tukey's outlier test identified both high and low values for lithium in well AD-28, and molybdenum for wells AD-17, AD-28, and AD-30. The low value for lithium was not flagged due to the value being consistent with

values reported for other wells for the same event. Additionally, low values for molybdenum in the aforementioned wells were not flagged due to the values being consistent across all downgradient wells for each given event and occurring more than once. These values appear to provide an accurate representation of the populations within their respective wells.

Note that the reporting limit for thallium for the February 2019 event was <0.01 mg/L, which is higher than the historical reporting limit of <0.002 mg/L and the GWPS. Since the <0.01 mg/L values cannot help distinguish whether other observations exceed the GWPS, they are flagged as outliers.

Tukey's outlier test on pooled upgradient well data did not identify any outliers; however, a high value was flagged for lithium in well AD-3 because the stability of background samples indicates that this value does not accurately represent the population of its respective well. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure J).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of the MCL, CCR-Rule specified level, or ACL as discussed above (Figure K). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No confidence interval exceedances were found except for cobalt in well AD-28. A summary of the confidence interval results follows this letter.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey West Bottom Ash Pond. If you have any questions or comments, please feel free to contact us.

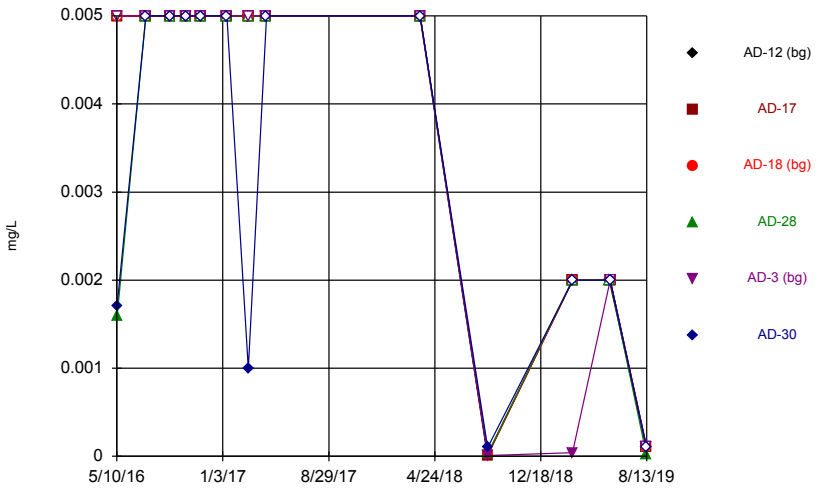
For Groundwater Stats Consulting,

Andrew T. Collins
Groundwater Analyst

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

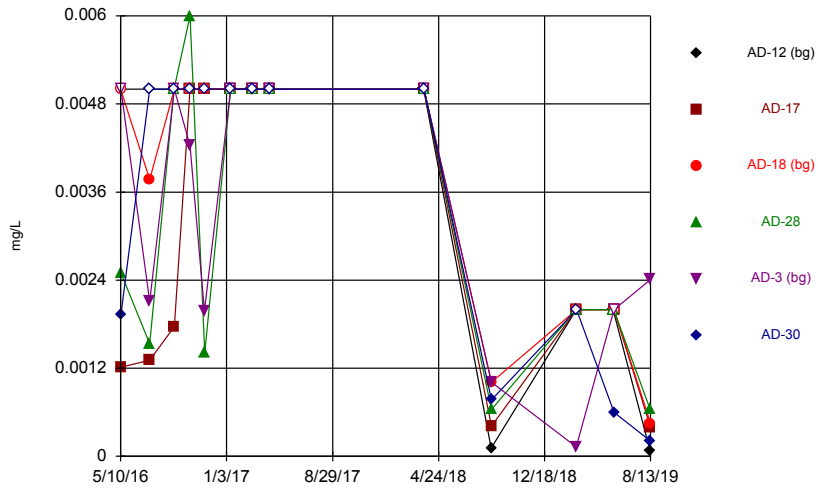
Time Series



Constituent: Antimony, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

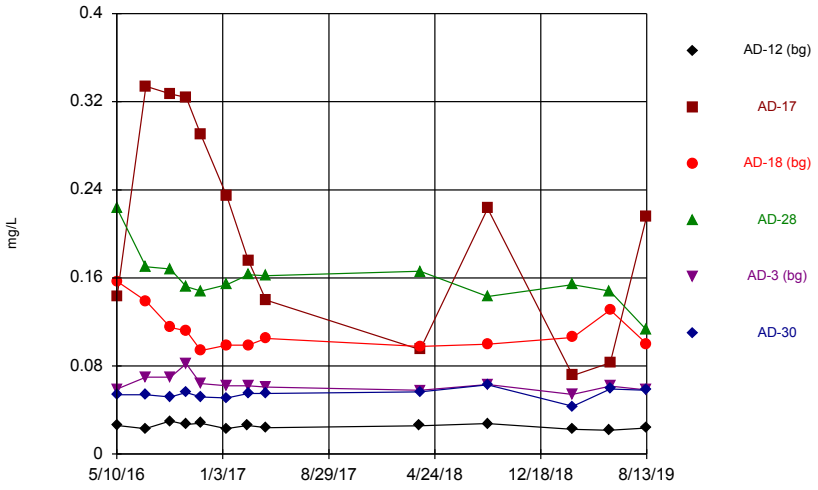
Time Series



Constituent: Arsenic, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

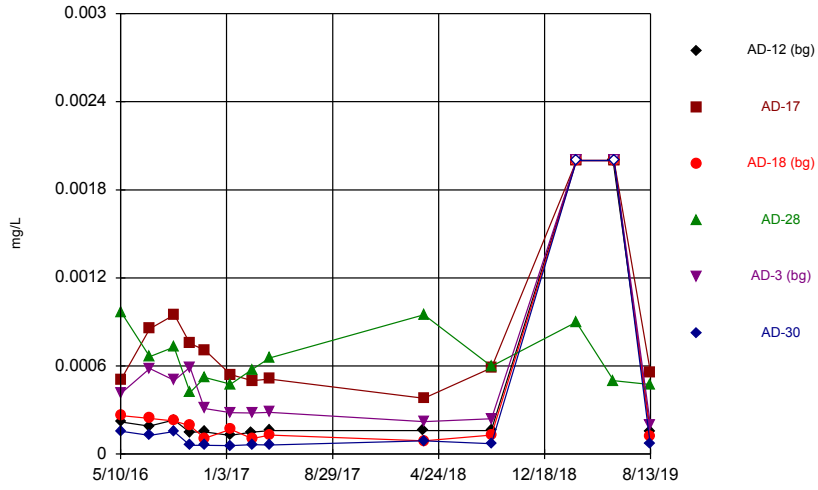
Time Series



Constituent: Barium, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

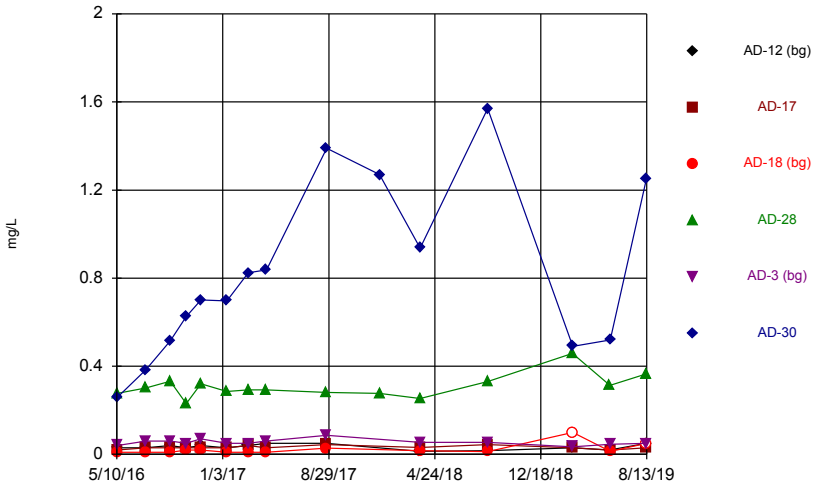
Time Series



Constituent: Beryllium, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

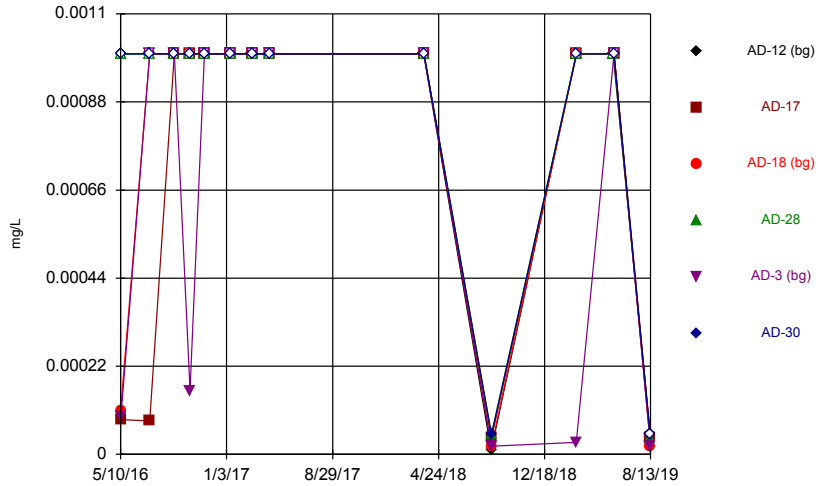
Time Series



Constituent: Boron, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

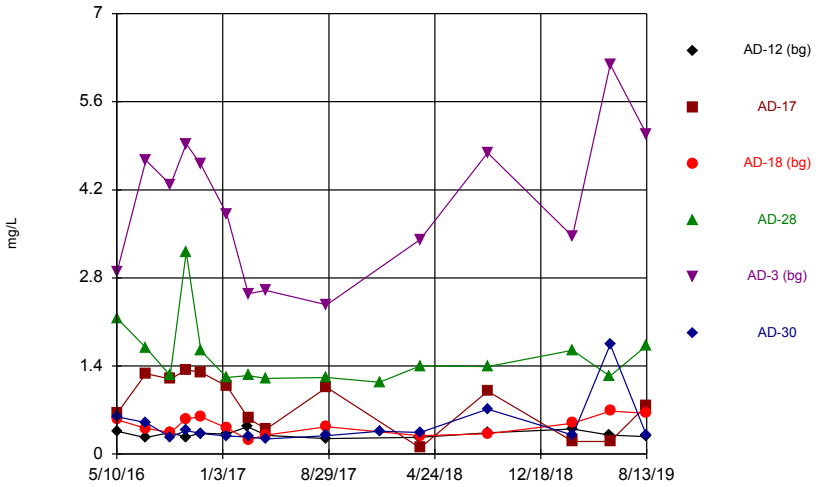
Time Series



Constituent: Cadmium, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

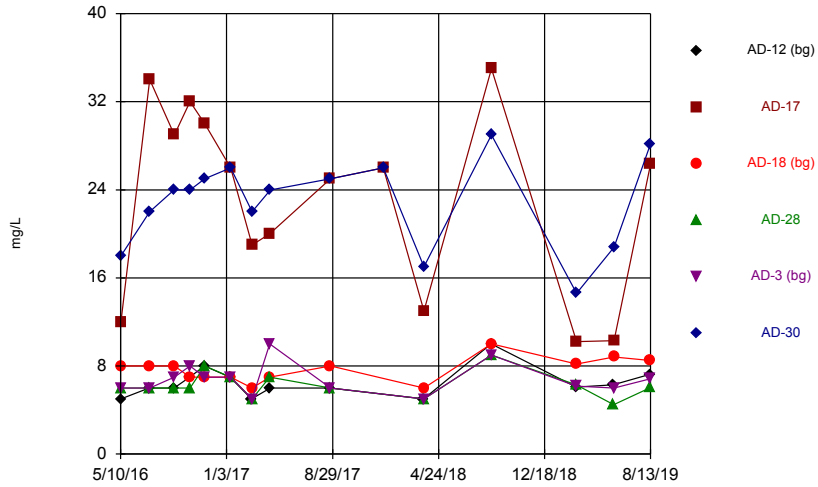
Time Series



Constituent: Calcium, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

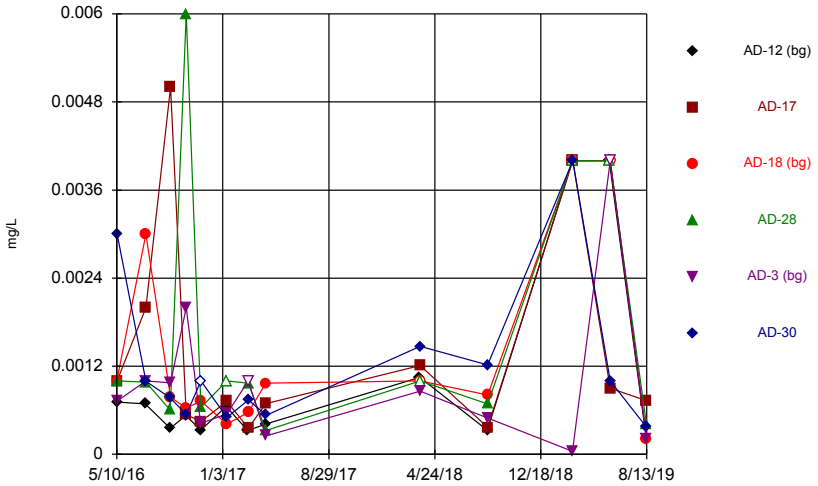
Time Series



Constituent: Chloride, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

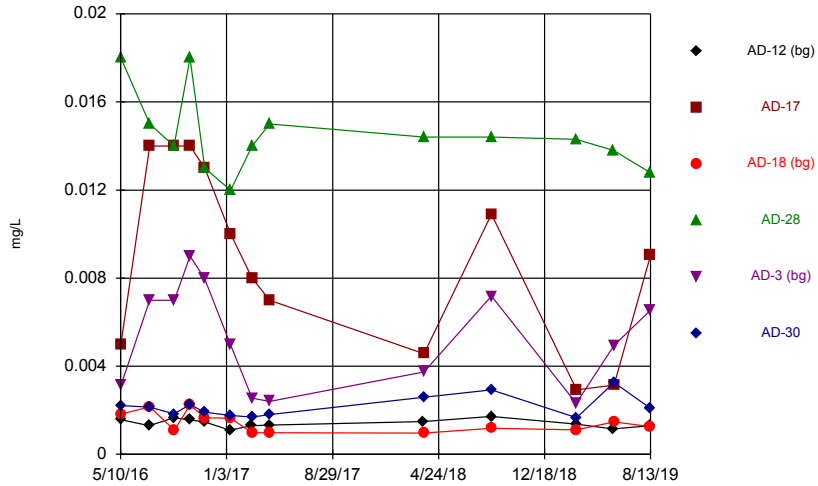
Time Series



Constituent: Chromium, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

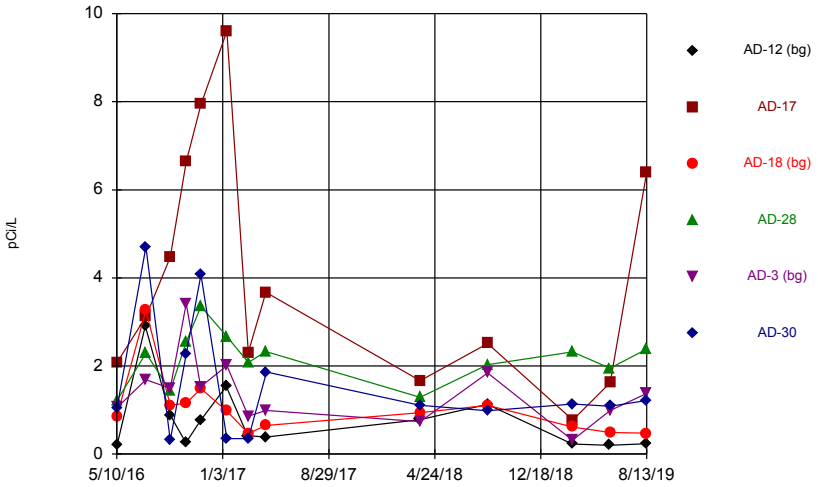
Time Series



Constituent: Cobalt, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

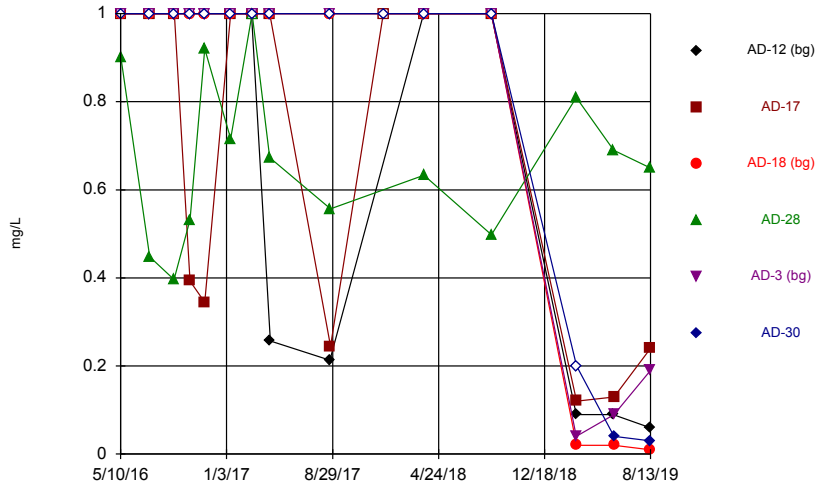
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

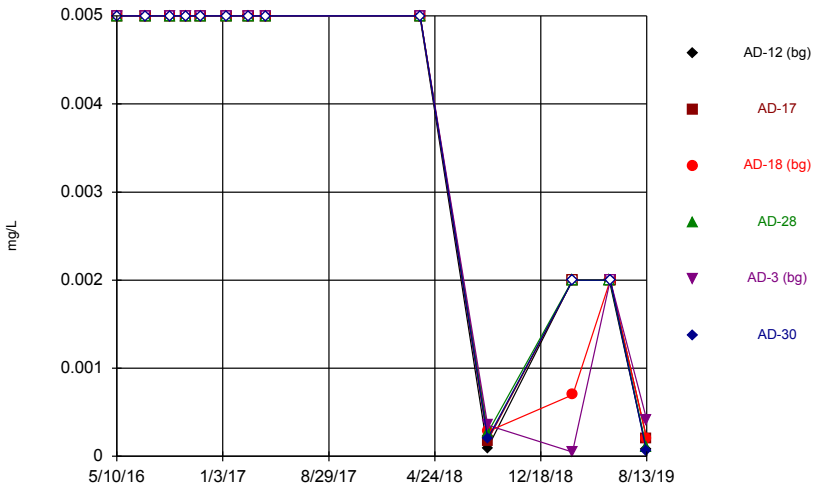
Time Series



Constituent: Fluoride, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

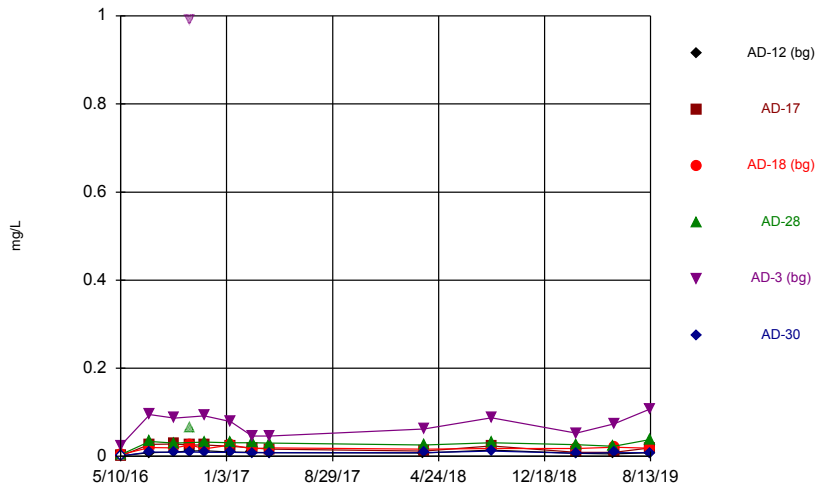
Time Series



Constituent: Lead, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

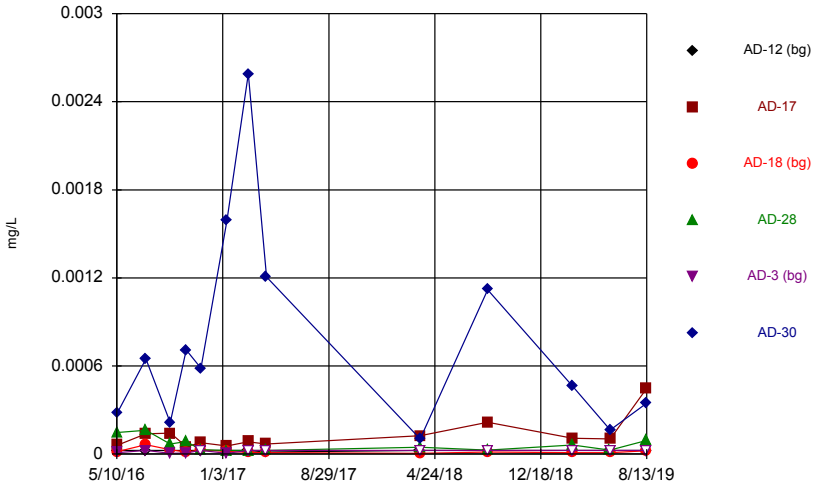
Time Series



Constituent: Lithium, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

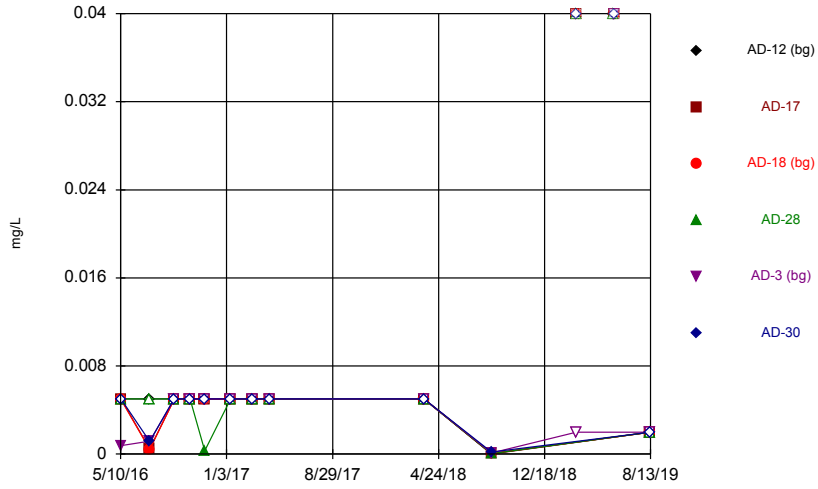
Time Series



Constituent: Mercury, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

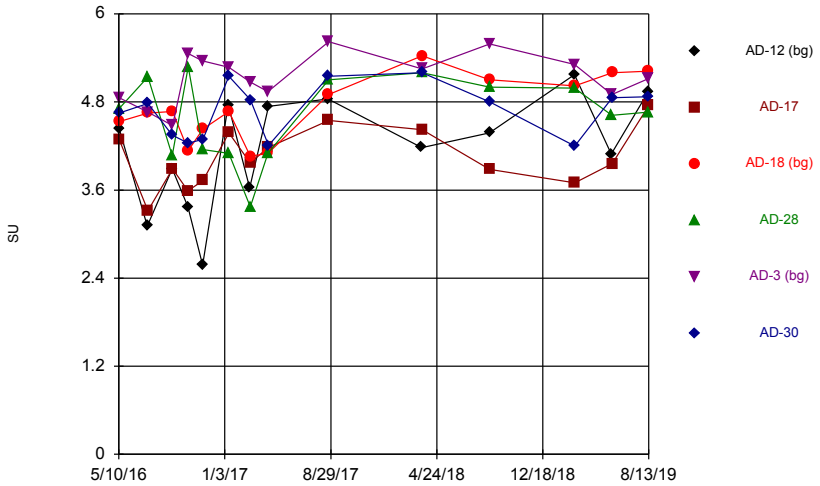
Time Series



Constituent: Molybdenum, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Time Series



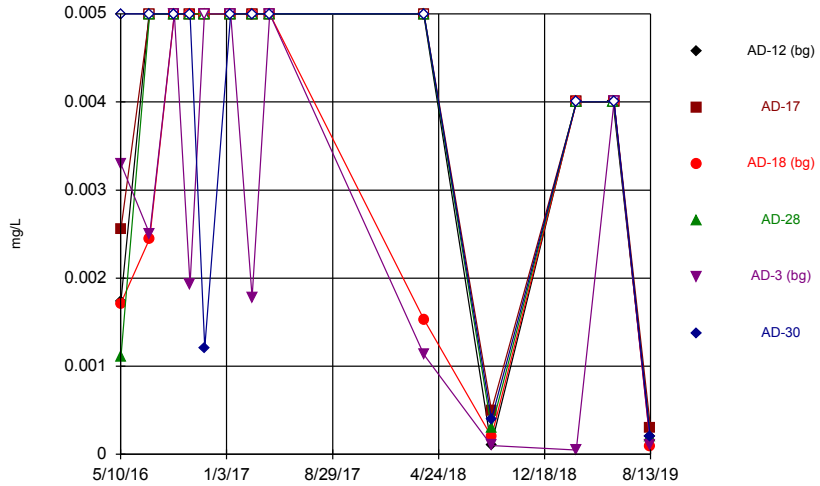
Constituent: pH, field Analysis Run 12/6/2019 8:34 AM

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Time Series

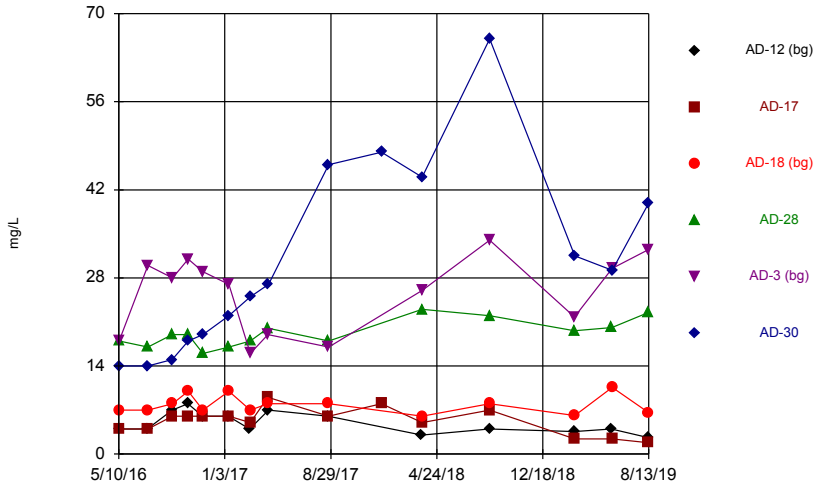


Constituent: Selenium, total Analysis Run 12/6/2019 8:34 AM

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Time Series



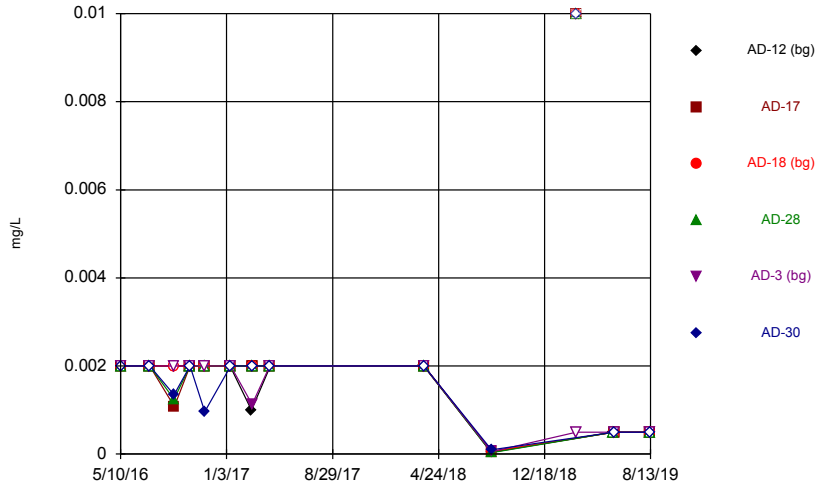
Constituent: Sulfate, total Analysis Run 12/6/2019 8:35 AM

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Time Series

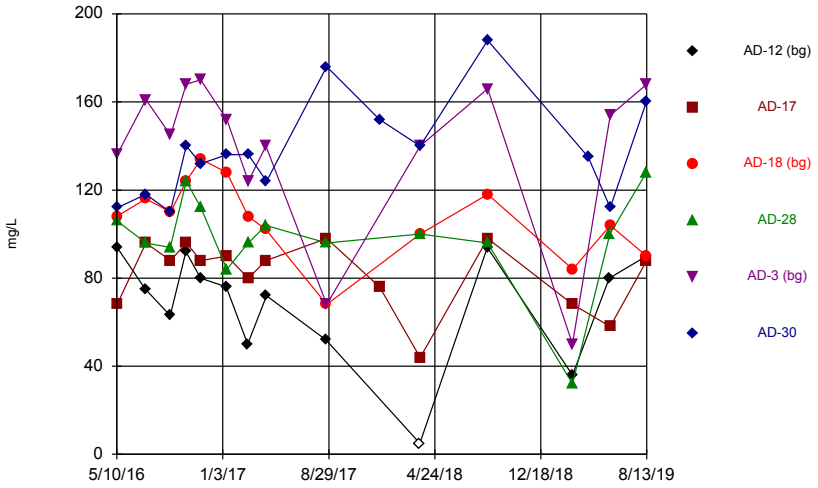


Constituent: Thallium, total Analysis Run 12/6/2019 8:35 AM

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

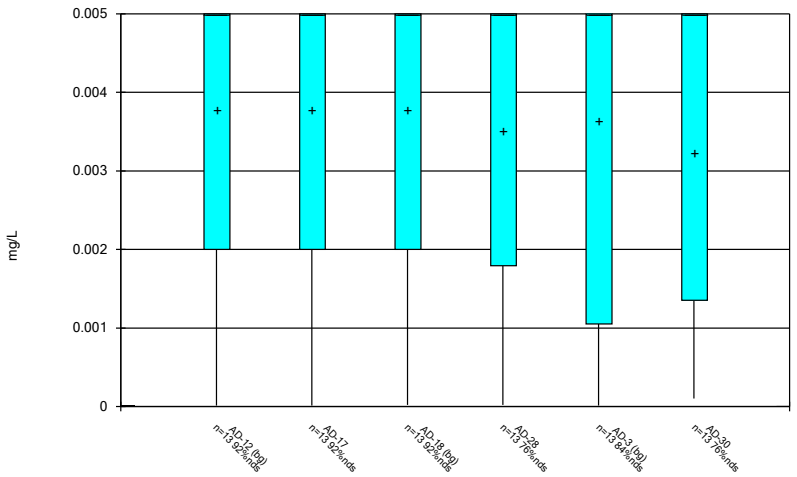
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



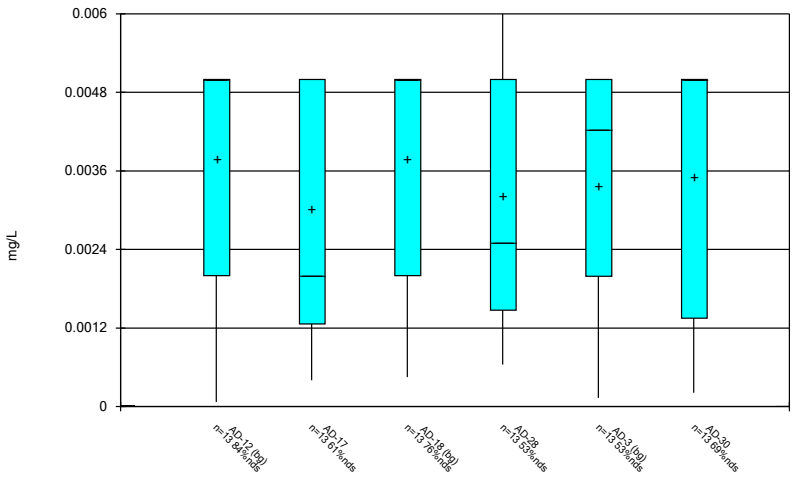
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/6/2019 8:35 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



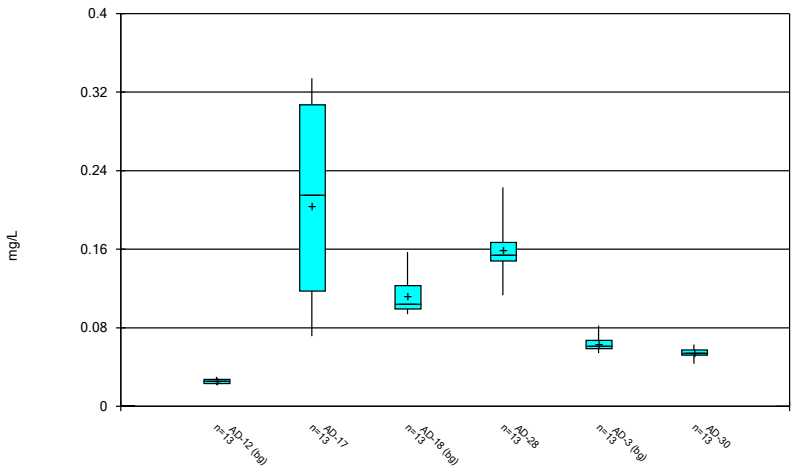
Constituent: Antimony, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



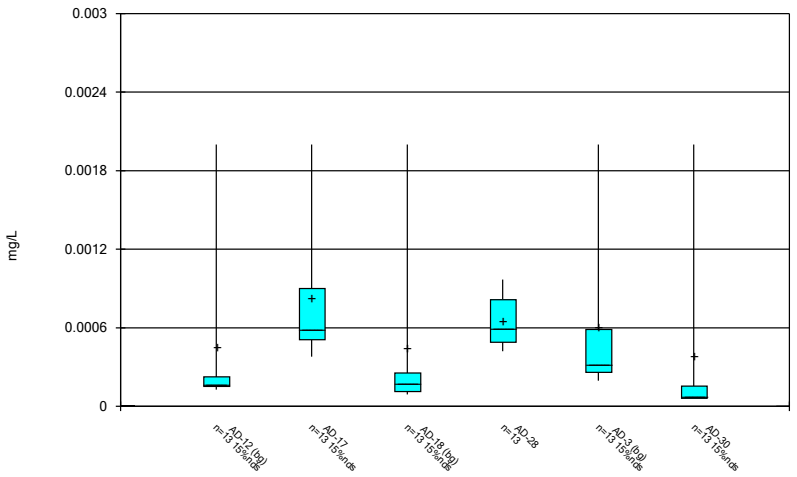
Constituent: Arsenic, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



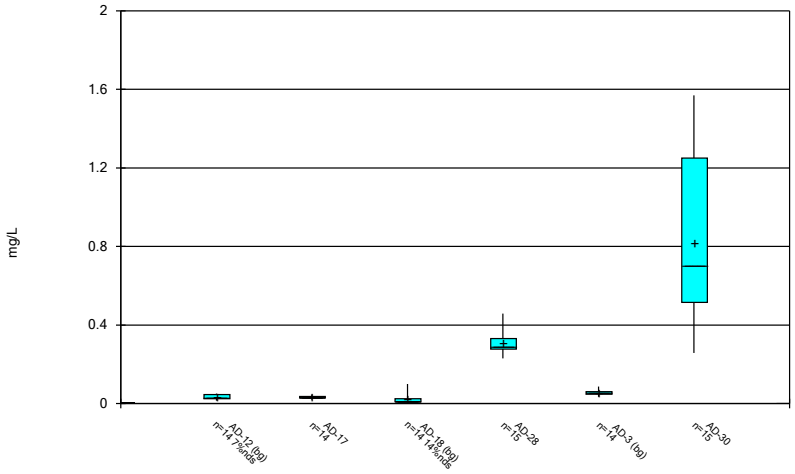
Constituent: Barium, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



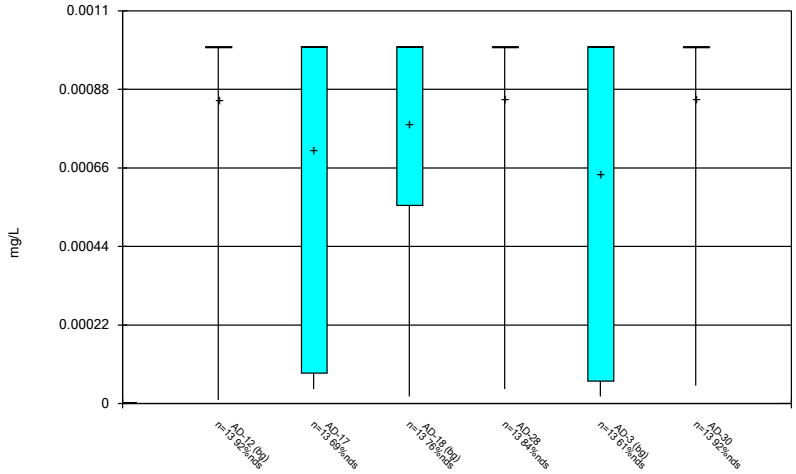
Constituent: Beryllium, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



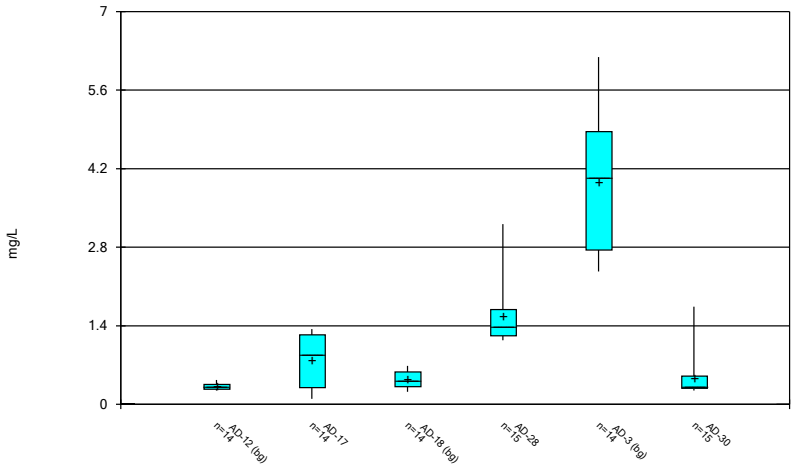
Constituent: Boron, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



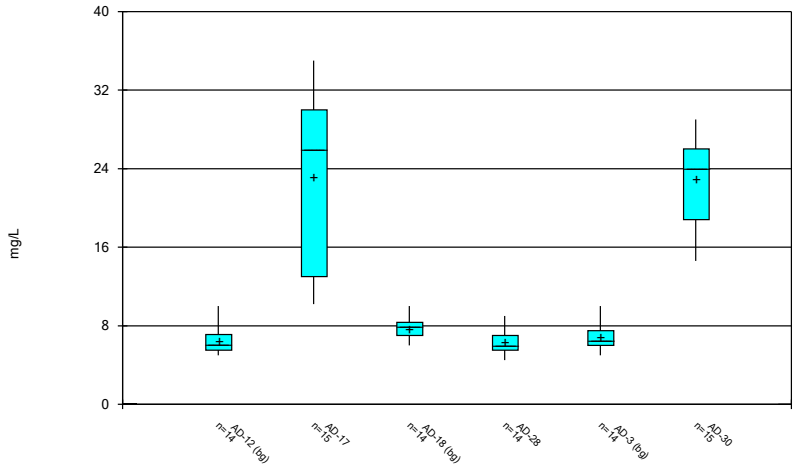
Constituent: Cadmium, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



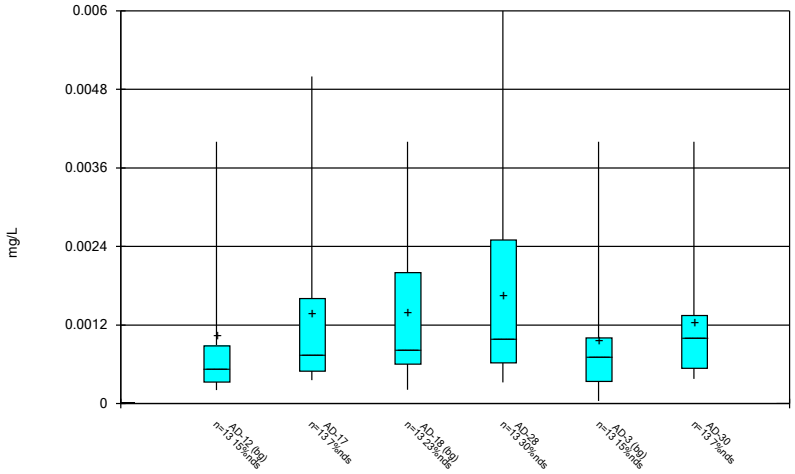
Constituent: Calcium, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



Constituent: Chloride, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

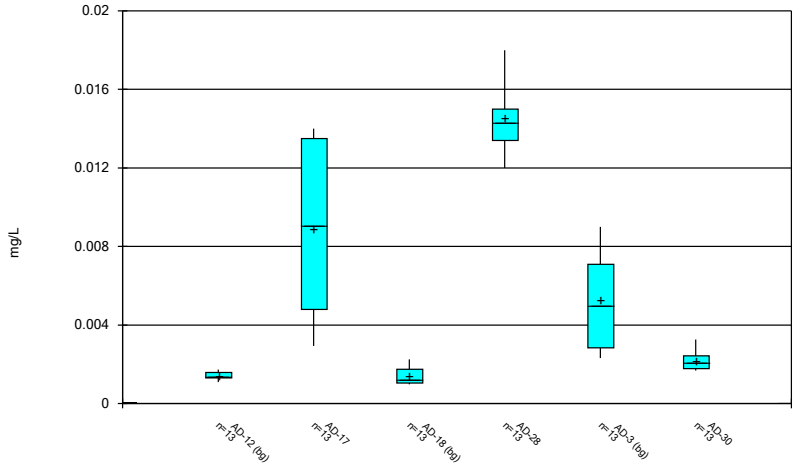
Box & Whiskers Plot



Constituent: Chromium, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

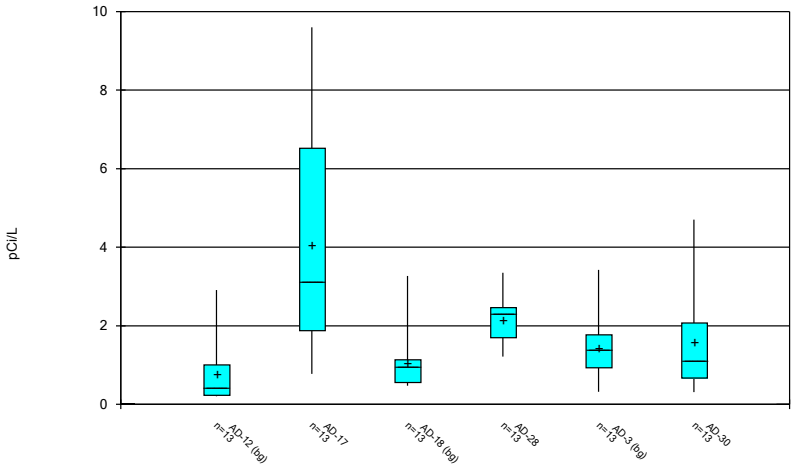
Box & Whiskers Plot



Constituent: Cobalt, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

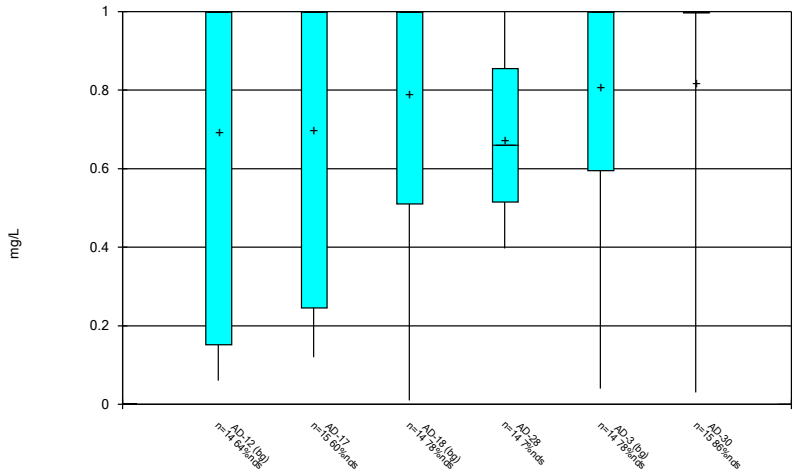
Box & Whiskers Plot



Constituent: Combined Radium 226 + 228 Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

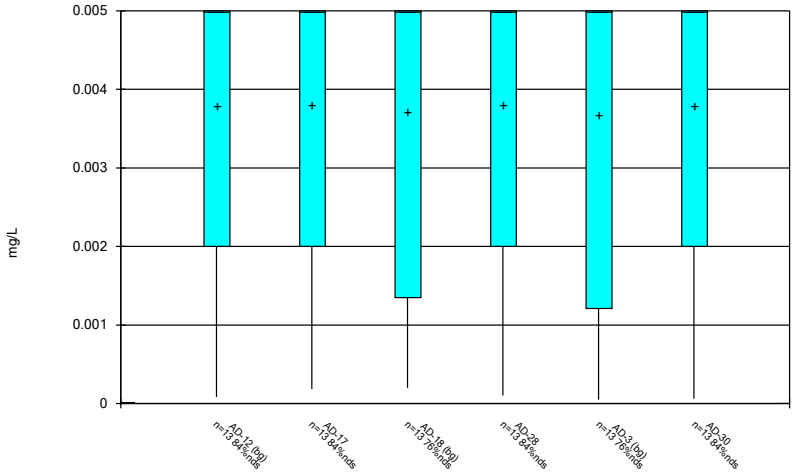
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot



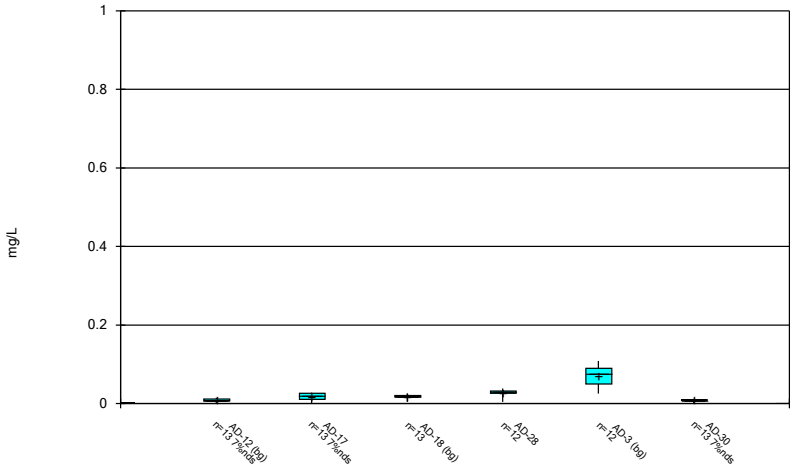
Constituent: Fluoride, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



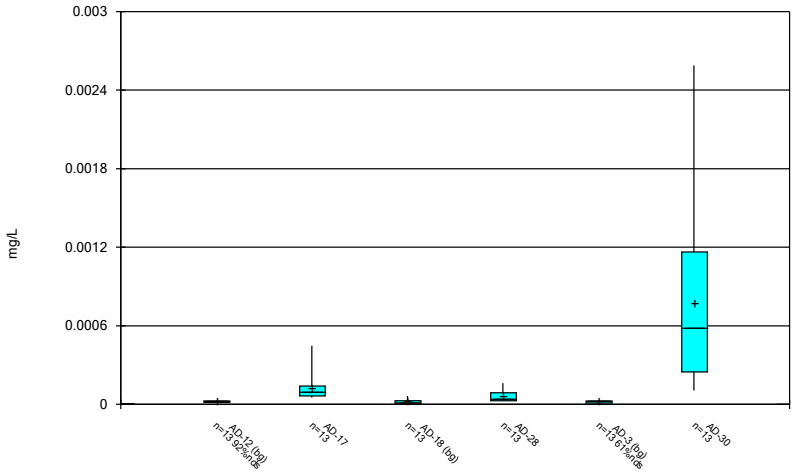
Constituent: Lead, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



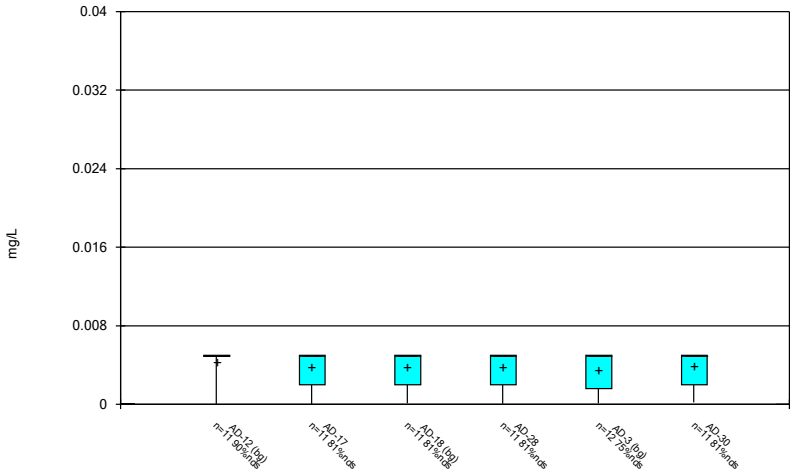
Constituent: Lithium, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



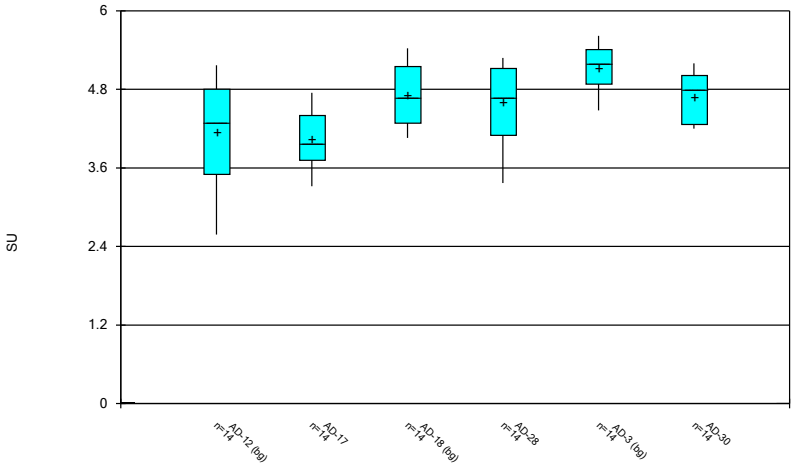
Constituent: Mercury, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



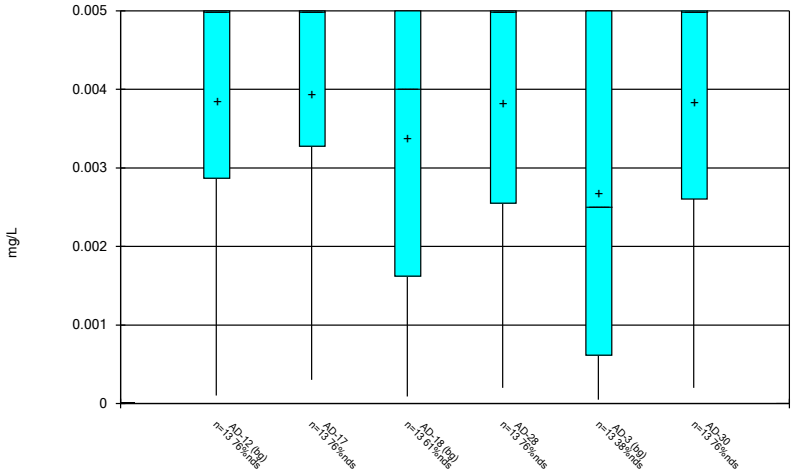
Constituent: Molybdenum, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



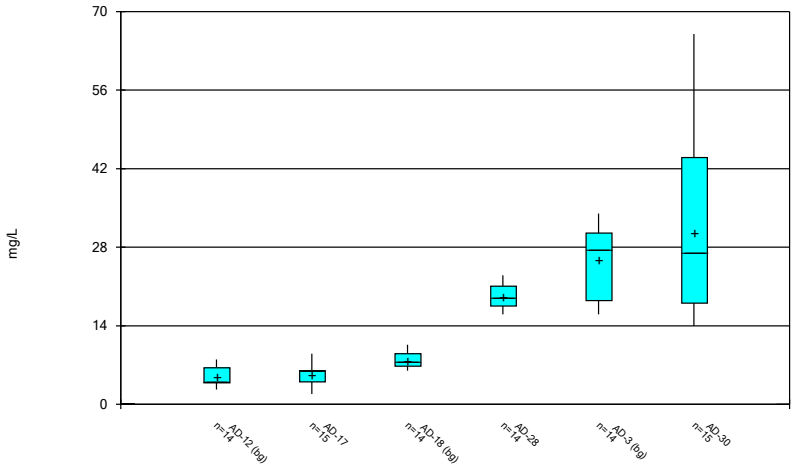
Constituent: pH, field Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



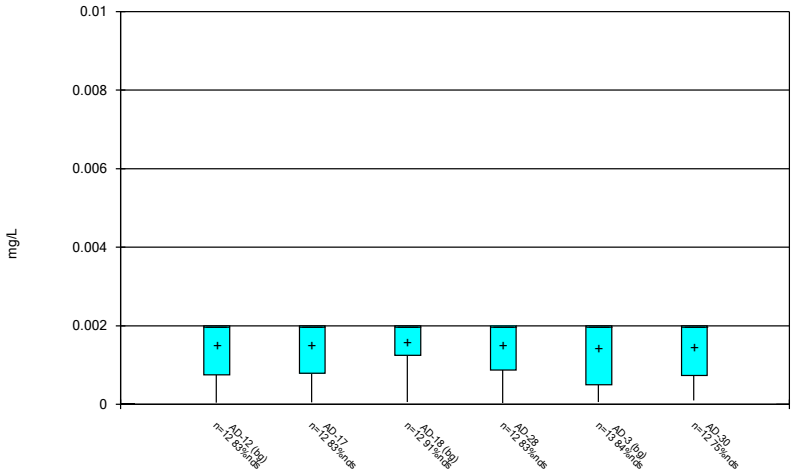
Constituent: Selenium, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



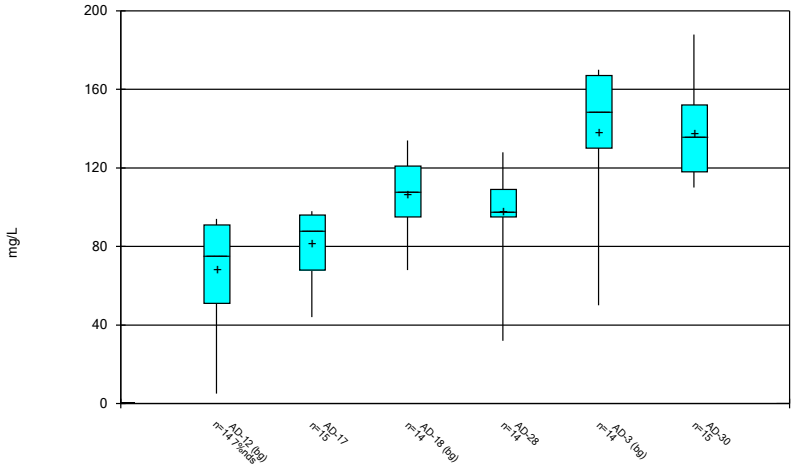
Constituent: Sulfate, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



Constituent: Thallium, total Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Outlier Summary

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/6/2019, 8:40 AM

	AD-28 Lithium, total (mg/L)	AD-3 Lithium, total (mg/L)	AD-12 Molybdenum, total (mg/L)	AD-17 Molybdenum, total (mg/L)	AD-18 Molybdenum, total (mg/L)	AD-28 Molybdenum, total (mg/L)	AD-3 Molybdenum, total (mg/L)	AD-30 Molybdenum, total (mg/L)	AD-12 Thallium, total (mg/L)	AD-17 Thallium, total (mg/L)
10/13/2016	0.066 (o)	0.991 (o)								
2/27/2019			<0.04 (o)			<0.04 (o)			<0.01 (o)	
2/28/2019				<0.04 (o)	<0.04 (o)			<0.04 (o)		<0.01 (o)
5/21/2019			<0.04 (o)							
5/22/2019						<0.04 (o)				
5/23/2019				<0.04 (o)	<0.04 (o)		<0.04 (o)	<0.04 (o)		

	AD-18 Thallium, total (mg/L)	AD-28 Thallium, total (mg/L)	AD-30 Thallium, total (mg/L)
10/13/2016			
2/27/2019		<0.01 (o)	
2/28/2019	<0.01 (o)		<0.01 (o)
5/21/2019			
5/22/2019			
5/23/2019			

Welch's t-test/Mann-Whitney - Significant Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/9/2019, 7:40 AM

Constituent	Well	Calc.	0.01	Method
pH, field (SU)	**AD-18 (bg)**	**2.637**	**Yes**	**Mann-W**
Sulfate, total (mg/L)	**AD-30**	**2.858**	**Yes**	**Mann-W**

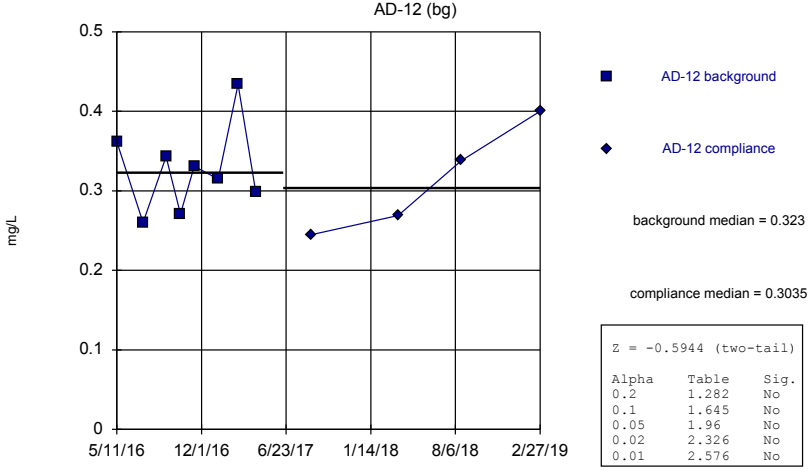
Welch's t-test/Mann-Whitney - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/9/2019, 7:40 AM

Constituent	Well	Calc.	0.01	Method
Calcium, total (mg/L)	AD-12 (bg)	-0.5944	No	Mann-W
Calcium, total (mg/L)	AD-17	-1.783	No	Mann-W
Calcium, total (mg/L)	AD-18 (bg)	-0.5944	No	Mann-W
Calcium, total (mg/L)	AD-28	-0.8807	No	Mann-W
Calcium, total (mg/L)	AD-3 (bg)	-0.5944	No	Mann-W
Calcium, total (mg/L)	AD-30	0.8051	No	Mann-W
pH, field (SU)	AD-12 (bg)	1.613	No	Mann-W
pH, field (SU)	AD-17	0.7643	No	Mann-W
pH, field (SU)	**AD-18 (bg)**	**2.637**	**Yes**	**Mann-W**
pH, field (SU)	AD-28	1.446	No	Mann-W
pH, field (SU)	AD-3 (bg)	1.783	No	Mann-W
pH, field (SU)	AD-30	0.8507	No	Mann-W
Sulfate, total (mg/L)	AD-12 (bg)	-1.919	No	Mann-W
Sulfate, total (mg/L)	AD-17	0.151	No	Mann-W
Sulfate, total (mg/L)	AD-18 (bg)	-1.147	No	Mann-W
Sulfate, total (mg/L)	AD-28	1.802	No	Mann-W
Sulfate, total (mg/L)	AD-3 (bg)	-0.2548	No	Mann-W
Sulfate, total (mg/L)	**AD-30**	**2.858**	**Yes**	**Mann-W**
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-1.361	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-17	-0.4434	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-18 (bg)	-1.957	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-28	-1.124	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-3 (bg)	-1.361	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-30	2.557	No	Mann-W

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



Z = -0.5944 (two-tail)

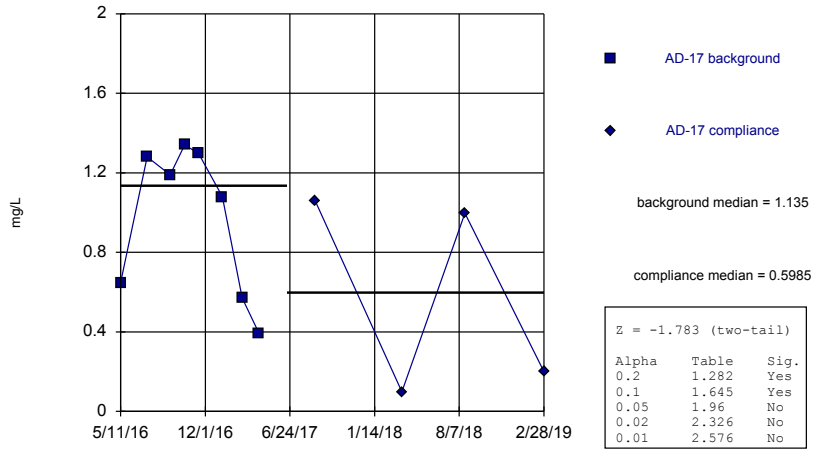
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-17



Z = -1.783 (two-tail)

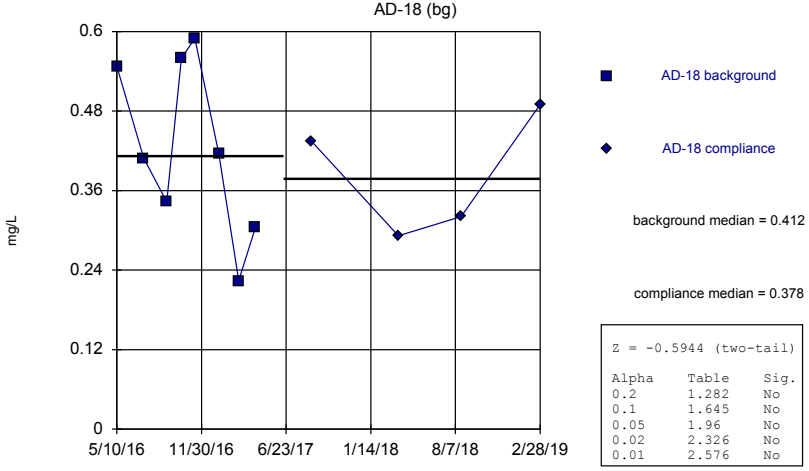
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-18 (bg)



Z = -0.5944 (two-tail)

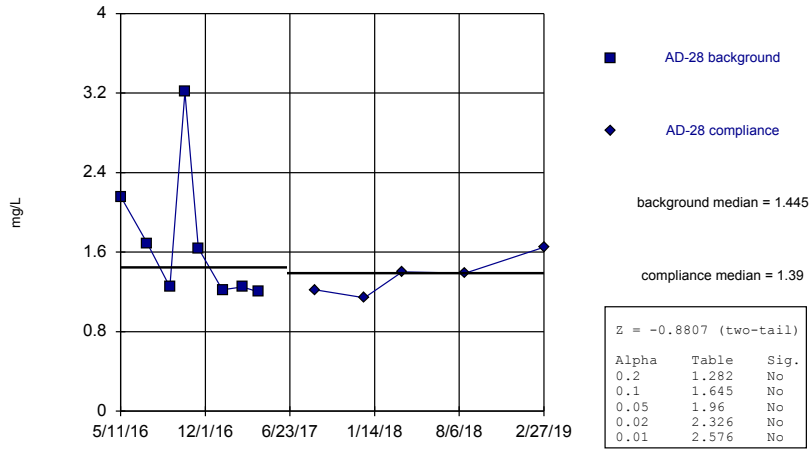
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-28



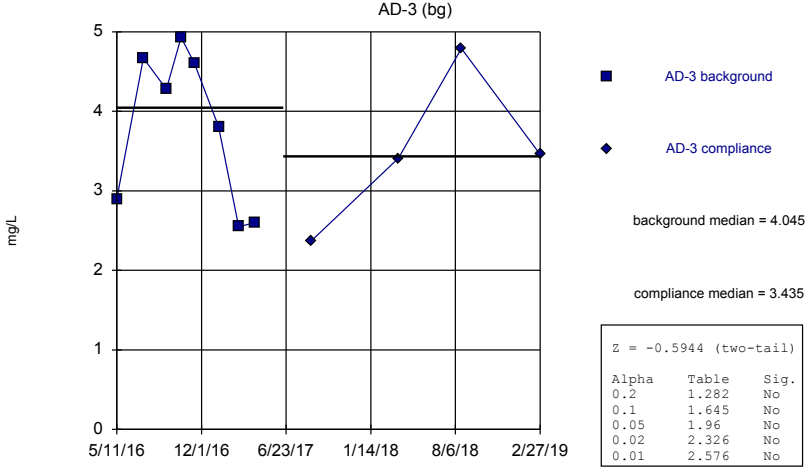
Z = -0.8807 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

AD-3 (bg)



Z = -0.5944 (two-tail)

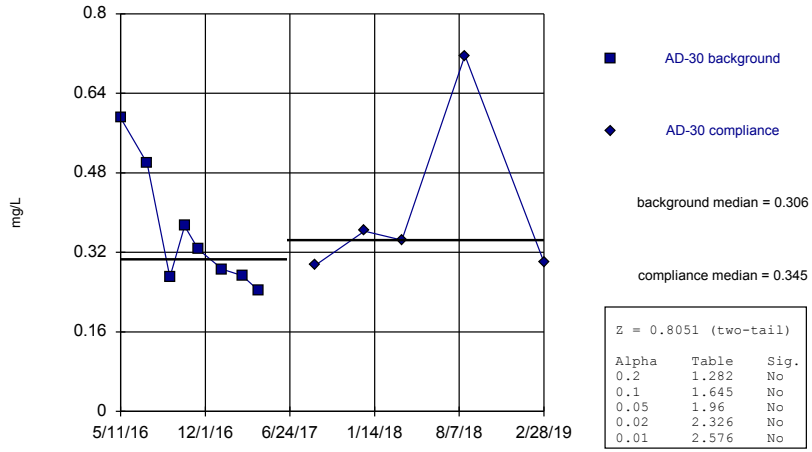
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-30



Z = 0.8051 (two-tail)

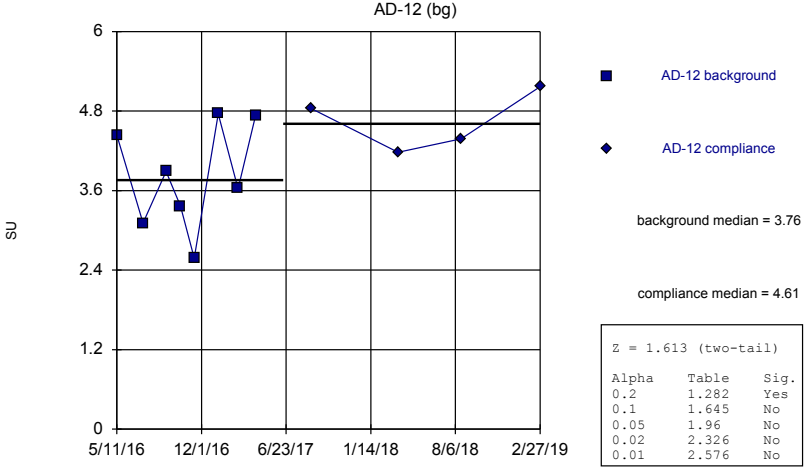
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



Z = 1.613 (two-tail)

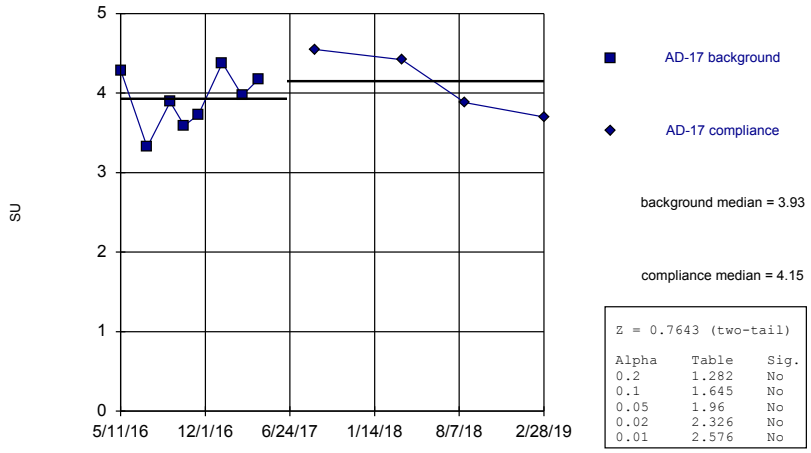
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: pH, field Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-17



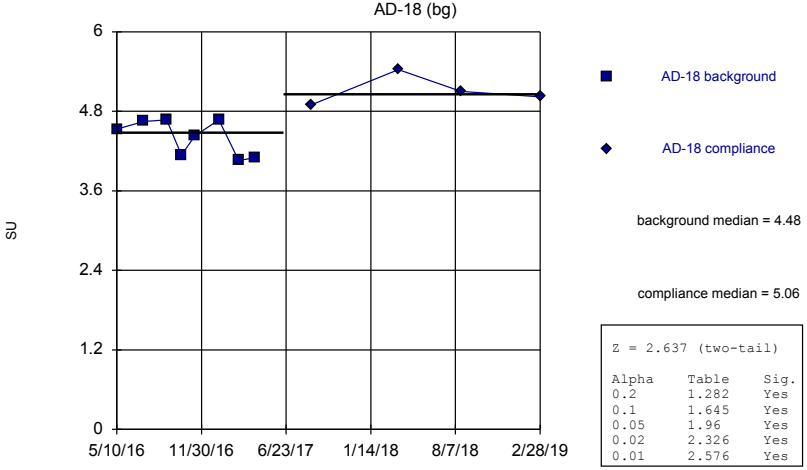
Z = 0.7643 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: pH, field Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

AD-18 (bg)

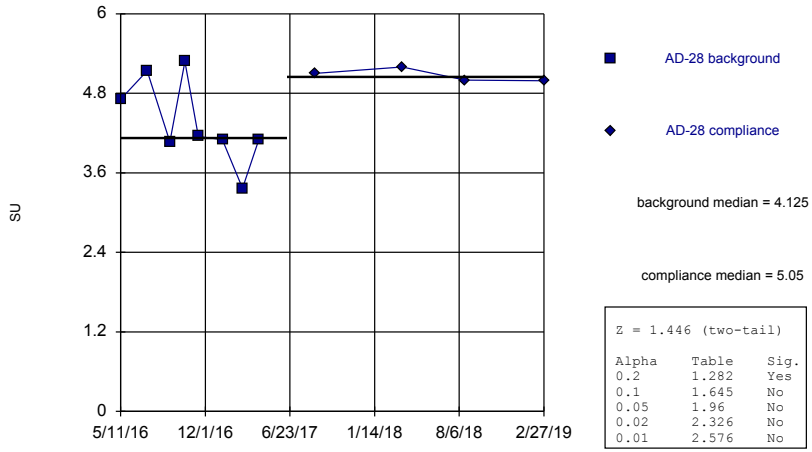


Constituent: pH, field Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-28

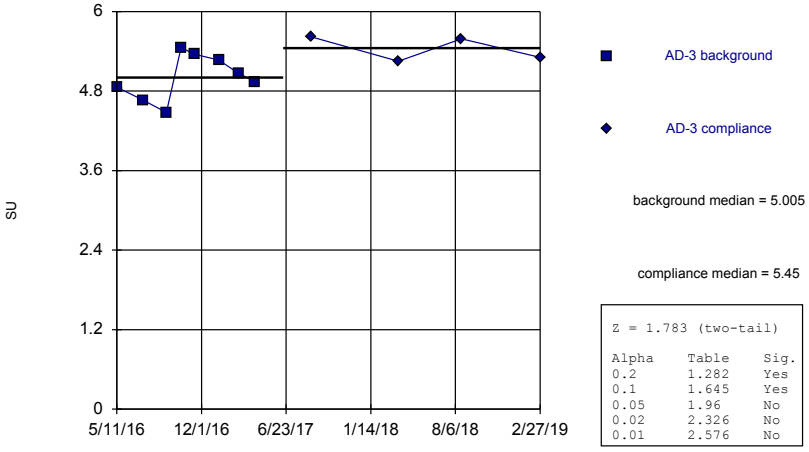


Constituent: pH, field Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-3 (bg)

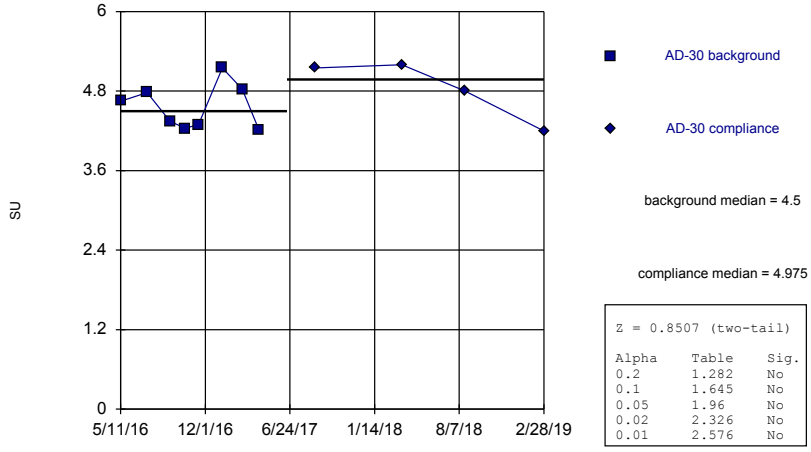


Constituent: pH, field Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

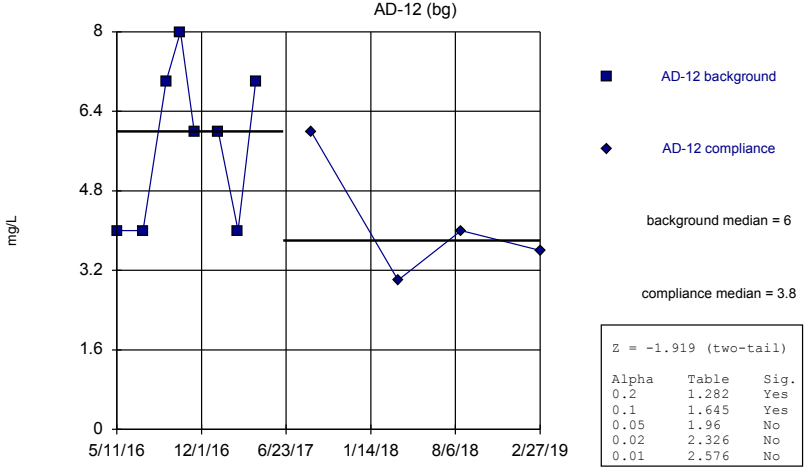
AD-30



Constituent: pH, field Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)

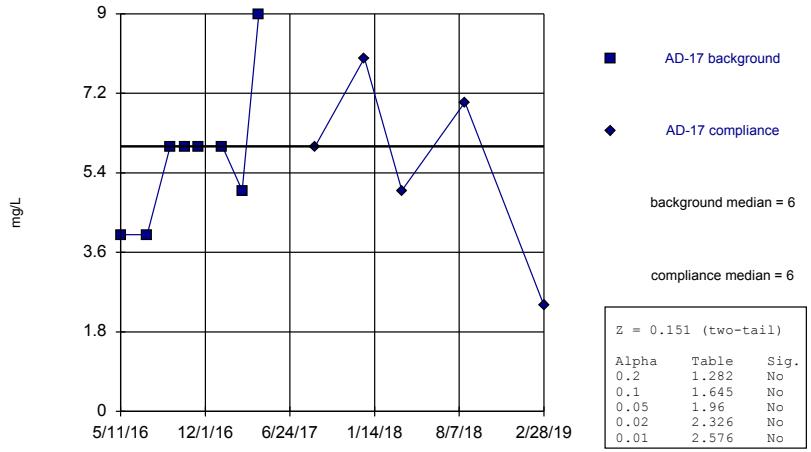


Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-17

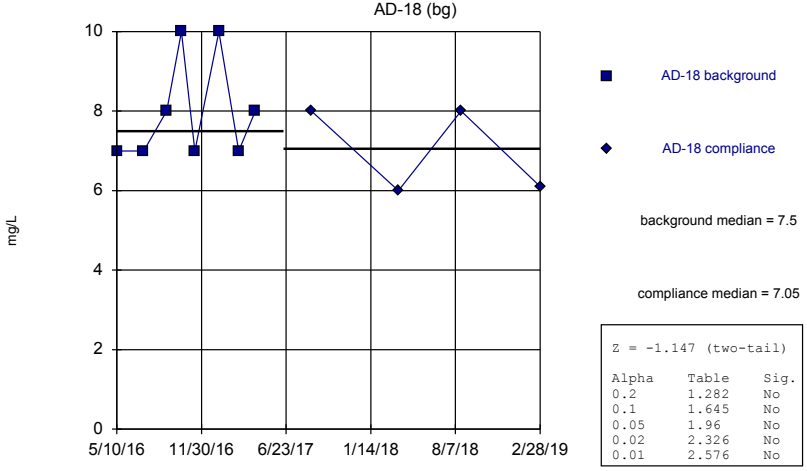


Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-18 (bg)

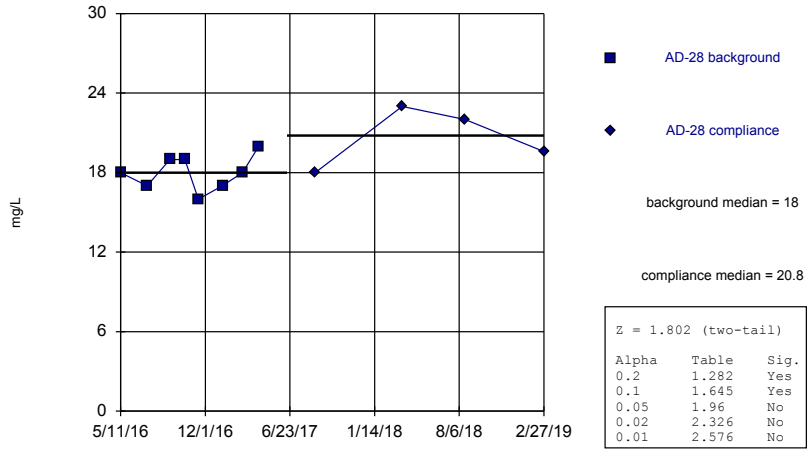


Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

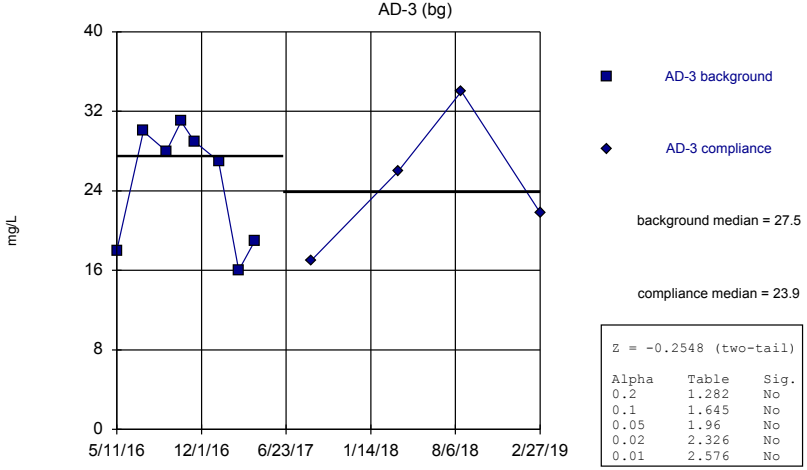
AD-28



Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

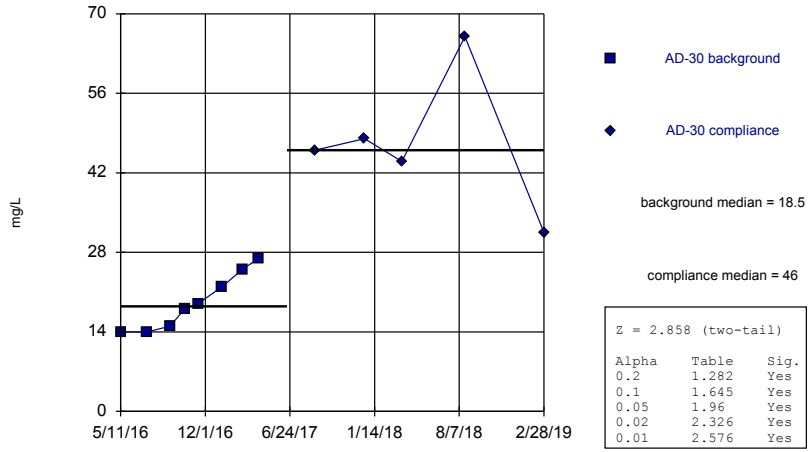
AD-3 (bg)



Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

AD-30

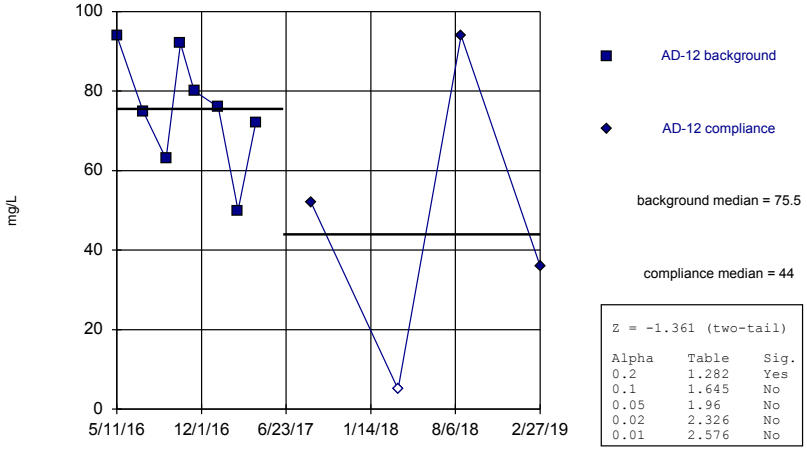


Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

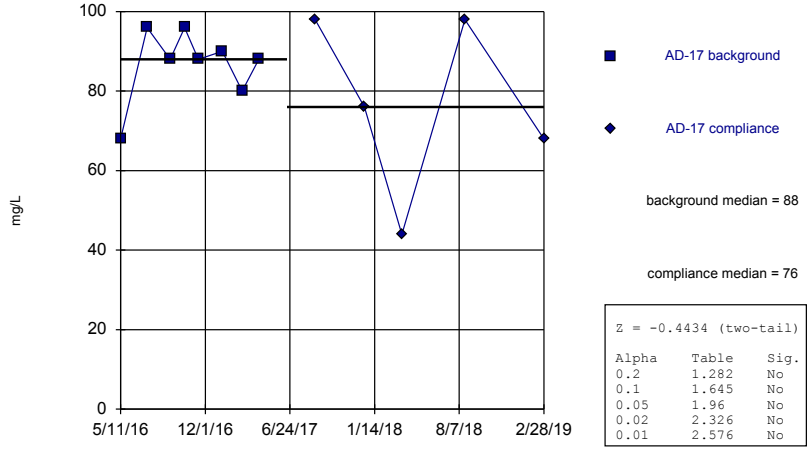
AD-12 (bg)



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

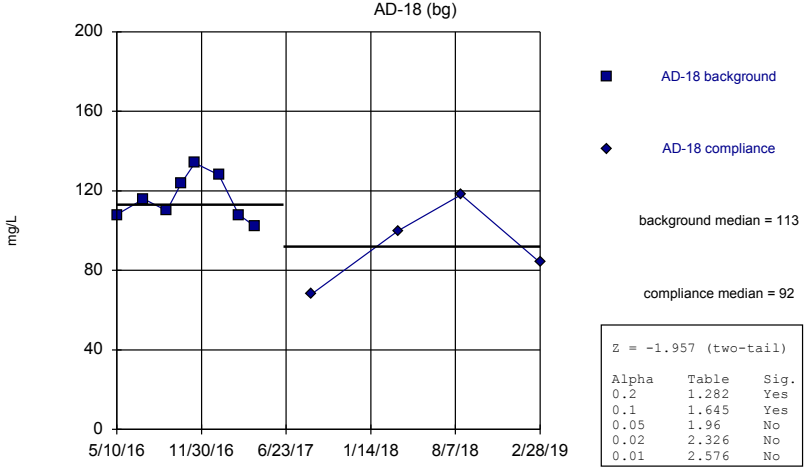
AD-17



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

AD-18 (bg)



Z = -1.957 (two-tail)

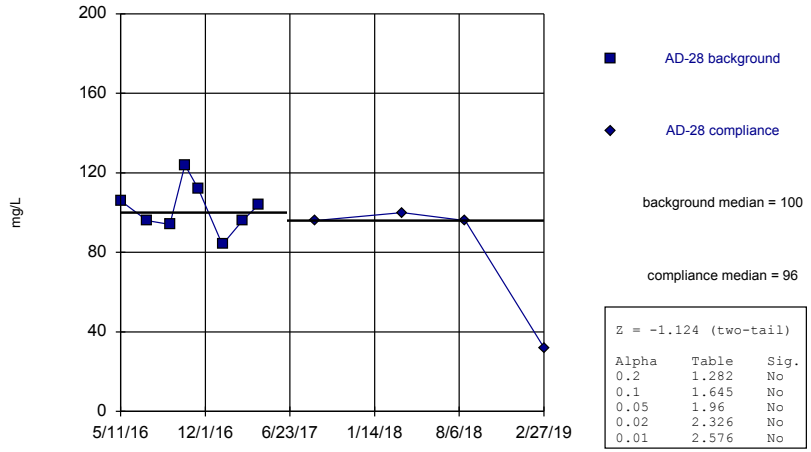
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-28



Z = -1.124 (two-tail)

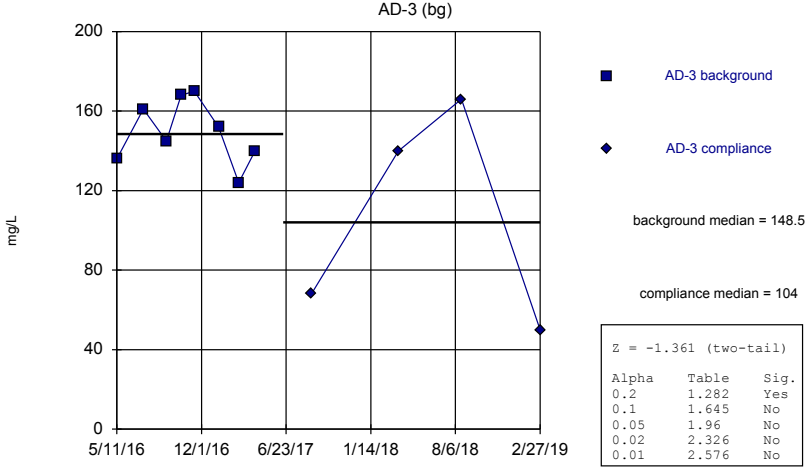
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-3 (bg)



Z = -1.361 (two-tail)

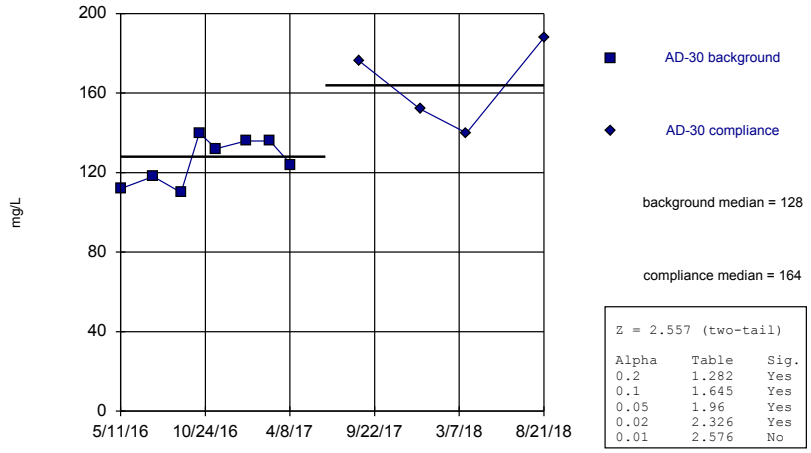
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-30



Z = 2.557 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	Yes
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Date Ranges

Date: 12/9/2019 7:43 AM

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

pH, field (SU)

AD-18 background:11/15/2016-2/28/2019

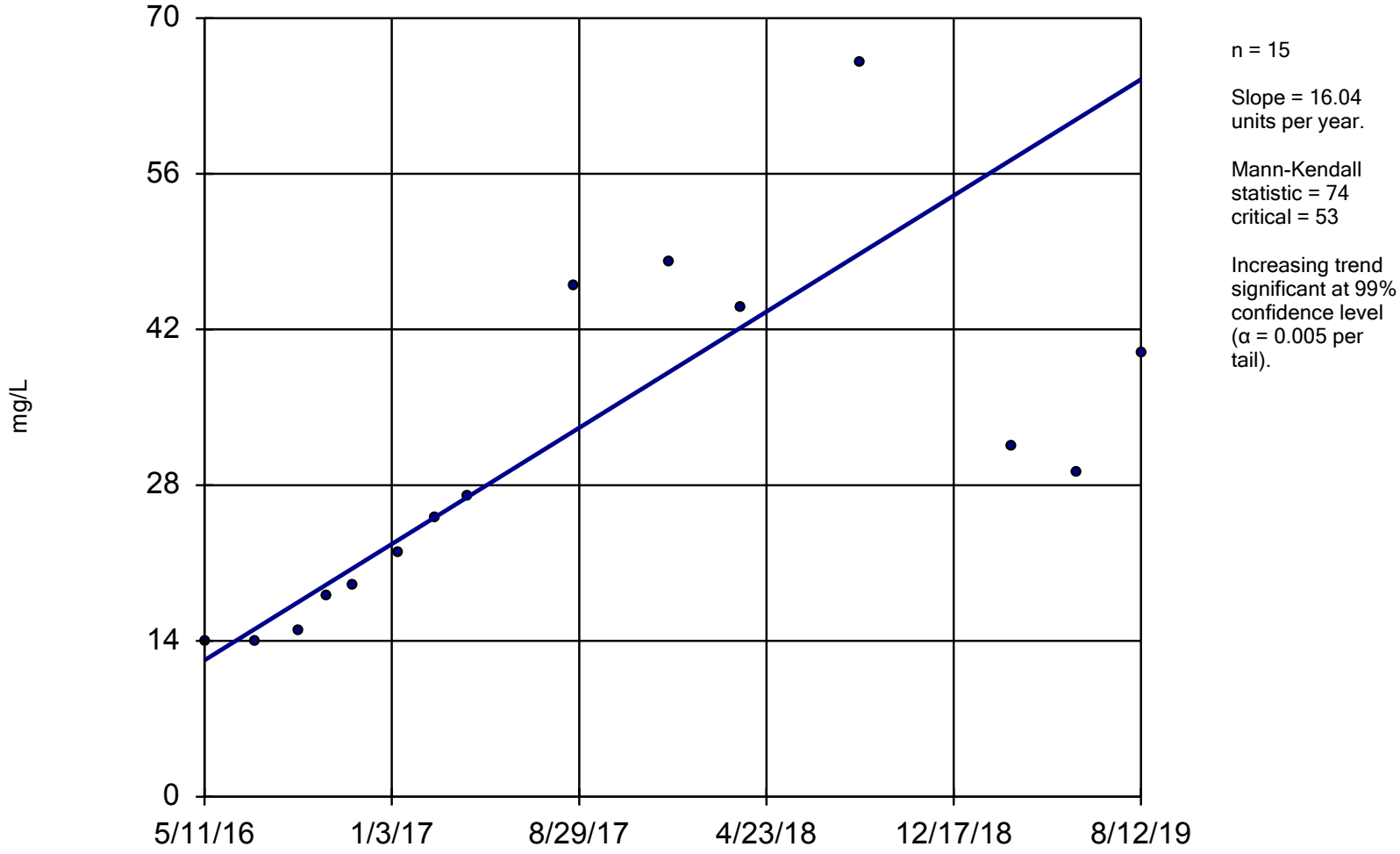
Trend Tests Summary Table - All Resuts

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 11/25/2019, 6:30 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Sulfate, total (mg/L)	**AD-30**	**16.04**	**74**	**53**	**Yes**	**15**	**0**	**n/a**	**n/a**	**0.01**	**NP**

Sen's Slope Estimator

AD-30



n = 15

Slope = 16.04 units per year.

Mann-Kendall statistic = 74
critical = 53

Increasing trend significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 11/25/2019 6:29 PM View: Intrawell Trend Tests

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

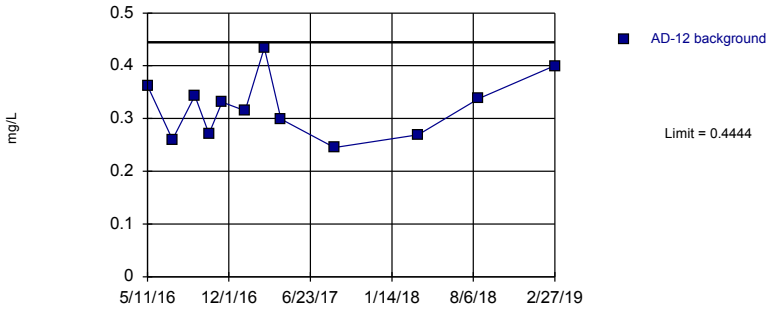
Intrawell Prediction Limit Summary Table - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/9/2019, 7:45 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-12	0.4444	n/a	n/a	1 future	n/a	12	0.3223	0.05781	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-17	1.786	n/a	n/a	1 future	n/a	12	0.8465	0.4447	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-18	0.6601	n/a	n/a	1 future	n/a	12	0.4109	0.118	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-28	2.758	n/a	n/a	1 future	n/a	13	0.4061	0.2931	0	None	ln(x)	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-3	5.702	n/a	n/a	1 future	n/a	12	3.698	0.9488	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-30	0.6804	n/a	n/a	1 future	n/a	13	0.604	0.1064	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
pH, field (SU)	AD-12	5.754	2.427	n/a	1 future	n/a	12	4.091	0.7877	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-17	4.787	3.196	n/a	1 future	n/a	12	3.992	0.3766	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-18	5.917	3.511	n/a	1 future	n/a	8	4.714	0.4895	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-28	5.903	3.298	n/a	1 future	n/a	12	4.601	0.6168	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-3	5.917	4.395	n/a	1 future	n/a	12	5.156	0.3603	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-30	5.474	3.834	n/a	1 future	n/a	12	4.654	0.3882	0	None	No	0.001253	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-12	8.669	n/a	n/a	1 future	n/a	12	5.217	1.635	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-17	9.318	n/a	n/a	1 future	n/a	13	5.723	1.731	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-18	10.4	n/a	n/a	1 future	n/a	12	7.675	1.291	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-28	23.21	n/a	n/a	1 future	n/a	12	18.88	2.049	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-3	37.65	n/a	n/a	1 future	n/a	12	24.73	6.115	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	121.8	n/a	n/a	1 future	n/a	12	65.75	26.52	8.333	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-17	115.4	n/a	n/a	1 future	n/a	13	82.92	15.65	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-18	147.5	n/a	n/a	1 future	n/a	12	108.3	18.52	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-28	129.1	n/a	n/a	1 future	n/a	12	9479	3403	0	None	x^2	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-3	194.3	n/a	n/a	1 future	n/a	12	19577	8603	0	None	x^2	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-30	189	n/a	n/a	1 future	n/a	12	138.7	23.82	0	None	No	0.002505	Param Intra 1 of 2

Prediction Limit

Intrawell Parametric, AD-12 (bg)

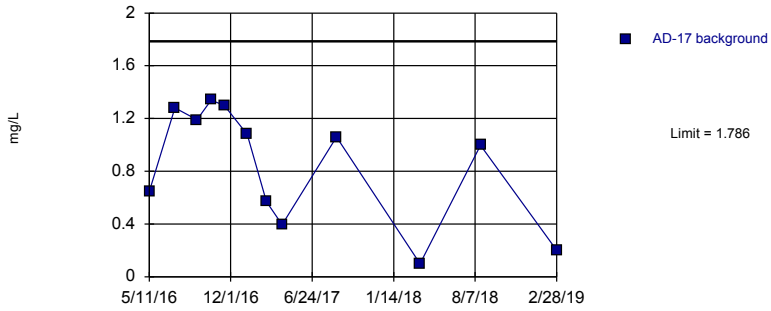


Background Data Summary: Mean=0.3223, Std. Dev.=0.05781, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9547, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-17

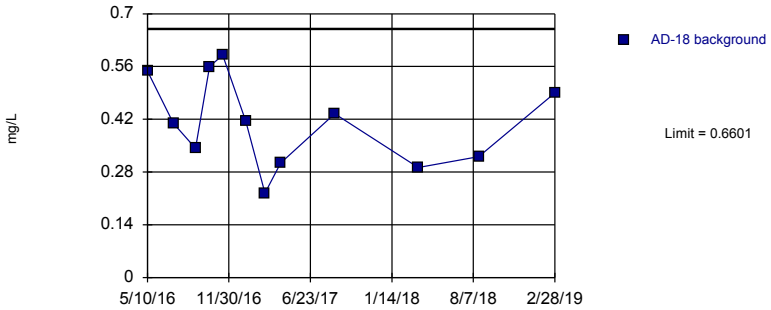


Background Data Summary: Mean=0.8465, Std. Dev.=0.4447, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8925, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-18 (bg)

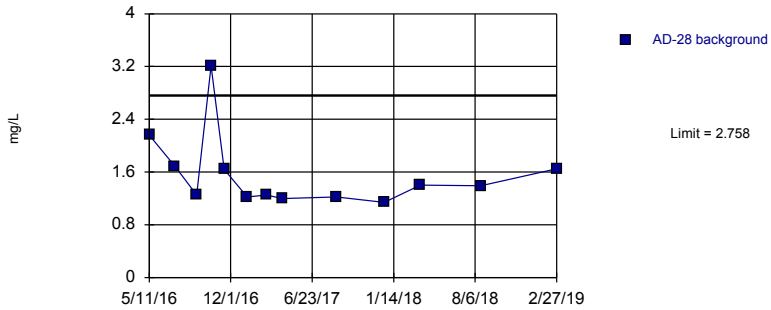


Background Data Summary: Mean=0.4109, Std. Dev.=0.118, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.954, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-28

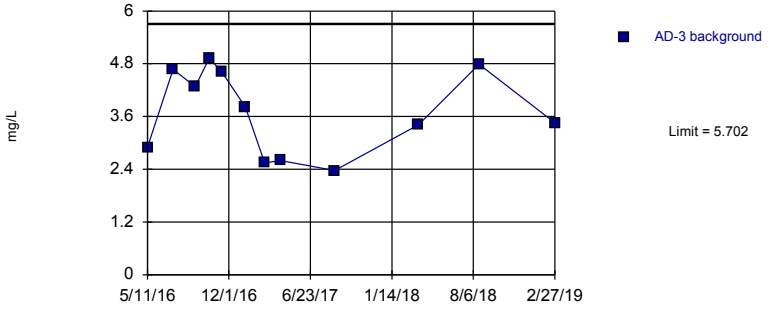


Background Data Summary (based on natural log transformation): Mean=0.4061, Std. Dev.=0.2931, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8147, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-3 (bg)

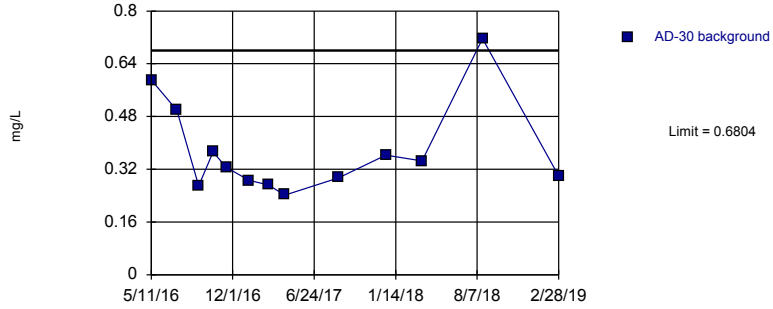


Background Data Summary: Mean=3.698, Std. Dev.=0.9488, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9055, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-30

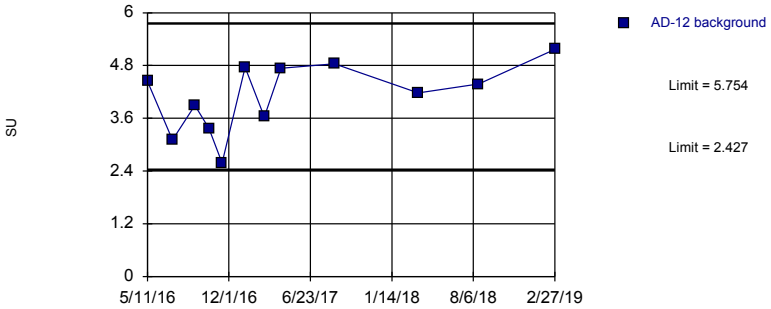


Background Data Summary (based on square root transformation): Mean=0.604, Std. Dev.=0.1064, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8451, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-12 (bg)

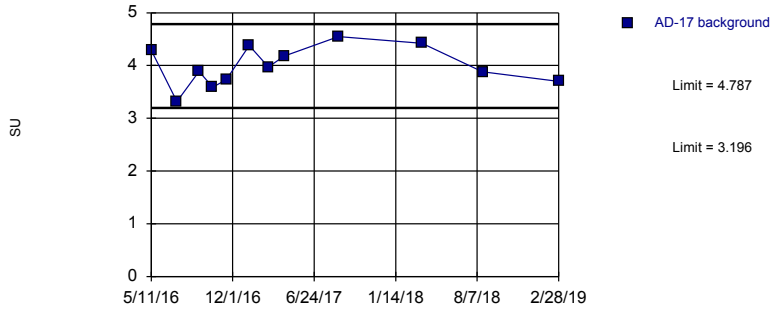


Background Data Summary: Mean=4.091, Std. Dev.=0.7877, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9544, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-17

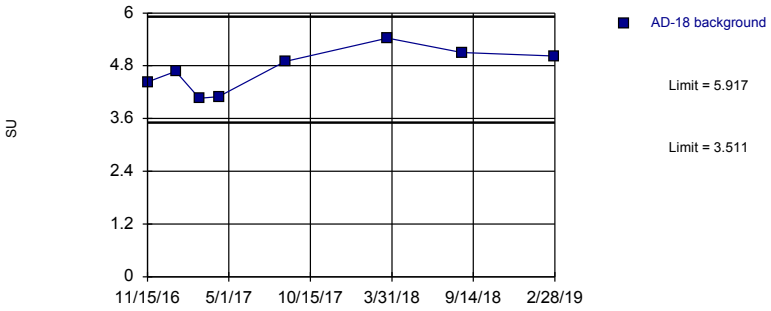


Background Data Summary: Mean=3.992, Std. Dev.=0.3766, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9666, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-18 (bg)

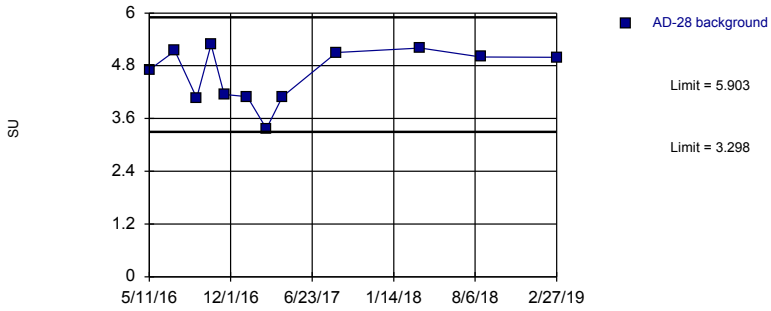


Background Data Summary: Mean=4.714, Std. Dev.=0.4895, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9485, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-28

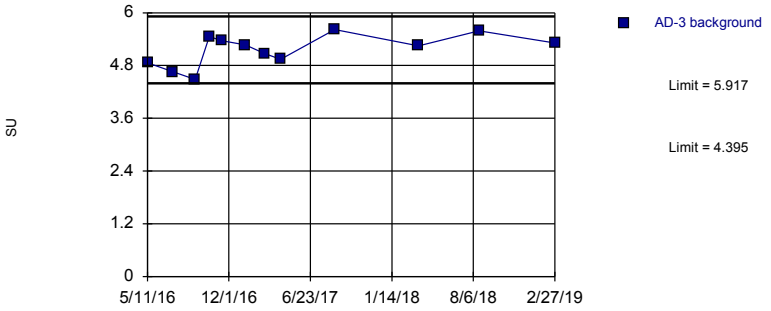


Background Data Summary: Mean=4.601, Std. Dev.=0.6168, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8727, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-3 (bg)

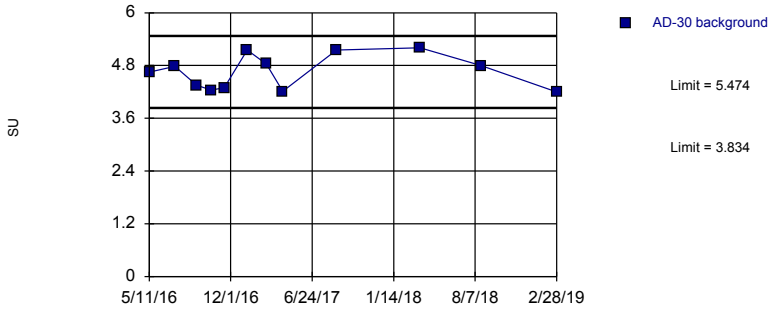


Background Data Summary: Mean=5.156, Std. Dev.=0.3603, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9481, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-30

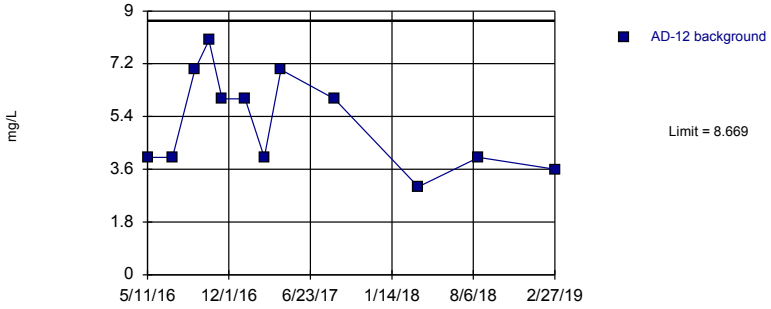


Background Data Summary: Mean=4.654, Std. Dev.=0.3882, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8754, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-12 (bg)

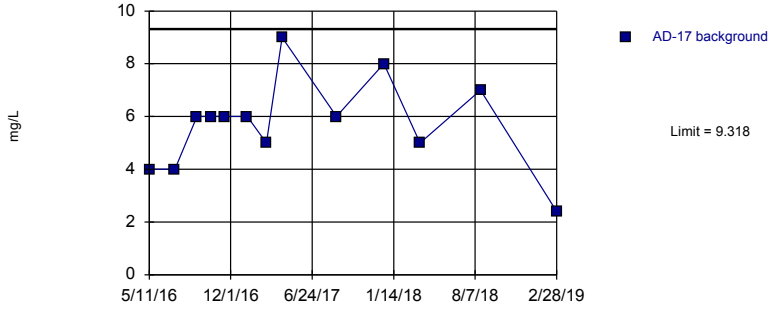


Background Data Summary: Mean=5.217, Std. Dev.=1.635, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8967, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-17

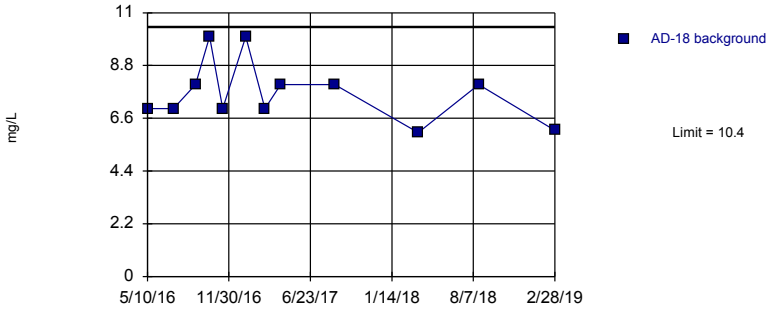


Background Data Summary: Mean=5.723, Std. Dev.=1.731, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9585, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-18 (bg)

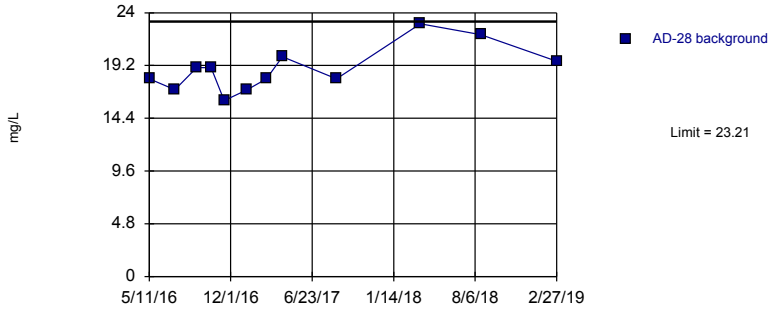


Background Data Summary: Mean=7.675, Std. Dev.=1.291, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8734, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-28

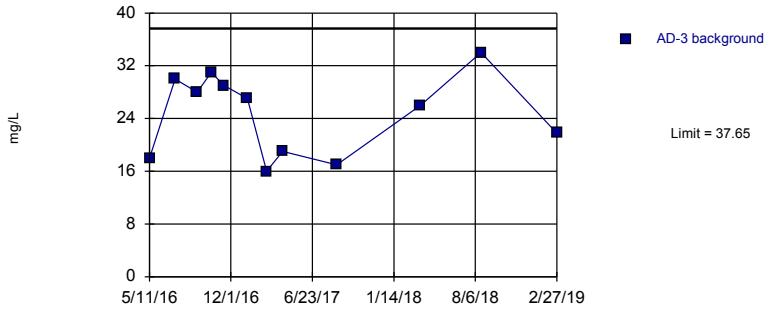


Background Data Summary: Mean=18.88, Std. Dev.=2.049, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9359, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-3 (bg)

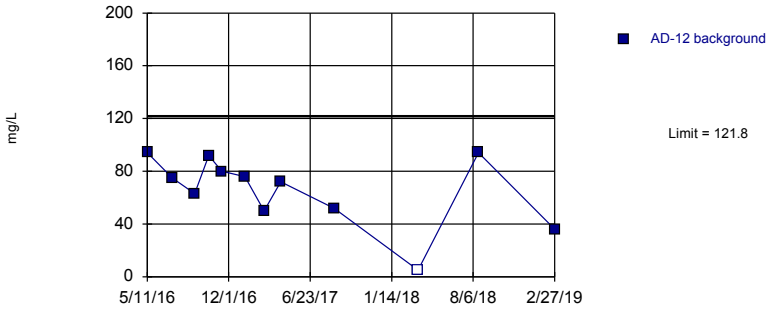


Background Data Summary: Mean=24.73, Std. Dev.=6.115, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9257, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-12 (bg)

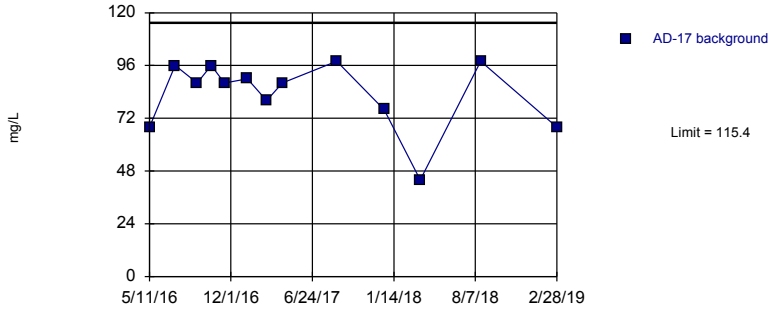


Background Data Summary: Mean=65.75, Std. Dev.=26.52, n=12, 8.333% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9032, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-17

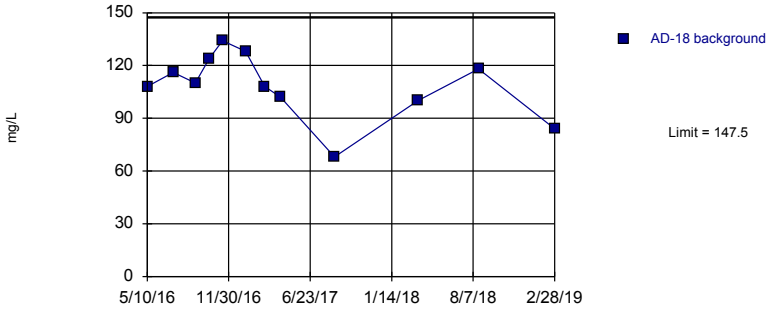


Background Data Summary: Mean=82.92, Std. Dev.=15.65, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8562, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-18 (bg)

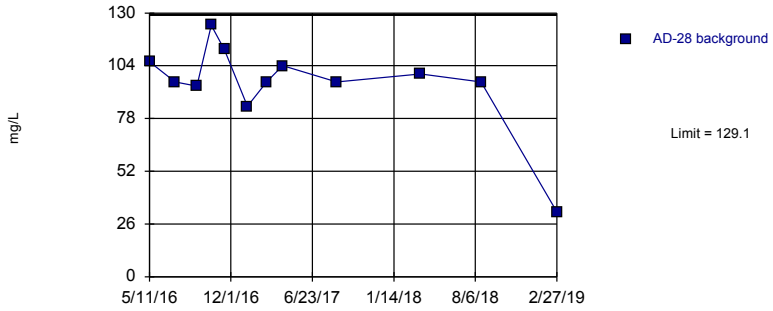


Background Data Summary: Mean=108.3, Std. Dev.=18.52, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9453, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Prediction Limit

Intrawell Parametric, AD-28



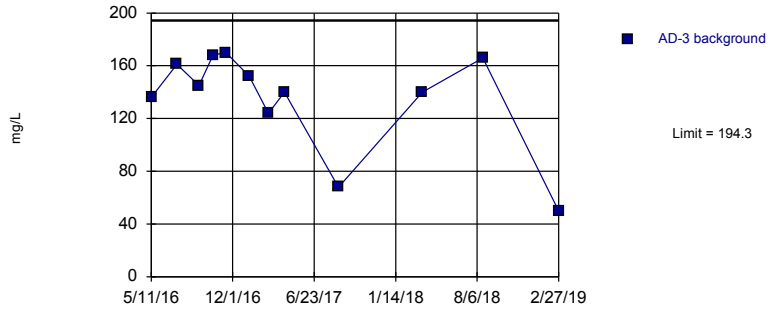
Background Data Summary (based on square transformation): Mean=9479, Std. Dev.=3403, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8775, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3 (bg)



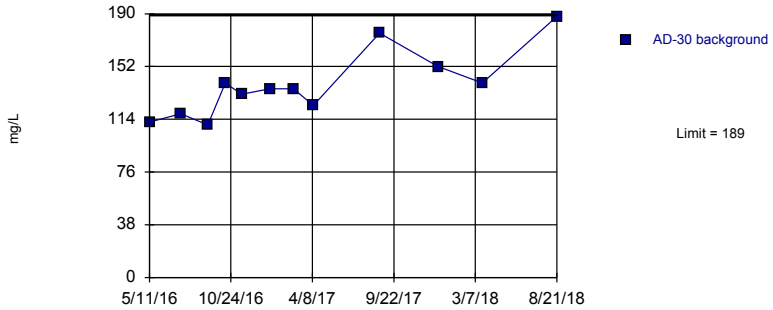
Background Data Summary (based on square transformation): Mean=19577, Std. Dev.=8603, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8758, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-30



Background Data Summary: Mean=138.7, Std. Dev.=23.82, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9068, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Interwell Prediction Limit Summary Table - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/9/2019, 7:47 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	n/a	0.07675	n/a	n/a	3 future	n/a	36	0.03686	0.02259	2.778	None	No	0.002505	Param Inter 1 of 2
Chloride, total (mg/L)	n/a	9.495	n/a	n/a	3 future	n/a	36	2.62	0.2615	0	None	sqrt(x)	0.002505	Param Inter 1 of 2
Fluoride, total (mg/L)	n/a	1	n/a	n/a	3 future	n/a	36	n/a	n/a	86.11	n/a	n/a	0.001409	NP Inter (NDs) 1 of 2

Trend Tests Summary Table - Upgradient Wells

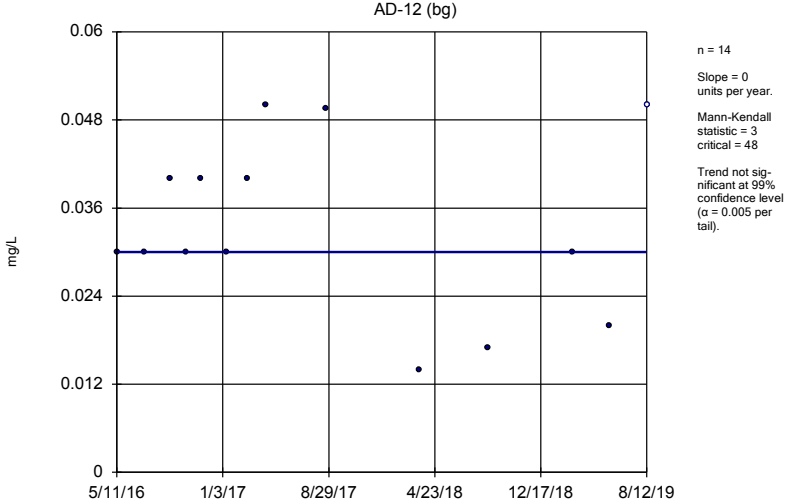
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/6/2019, 9:02 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-12 (bg)	0	3	48	No	14	7.143	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-18 (bg)	0.001357	37	48	No	14	14.29	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-3 (bg)	-0.00212	-14	-48	No	14	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.1051	23	48	No	14	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-18 (bg)	0.0768	18	48	No	14	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-3 (bg)	0	-4	-48	No	14	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-12 (bg)	-0.08118	-46	-48	No	14	64.29	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-18 (bg)	0	-35	-48	No	14	78.57	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-3 (bg)	0	-30	-48	No	14	78.57	n/a	n/a	0.01	NP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = 0 units per year.

Mann-Kendall statistic = 3
critical = 48

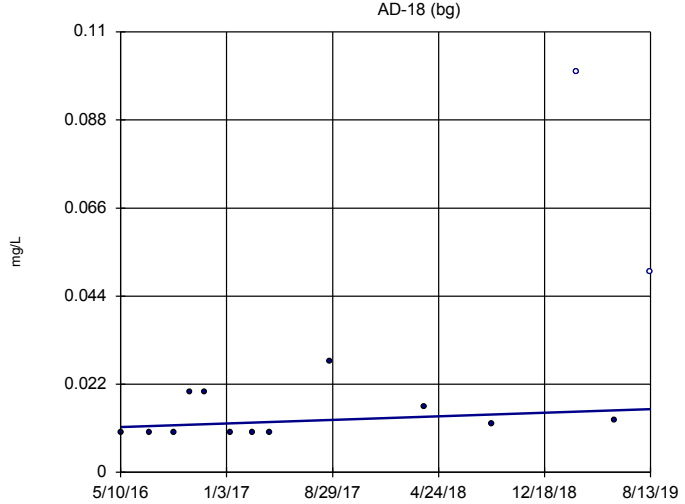
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/6/2019 9:01 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0.001357 units per year.

Mann-Kendall statistic = 37
critical = 48

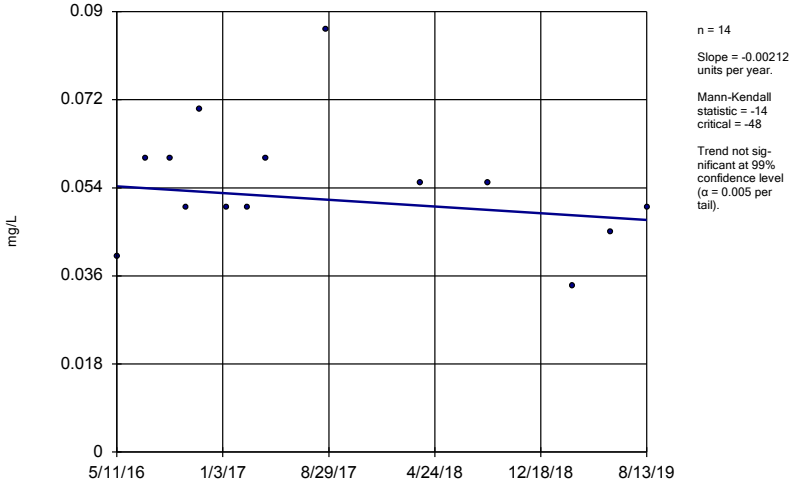
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/6/2019 9:01 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-3 (bg)



n = 14

Slope = -0.00212 units per year.

Mann-Kendall statistic = -14
critical = -48

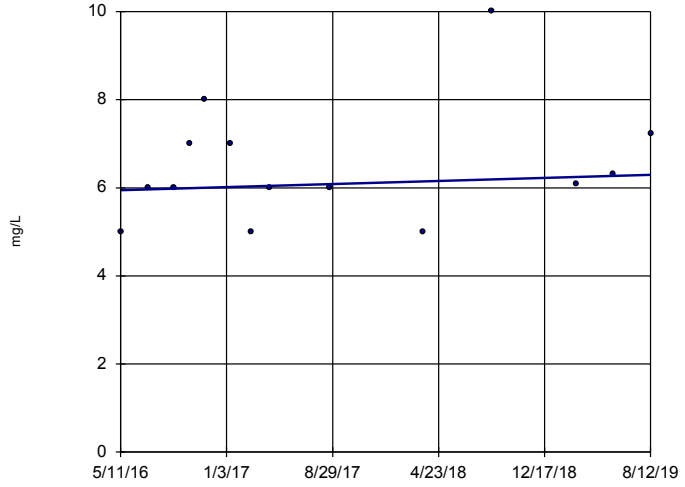
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/6/2019 9:01 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = 0.1051 units per year.

Mann-Kendall statistic = 23
critical = 48

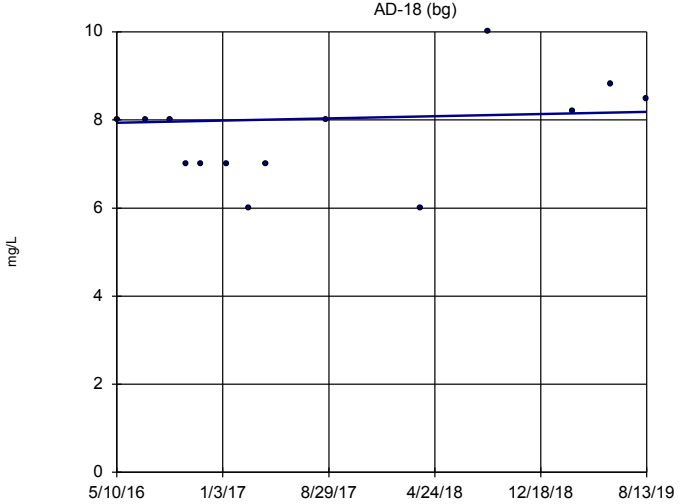
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 12/6/2019 9:01 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0.0768 units per year.

Mann-Kendall statistic = 18 critical = 48

Trend not significant at 99% confidence level (α = 0.005 per tail).

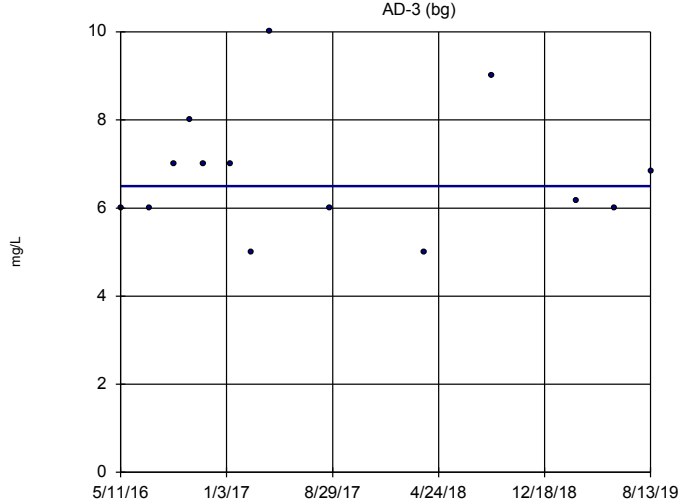
Constituent: Chloride, total Analysis Run 12/6/2019 9:02 AM View: Interwell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-3 (bg)



n = 14

Slope = 0 units per year.

Mann-Kendall statistic = -4 critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 12/6/2019 9:02 AM View: Interwell

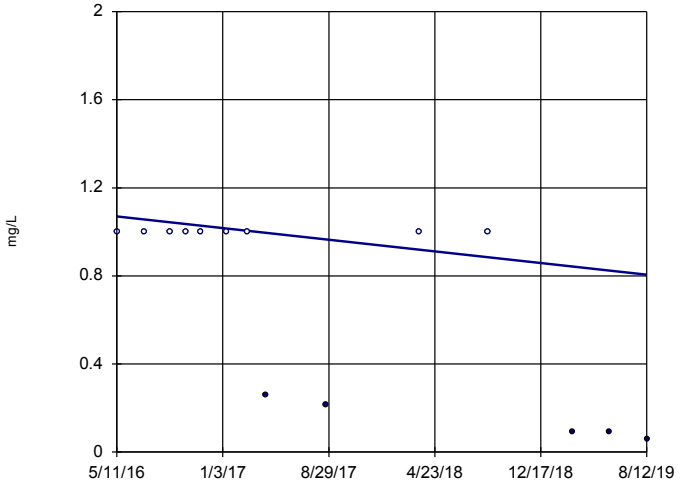
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.08118 units per year.

Mann-Kendall statistic = -46 critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 12/6/2019 9:02 AM View: Interwell

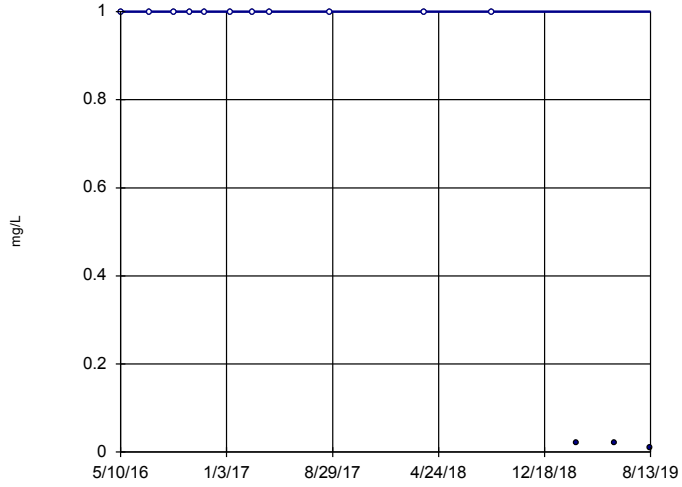
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0 units per year.

Mann-Kendall statistic = -35 critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

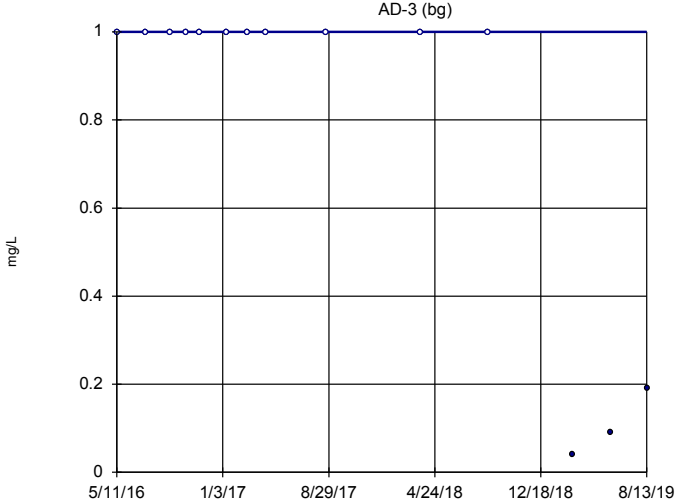
Constituent: Fluoride, total Analysis Run 12/6/2019 9:02 AM View: Interwell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-3 (bg)



n = 14

Slope = 0 units per year.

Mann-Kendall statistic = -30
critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 12/6/2019 9:02 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Upper Tolerance Limits - App IV

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/6/2019, 9:09 AM

Constituent	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.005	39	n/a	n/a	89.74	n/a	n/a	0.1353	NP Inter(NDs)
Arsenic, total (mg/L)	0.005	39	n/a	n/a	71.79	n/a	n/a	0.1353	NP Inter(normality)
Barium, total (mg/L)	0.157	39	n/a	n/a	0	n/a	n/a	0.1353	NP Inter(normality)
Beryllium, total (mg/L)	0.002	39	n/a	n/a	15.38	n/a	n/a	0.1353	NP Inter(normality)
Cadmium, total (mg/L)	0.001	39	n/a	n/a	76.92	n/a	n/a	0.1353	NP Inter(NDs)
Chromium, total (mg/L)	0.003171	39	-7.563	0.7605	17.95	Kaplan-Meier	ln(x)	0.01	Inter
Cobalt, total (mg/L)	0.009	39	n/a	n/a	0	n/a	n/a	0.1353	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	3.305	39	0.9749	0.3544	0	None	sqrt(x)	0.01	Inter
Fluoride, total (mg/L)	1	42	n/a	n/a	73.81	n/a	n/a	0.116	NP Inter(normality)
Lead, total (mg/L)	0.005	39	n/a	n/a	79.49	n/a	n/a	0.1353	NP Inter(NDs)
Lithium, total (mg/L)	0.1378	38	0.2867	0.09613	2.632	None	x^(1/3)	0.01	Inter
Mercury, total (mg/L)	0.000064	39	n/a	n/a	51.28	n/a	n/a	0.1353	NP Inter(normality)
Molybdenum, total (mg/L)	0.005	34	n/a	n/a	82.35	n/a	n/a	0.1748	NP Inter(NDs)
Selenium, total (mg/L)	0.005	39	n/a	n/a	58.97	n/a	n/a	0.1353	NP Inter(normality)
Thallium, total (mg/L)	0.002	37	n/a	n/a	86.49	n/a	n/a	0.1499	NP Inter(NDs)

PIRKEY WBAP GWPS				
Constituent Name	**MCL**	**CCR-Rule Specified**	**Background Limit**	**GWPS**
Antimony, Total (mg/L)	0.006		0.005	0.006
Arsenic, Total (mg/L)	0.01		0.005	0.01
Barium, Total (mg/L)	2		0.16	2
Beryllium, Total (mg/L)	0.004		0.002	0.004
Cadmium, Total (mg/L)	0.005		0.001	0.005
Chromium, Total (mg/L)	0.1		0.0032	0.1
Cobalt, Total (mg/L)	n/a	0.006	0.009	0.009
Combined Radium, Total (pCi/L)	5		3.31	5
Fluoride, Total (mg/L)	4		1	4
Lead, Total (mg/L)	0.015		0.005	0.015
Lithium, Total (mg/L)	n/a	0.04	0.14	0.14
Mercury, Total (mg/L)	0.002		0.000064	0.002
Molybdenum, Total (mg/L)	n/a	0.1	0.005	0.1
Selenium, Total (mg/L)	0.05		0.005	0.05
Thallium, Total (mg/L)	0.002		0.002	0.002

**Grey cell indicates Background Limit is higher than MCL.*

**MCL = Maximum Contaminant Level*

**GWPS = Groundwater Protection Standard*

Confidence Intervals - Significant Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/6/2019, 9:13 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-28**	**0.01583**	**0.0132**	**0.009**	**Yes**	**13**	**0.01452**	**0.001766**	**0**	**None**	**No**	**0.01**	**Param.**

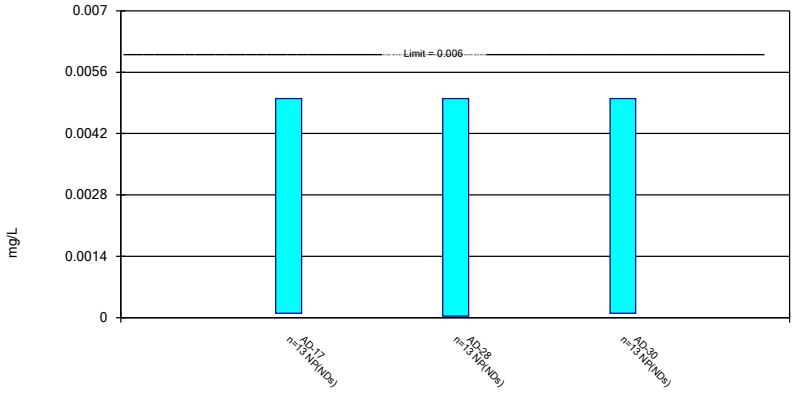
Confidence Intervals - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/6/2019, 9:13 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	AD-17	0.005	0.0001	0.006	No	13	0.003778	0.001989	92.31	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-28	0.005	0.00003	0.006	No	13	0.003511	0.002047	76.92	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-30	0.005	0.0001	0.006	No	13	0.003224	0.002078	76.92	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-17	0.005	0.00041	0.01	No	13	0.003008	0.00198	61.54	None	No	0.01	NP (normality)
Arsenic, total (mg/L)	AD-28	0.006	0.001409	0.01	No	13	0.003209	0.001969	53.85	None	No	0.01	NP (normality)
Arsenic, total (mg/L)	AD-30	0.005	0.0006	0.01	No	13	0.003501	0.002029	69.23	None	No	0.01	NP (normality)
Barium, total (mg/L)	AD-17	0.2749	0.1338	2	No	13	0.2043	0.09487	0	None	No	0.01	Param.
Barium, total (mg/L)	AD-28	0.1761	0.1408	2	No	13	0.1588	0.0243	0	None	sqrt(x)	0.01	Param.
Barium, total (mg/L)	AD-30	0.058	0.05105	2	No	13	0.05452	0.004672	0	None	No	0.01	Param.
Beryllium, total (mg/L)	AD-17	0.000948	0.0004991	0.004	No	13	0.0008342	0.0005407	15.38	None	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-28	0.0007879	0.000509	0.004	No	13	0.0006484	0.0001876	0	None	No	0.01	Param.
Beryllium, total (mg/L)	AD-30	0.0001554	0.0000604	0.004	No	13	0.0003823	0.0007188	15.38	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-17	0.001	0.0000833	0.005	No	13	0.0007115	0.0004505	69.23	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-28	0.001	0.00005	0.005	No	13	0.0008531	0.0003586	84.62	None	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-30	0.001	0.00005	0.005	No	13	0.0008538	0.0003568	92.31	None	No	0.01	NP (NDs)
Chromium, total (mg/L)	AD-17	0.00177	0.0005093	0.1	No	13	0.001382	0.001464	7.692	None	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-28	0.004	0.000416	0.1	No	13	0.001663	0.00179	30.77	None	No	0.01	NP (Cohens/xfrm)
Chromium, total (mg/L)	AD-30	0.001742	0.0005665	0.1	No	13	0.001242	0.001068	7.692	None	x^(1/3)	0.01	Param.
Cobalt, total (mg/L)	AD-17	0.01198	0.005801	0.009	No	13	0.008891	0.004155	0	None	No	0.01	Param.
Cobalt, total (mg/L)	**AD-28**	**0.01583**	**0.0132**	**0.009**	**Yes**	**13**	**0.01452**	**0.001766**	**0**	**None**	**No**	**0.01**	**Param.**
Cobalt, total (mg/L)	AD-30	0.002535	0.001801	0.009	No	13	0.002168	0.0004933	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-17	6.109	2.015	5	No	13	4.062	2.753	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-28	2.585	1.706	5	No	13	2.145	0.5906	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-30	2.349	0.6237	5	No	13	1.579	1.37	0	None	sqrt(x)	0.01	Param.
Fluoride, total (mg/L)	AD-17	1	0.24	4	No	15	0.6982	0.3883	60	None	No	0.01	NP (normality)
Fluoride, total (mg/L)	AD-28	0.8025	0.5437	4	No	14	0.6731	0.1827	7.143	None	No	0.01	Param.
Fluoride, total (mg/L)	AD-30	1	0.2	4	No	15	0.818	0.3785	86.67	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-17	0.005	0.0002	0.015	No	13	0.003799	0.001947	84.62	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-28	0.005	0.000266	0.015	No	13	0.003797	0.00195	84.62	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-30	0.005	0.0002	0.015	No	13	0.003789	0.001966	84.62	None	No	0.01	NP (NDs)
Lithium, total (mg/L)	AD-17	0.02464	0.01211	0.14	No	13	0.01837	0.008427	7.692	None	No	0.01	Param.
Lithium, total (mg/L)	AD-28	0.03356	0.02389	0.14	No	12	0.02797	0.008512	0	None	x^2	0.01	Param.
Lithium, total (mg/L)	AD-30	0.009892	0.007132	0.14	No	13	0.008284	0.002493	7.692	None	x^2	0.01	Param.
Mercury, total (mg/L)	AD-17	0.0001652	0.00006705	0.002	No	13	0.0001288	0.000106	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-28	0.00008396	0.00003015	0.002	No	13	0.00006323	0.00004673	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-30	0.001162	0.0002761	0.002	No	13	0.0007703	0.0007062	0	None	sqrt(x)	0.01	Param.
Molybdenum, total (mg/L)	AD-17	0.005	0.0004858	0.1	No	11	0.003864	0.002	81.82	None	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-28	0.005	0.0002942	0.1	No	11	0.003849	0.002027	81.82	None	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-30	0.005	0.001142	0.1	No	11	0.00394	0.001859	81.82	None	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-17	0.005	0.0005	0.05	No	13	0.00395	0.001732	76.92	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-28	0.005	0.0003	0.05	No	13	0.003816	0.001917	76.92	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-30	0.005	0.0004	0.05	No	13	0.003831	0.001889	76.92	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-17	0.002	0.0005	0.002	No	12	0.001511	0.0007555	83.33	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-28	0.002	0.0005	0.002	No	12	0.001523	0.0007519	83.33	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-30	0.002	0.0005	0.002	No	12	0.00145	0.0007383	75	None	No	0.01	NP (normality)

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

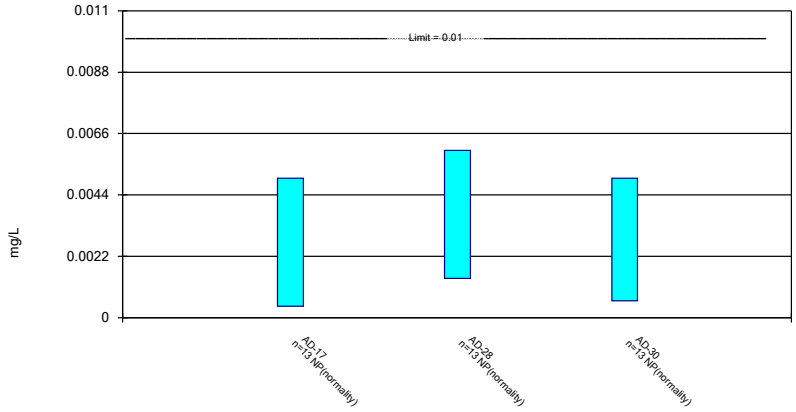


Constituent: Antimony, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

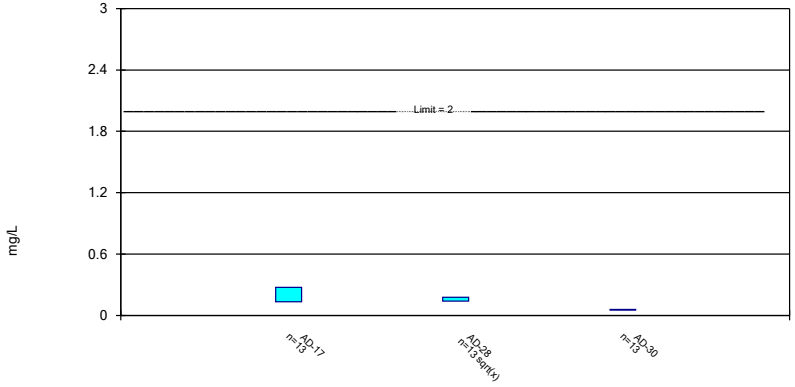


Constituent: Arsenic, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

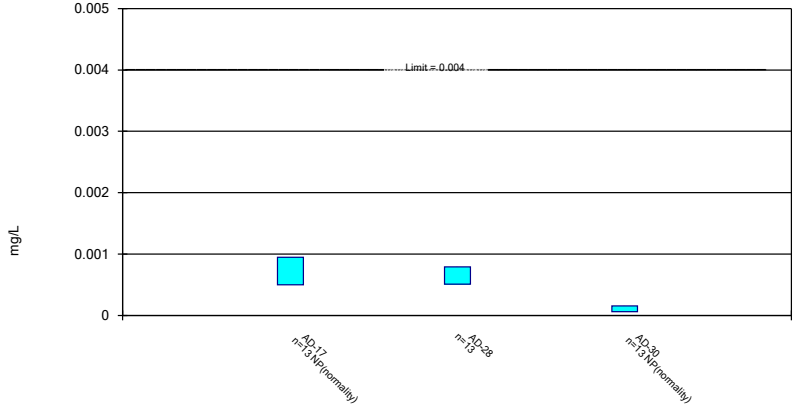


Constituent: Barium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

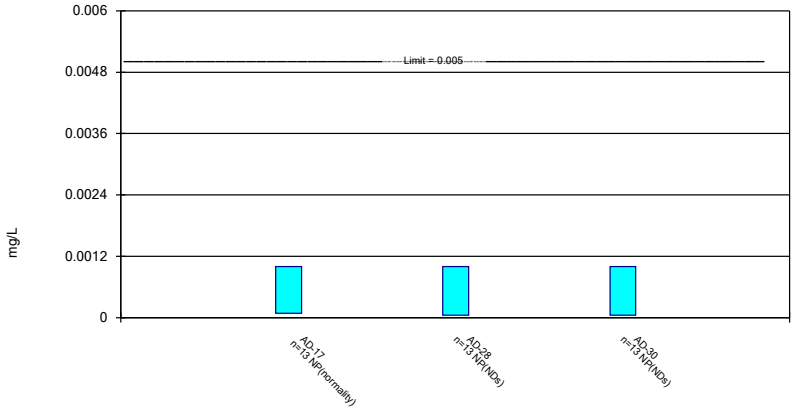
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Beryllium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

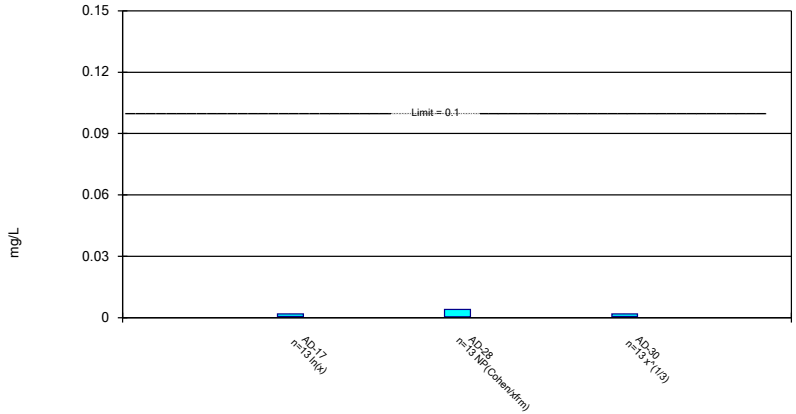
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Cadmium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

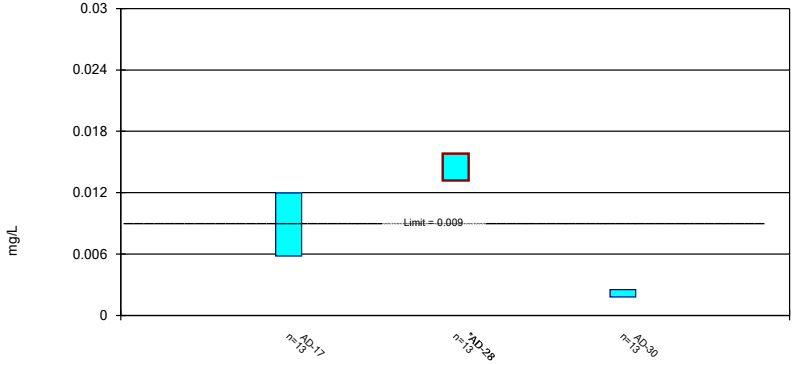
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chromium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

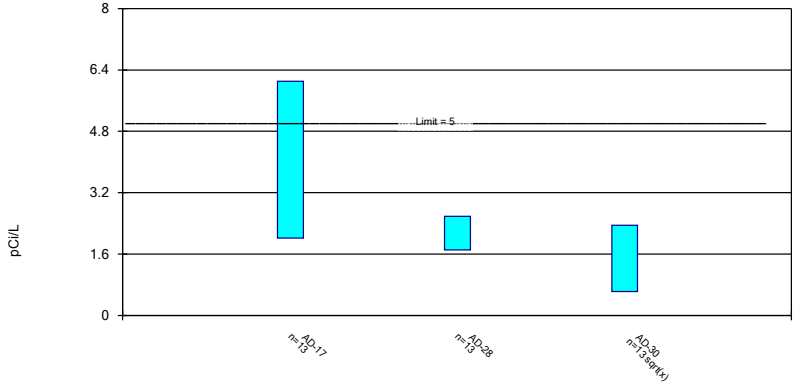
Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cobalt, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

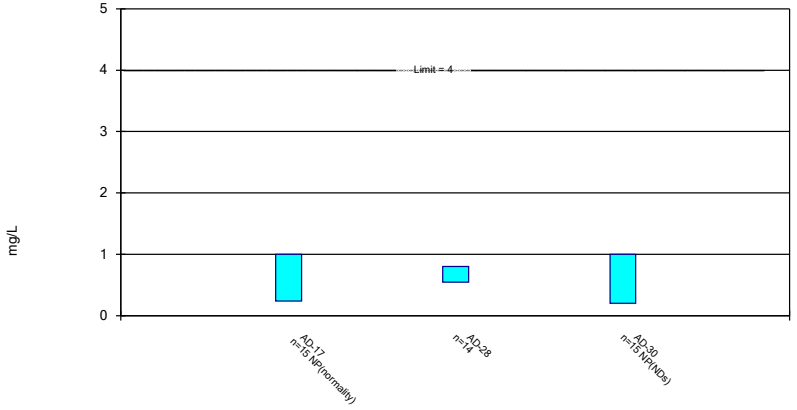
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

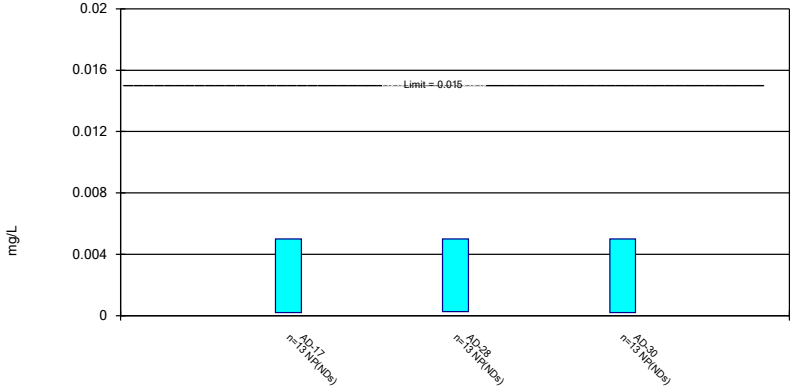
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Fluoride, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

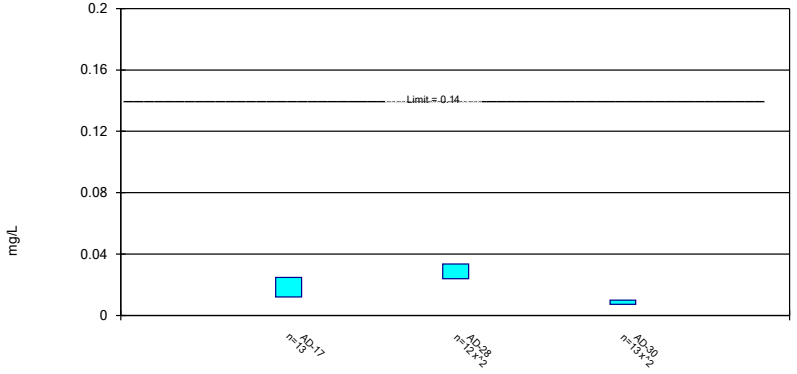
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Lead, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

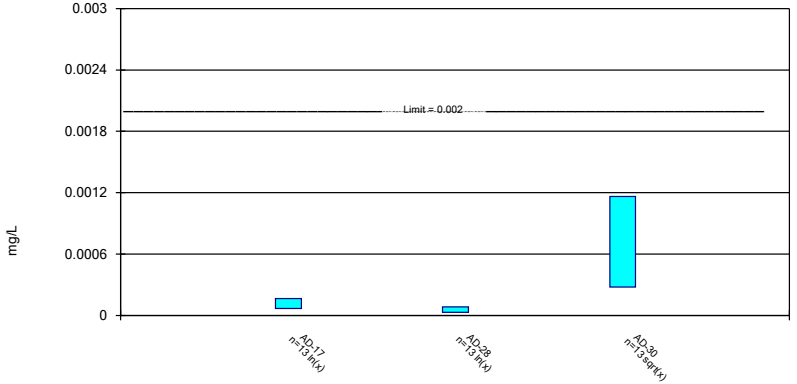
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Lithium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

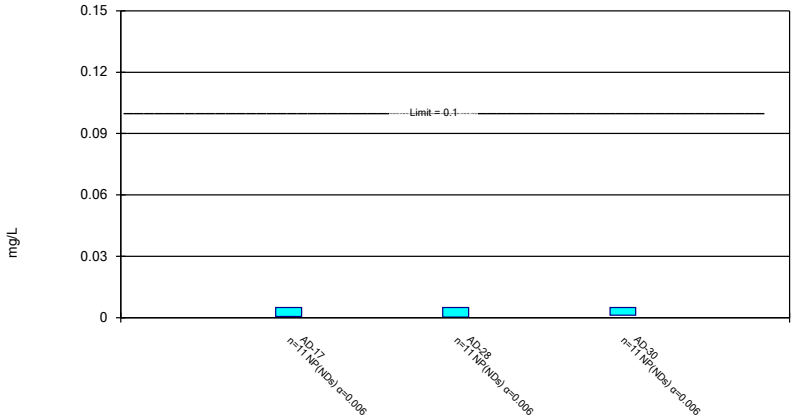
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Mercury, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

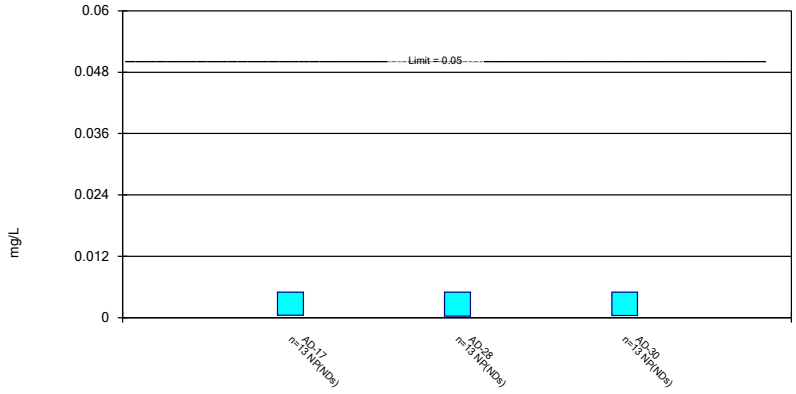
Compliance Limit is not exceeded.



Constituent: Molybdenum, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

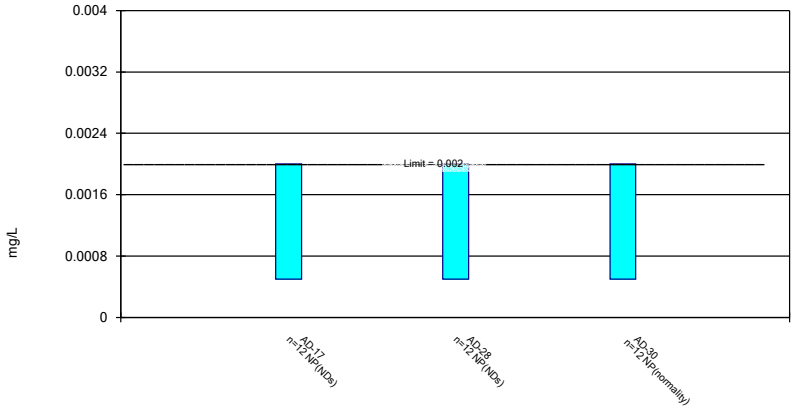
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Selenium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Thallium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
West Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

March 26, 2019

CHA8462

TABLE OF CONTENTS

FIGURES

TABLES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
WBAP	West Bottom Ash Pond

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the West Bottom Ash Pond (WBAP, Figure 1). In 2018, two assessment monitoring events were conducted at the WBAP in accordance with 40 CFR 257.95. The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or regional screening level (RSL). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). An SSL was identified for cobalt at AD-28 at the WBAP where the LCL of 0.0131 mg/L was above the calculated GWPS of 0.009 mg/L (Geosyntec, 2018). No other SSLs were identified.

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSL identified for cobalt at AD-28 should not be attributed to the WBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSL identified for cobalt at AD-28 was based on a Type IV cause and not by a release from the Pirkey WBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSL identified for cobalt and the proposed alternative source are described below.

2.1 Proposed Alternative Source

Initial review of site geochemistry, site historical data, and laboratory QA/QC data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSL has been attributed to natural variation associated with the underlying geology, which is a Type IV issue.

The onsite hydrostratigraphic unit for the WBAP was identified as the clayey and silty sand stratum located between an elevation of approximately 325 and 340 feet above mean sea level (Arcadis, 2016). This unit is within the Reklaw Formation, which consists predominantly of clay and fine-grained sand and is underlain by the Eocene-age Carrizo Sand. The presence of lignite in the area is well-documented (Broom and Myers, 1966; ETTL, 2010). The Sabine Mining Company operates a lignite surface mining operation immediately to the southwest of the site which supplies lignite to the Pirkey Plant.

Soil samples collected across the site identified cobalt in the aquifer material at varying concentrations (Table 1), including locations near the WBAP. The highest reported cobalt concentration of 15 milligrams per kilogram (mg/kg) was collected at AD-30, which is located south of the WBAP and approximately 600 feet northeast of AD-28 (Figure 2). Additionally, mineralogic samples collected from these locations identified the presence of pyrite (cubic FeS_2) and marcasite (orthorhombic FeS_2) at concentrations up to 3% of the total composition of the material (Table 1). Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2019). While not detected in the mineralogical analyses, the presence of limonite (FeO(OH)) in the Reklaw formation has been noted (Brooms and Myers, 1966). In addition to iron sulfides, cobalt can also substitute in iron oxides such as limonite (Hitzman et al., 2019). While soil analytical and mineralogical data are not available for AD-28, the wide distribution of cobalt and iron sulfides across the site suggests that naturally occurring cobalt may be present in the aquifer media near AD-28.

Naturally occurring cobalt in the aquifer media is proposed as the alternate source for cobalt concentrations in the groundwater which exceed the GWPS at AD-28. Further investigation shows that a release from the WBAP itself does not appear to be a source for cobalt. Analysis of the bottom ash sluiced to the WBAP had a reported cobalt concentration of 5.8 mg/kg (Attachment A). When Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-864 Test Method 1312, [USEPA, 1994]) was conducted on the ash sample to evaluate cobalt mobility under

simulated conditions, cobalt was not detected above the reporting limit of 0.01 milligrams per liter (mg/L) in the leachate sample (Attachment A). Cobalt was also not detected above the reporting limit of 0.005 mg/L in a grab sample of the pond water (Attachment B). The reporting limit for both the SPLP and pond water analyses are both over an order of magnitude lower than the average concentration of cobalt observed at AD-28 during the background and assessment monitoring period. The analytical sample results are summarized in Table 2.

Because cobalt mobility is affected by pH, the SPLP test results are likely even more conservative than actual pond conditions, as SPLP is run at a pH of 5 SU, whereas the operational pH of the pond varies between approximately 5.8 and 7.0 SU. According to a recent study, cobalt mobility increases under more acidic conditions, although even at a pH of approximately 5, only 2% of cobalt in fly ash is mobile (Izquierdo and Querol, 2012).

The pond was not identified as the source of cobalt at AD-28 based on the documented low mobility of cobalt under the pond conditions. This is further supported by the lack of detected cobalt in the SPLP and pond water analyses. Instead, the widespread distribution of cobalt within the aquifer material is proposed as the alternate source. This cobalt could be present as substitutions within iron-containing minerals such as pyrite, marcasite, or limonite, all of which are observed across the site.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSL is not due to a release from the Pirkey WBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of cobalt for AD-28 identified during assessment monitoring in 2018 was not due to a release from the WBAP. The identified SSL was, instead, attributed to natural variation in the underlying geology. Therefore, no further action is warranted, and the Pirkey WBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment C.

SECTION 4

REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

Arcadis, 2016. West Bottom Ash Pond – CCR Groundwater Monitoring Well Network Evaluation. H.W. Pirkey Power Plant. May.

Broom, M.E. and Myers, B.N., 1966. Ground-Water Resources of Harrison County, Texas. Texas Water Development Board Report 27. August.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.

ETTL, 2010. Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas, Geotechnical Investigation. October.

Geosyntec Consultants, 2018. Statistical Analysis Summary, West Bottom Pond. H.W. Pirkey Power Plant. Hallsville, Texas. December.

Hitzman, M.W., Bookstrom, A.A., Slack, J.F., and Zientek, M.L., 2017. Cobalt – Styles of Deposits and the Search for Primary Deposits. USGS Open File Report 2017-1155.

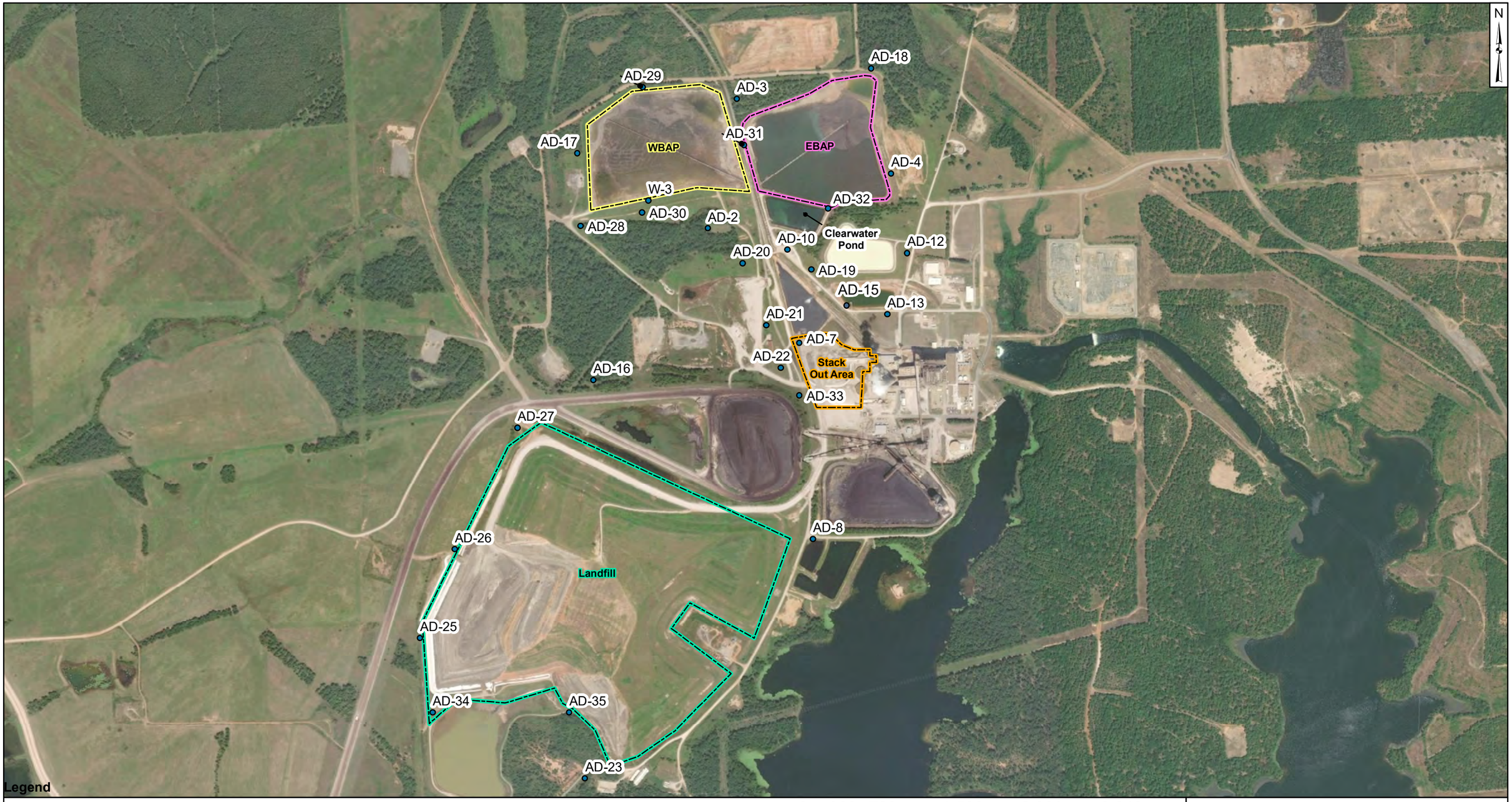
Izquierdo, M. and Querol, X., 2012. Leaching Behaviour of Elements from Coal Combustion Fly Ash: An Overview. *International Journal of Coal Geology*, 94, 54-66.

Krupka, K. M. and Serne, R. J., 2002. Geochemical Factors Affecting the Behavior of Antimony, Cobalt, Europium, Technetium, and Uranium in Vadose Sediments. Pacific Northwest National Lab, PNNL-14126. December.

United States Environmental Protection Agency (USEPA), 1994. Method 1312 – Synthetic Precipitation Leaching Procedure, Revision 0, September 1994, Final Update to the Third Edition of the Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA publication SW-846.

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

FIGURES



Legend

- AD-15
- Monitoring Wells

Location Boundaries

CCR Units

- EBAP
- Landfill
- Stack Out Area
- WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- AD-15 location is approximate.

0 380 760 1,520 2,280 3,040 Feet

Site Layout

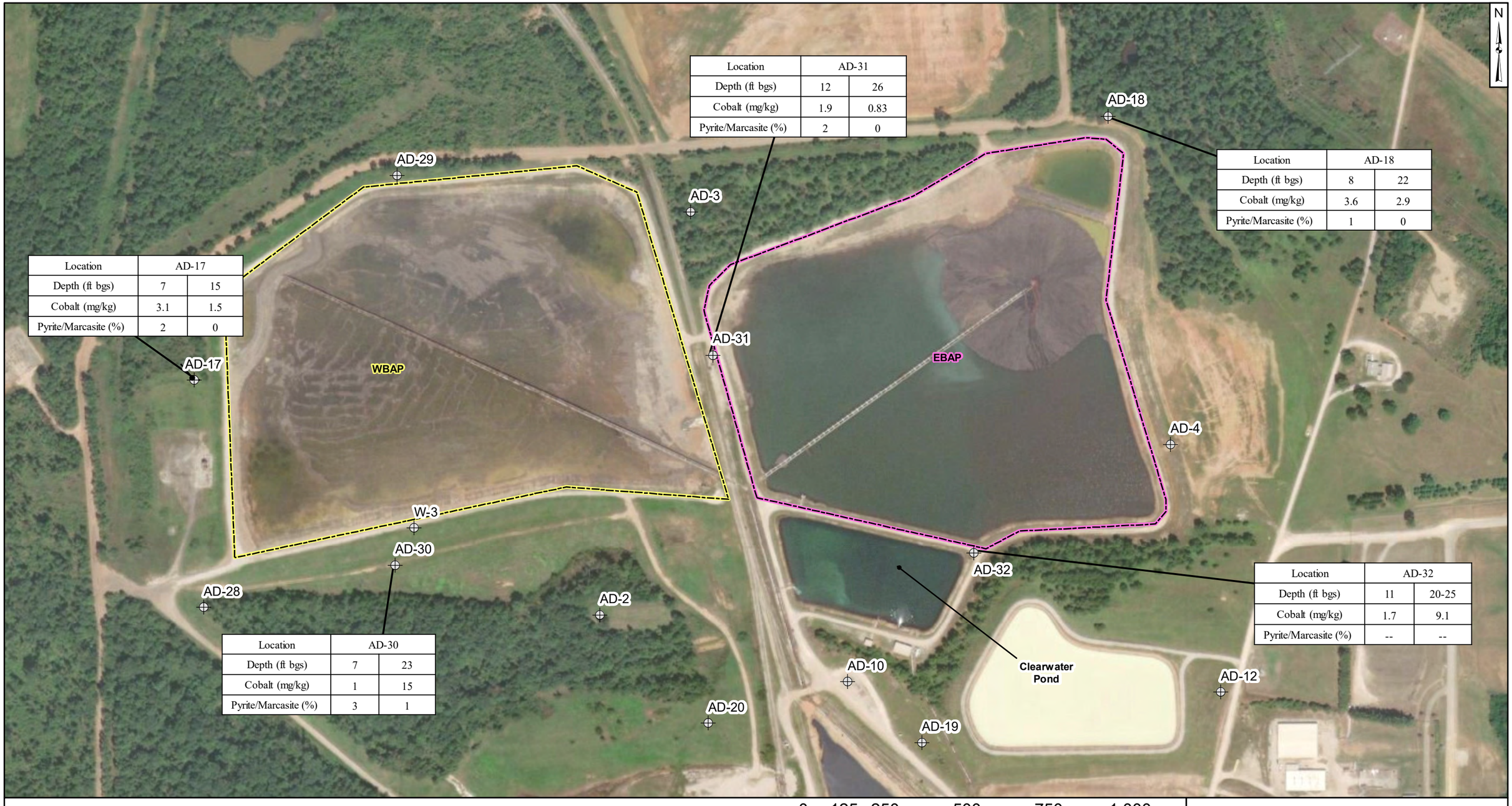
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/03/25

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_20190322.mxd. HDuff. 3/25/2019. Project/Phase/Task.



Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	AD-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

Legend

Monitoring Wells

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- ft bgs: feet below ground surface
- mg/kg: milligrams per kilogram

0 125 250 500 750 1,000 Feet

Soil Chemical and Mineralogical Analysis Results

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/03/25

Figure 2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Pirkey_SoilChem_minerals_March2019.mxd. SKaroly. 3/25/2019. Project/Phase/Task.

TABLES

Table 1: Soil Cobalt and Mineralogy Data
West Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Sample Depth (ft bgs)	Cobalt (mg/kg)	Pyrite/Marcasite (%)
AD-15	13	0.85	--
	40-43	0.79	--
AD-16	10	0.17	0
	19	0.44	1
AD-17	7	3.10	2
	15	1.50	0
AD-18	8	3.60	1
	22	2.90	0
AD-30	7	1.00	3
	23	15.0	1
AD-31	12	1.90	2
	26	0.83	0
AD-32	11	1.70	--
	20-25	9.10	--
AD-33	11	0.61	1
	21	0.64	--
AD-34	6	1.10	1
	24	6.50	2
AD-35	2	2.10	2
	17	0.18	0

Notes:
'--' - analysis not completed
mg/kg- milligram per kilogram
ft bgs - feet below ground surface

Samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation.

Table 2: Summary of Key Analytical Data
West Bottom Ash Pond - H.W. Pirkey Plant

Sample	Unit	Cobalt Concentration
Bottom Ash	mg/kg	5.8
SPLP Leachate	mg/L	<0.01
WBAP Pond Water	mg/L	<0.005
AD-28 - Average	mg/L	0.0148

Notes:
mg/kg - milligram per kilogram
mg/L - milligram per liter
AD-28 - Average value was calculated using all cobalt data collected under 40 CFR 257 Subpart D.

ATTACHMENT A
Bottom Ash and Bottom Ash SPLP
Laboratory Analytical Data

Client Sample ID: CCR SAMPLE-WBAP-1

Date Collected: 02/11/19 16:40
Date Received: 02/13/19 09:40

Lab Sample ID: 490-168389-1

Matrix: Solid
Percent Solids: 75.9

Method: 9056 - Anions, Ion Chromatography - Soluble

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	1.3	U	1.3	1.0	mg/Kg	☼		02/14/19 00:30	1

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	11	U	11	1.1	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Arsenic	**2.2**		2.2	1.3	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Barium	**250**		2.2	1.1	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Beryllium	**0.25**	**J**	1.1	0.22	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Boron	**93**		11	4.8	mg/Kg	☼	02/13/19 16:11	02/18/19 22:40	1
Cadmium	1.1	U	1.1	0.11	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Chromium	**12**		1.1	1.0	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Cobalt	**5.8**		2.2	1.1	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Lead	**1.2**	**F1**	1.1	0.56	mg/Kg	☼	02/13/19 16:11	02/19/19 18:53	1
Lithium	**4.2**	**J**	11	1.1	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Molybdenum	11	U	11	5.6	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Selenium	2.2	U	2.2	1.2	mg/Kg	☼	02/13/19 16:11	02/19/19 18:53	1
Thallium	2.2	U	2.2	0.67	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.13	U	0.13	0.039	mg/Kg	☼	02/14/19 10:07	02/14/19 13:12	1

Client Sample ID: CCR SAMPLE-WBAP-1

Lab Sample ID: 490-168389-1

Date Collected: 02/11/19 16:40

Matrix: Solid

Date Received: 02/13/19 09:40

Method: 9056 - Anions, Ion Chromatography - SPLP West

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	**0.035**	**J B**	0.10	0.010	mg/L			02/19/19 23:08	1

Method: 6010C - Metals (ICP) - SPLP West

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:32	1
Arsenic	0.010	U	0.010	0.0086	mg/L		02/19/19 16:41	02/20/19 13:32	1
Barium	**0.11**		0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:32	1
Beryllium	0.0040	U	0.0040	0.0020	mg/L		02/19/19 16:41	02/20/19 13:32	1
Boron	**0.15**		0.050	0.020	mg/L		02/19/19 16:41	02/20/19 13:32	1
Cadmium	0.0010	U	0.0010	0.00050	mg/L		02/19/19 16:41	02/20/19 13:32	1
Chromium	0.0050	U	0.0050	0.0030	mg/L		02/19/19 16:41	02/20/19 13:32	1
Cobalt	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:32	1
Lead	0.0050	U	0.0050	0.0020	mg/L		02/19/19 16:41	02/20/19 13:32	1
Lithium	**0.016**	**J B ***	0.050	0.010	mg/L		02/19/19 16:41	02/20/19 13:32	1
Molybdenum	0.050	U	0.050	0.030	mg/L		02/19/19 16:41	02/20/19 13:32	1
Selenium	**0.0052**	**J**	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:32	1
Thallium	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:32	1

Method: 7470A - Mercury (CVAA) - SPLP West

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.00020	U	0.00020	0.00010	mg/L		02/19/19 16:03	02/21/19 15:39	1

General Chemistry

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Solids	**75.9**		0.1	0.1	%			02/17/19 12:25	1

ATTACHMENT B

Bottom Ash Pond Water Laboratory Analytical Data

Client Sample ID: SW-WBAP-1

Date Collected: 12/15/18 14:15
Date Received: 12/18/18 10:30

Lab Sample ID: 490-165222-5

Matrix: Water

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	**0.88**	**J**	1.0	0.010	mg/L			12/20/18 19:29	1
Sulfate	**1400**		1000	6.0	mg/L			12/30/18 09:25	200
Chloride	**61**	**B**	15	1.0	mg/L			12/30/18 09:08	5

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.0030	U	0.0030	0.00080	mg/L		12/19/18 14:26	12/27/18 15:30	1
Arsenic	**0.0030**	**J**	0.0050	0.00040	mg/L		12/28/18 12:47	01/03/19 11:39	1
Barium	0.20	U	0.20	0.00010	mg/L		12/19/18 14:26	12/27/18 15:30	1
Beryllium	**0.00029**	**J**	0.0040	0.00010	mg/L		12/19/18 14:26	12/26/18 22:24	1
Boron	**7.3**	**J ***	10	0.35	mg/L		12/28/18 12:47	01/03/19 11:48	10
Cadmium	0.0050	U	0.0050	0.00010	mg/L		12/19/18 14:26	12/27/18 15:30	1
Calcium	**220**		1.0	0.053	mg/L		12/19/18 14:26	12/26/18 22:24	1
Chromium	0.0050	U	0.0050	0.00050	mg/L		12/19/18 14:26	12/27/18 15:30	1
Cobalt	0.0050	U	0.0050	0.00010	mg/L		12/19/18 14:26	12/27/18 15:30	1
Lead	**0.00077**	**J**	0.0050	0.00010	mg/L		12/19/18 14:26	12/21/18 21:37	1
Lithium	**0.053**		0.040	0.0030	mg/L		12/19/18 14:26	12/21/18 21:37	1
Molybdenum	**0.0047**	**J**	0.010	0.0010	mg/L		12/19/18 14:26	12/26/18 22:24	1
Selenium	**0.015**		0.010	0.00030	mg/L		12/19/18 14:26	12/26/18 22:24	1
Thallium	0.0020	U	0.0020	0.00080	mg/L		12/19/18 14:26	12/21/18 21:37	1

Method: 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.00020	U	0.00020	0.00010	mg/L		12/20/18 12:26	12/21/18 12:20	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**2000**		50	14	mg/L			12/19/18 23:00	1

ATTACHMENT C
Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864	Texas	3/26/2019
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
West Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

September 23, 2019

CHA8462

TABLE OF CONTENTS

FIGURES

TABLES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
VAP	Vertical Aquifer Profiling
WBAP	West Bottom Ash Pond
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the West Bottom Ash Pond (WBAP, Figure 1). In February 2019, a semi-annual assessment monitoring event was conducted at the WBAP in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were previously established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). At the WBAP, an SSL was identified for cobalt at AD-28, where the LCL of 0.0132 milligrams per liter (mg/L) was above the calculated GWPS of 0.009 mg/L (Geosyntec, 2019a). No other SSLs were identified.

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSL identified for cobalt at AD-28 should not be attributed to the WBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSL identified for cobalt at AD-28 was based on a Type IV cause and not by a release from the Pirkey WBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSL identified for cobalt and the proposed alternative source are described below.

2.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSL has been attributed to natural variation associated with the underlying geology, which is a Type IV issue.

AD-28 is located at the southwest corner of the pond, as shown in Figure 1. In a previous ASD for cobalt at the WBAP, evidence was provided to show that cobalt is present in the aquifer media at the site and that the observed cobalt concentrations were due to natural variation (Geosyntec, 2019b). The previous ASD discussed how the WBAP itself did not appear to be a source for cobalt in downgradient groundwater, based on observed concentrations of cobalt both in the ash material and in leachate from Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-864 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP leachate above the reporting limit of 0.01 mg/L. Because cobalt mobility is affected by pH, the SPLP test results are likely even more conservative than actual pond conditions. SPLP is run at a pH of 5 SU, whereas the operational pH of the pond varies between approximately 5.8 and 7.0 SU. Cobalt mobility increases under more acidic conditions, although even at a pH of approximately 5, only 2% of cobalt in fly ash is mobile (Izquierdo and Querol, 2012).

Cobalt was also not detected above the reporting limit of 0.005 mg/L in a grab sample of the pond water. As shown in Table 1, the reporting limits for the SPLP ash leachate test and pond water analysis are both below the average concentration of cobalt observed at AD-28 during the background and assessment monitoring periods (0.0147 mg/L). Since the previous ASD was prepared, there have been no notable changes in coal handling or sourcing at the plant that would have affected the composition of the ash or pond water.

Since completion of the prior ASD, four additional permanent wells (B-2, B-3, AD-40, and AD-41) have been installed upgradient of the WBAP. The most recent data available for select wells in the vicinity of the WBAP, including the new upgradient locations, are shown in Figure 2. Groundwater cobalt concentrations at upgradient locations vary from 0.0008 mg/L to 0.0345 mg/L at AD-40 and B-3, respectively. This wide range in cobalt concentrations provides further evidence for the natural variation of cobalt at the Site, particularly as the concentrations at B-3 exceed both the GWPS for the WBAP and the LCL calculated for cobalt at AD-28 (the well of interest).

As noted in the prior ASD, soil samples collected across the site, including from locations near the WBAP, identified cobalt in the aquifer solids at varying concentrations. Since completion of the prior ASD, additional soil samples have been collected from locations upgradient of the WBAP. Select soil sample data from the previous ASD and recently collected data are summarized in Table 2. Cobalt was identified in the aquifer solids at varying concentrations, with the highest value of 24 milligrams per kilogram (mg/kg) reported at AD-41, which is upgradient of the EBAP (Figure 3). Other testing included collection of aquifer solids to evaluate for the presence of cobalt-containing minerals. X-ray diffraction evidence identified pyrite and marcasite (both iron sulfides) at select locations at concentrations up to 3% by weight (Table 2). Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2019).

Groundwater samples were collected from upgradient location B-3 via vertical aquifer profiling (VAP), as described in an ASD previously generated for the EBAP (Geosyntec, 2019c). The VAP groundwater samples were centrifuged to separate solid and liquid phases, and the solid material was submitted for analysis of total metals and mineralogy by X-ray diffraction (XRD). The samples were also submitted for analysis of chemical composition and mineralogy by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). Following installation of permanent monitoring wells at B-2 and B-3, groundwater samples were collected by purging groundwater through the filter pack using a submersible pump. An additional groundwater sample was collected at AD-30. These permanent well groundwater samples were filtered through a 1.5-micron filter, and the solid material retained on the filter was submitted for analysis of total metals and by SEM/EDS.

Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from B-2 and B-3 (Table 2). Cobalt was detected in the AD-30 solid material at estimated value of 9.3 mg/kg, which is comparable to the concentration observed in bulk soil collected at the same location at the screened interval (15 mg/kg). These results provide further evidence that cobalt concentrations reported during groundwater sampling are naturally occurring and associated with the solid phase in the aquifer.

According to XRD results of the centrifuged solid sample [VAP-B3-(40-45)], pyrite was present as approximately 3% of the solid phase, with hematite (an iron(III) oxide) present at 2% (Table 3). Logging completed while the VAP boring was advanced identified coal at several intervals, including 45 and 48 ft bgs (Figure 4). Furthermore, SEM/EDS of both centrifuged solid samples [VAP-B3-(40-45) and VAP-B3-(50-55)] identified pyrite in backscattered electron micrographs by the distinctive framboid pattern (Harris, 1981; Sawlowicz, 2000). Major peaks involving iron and sulfur were identified in the EDS spectrum, which further support the identification of pyrite (Attachment A). While cobalt was not identified in the EDS spectrum, it is likely present at concentrations below the detection limit. Pyrite was also identified during SEM/EDS analysis of lignite which is mined immediately adjacent to the site.

While soil analytical and mineralogical data are not available for AD-28, the wide distribution of pyrite across the site suggests that naturally occurring cobalt, which may substitute for iron in pyrite, may also be present in the aquifer solids near AD-28. The presence of lignite in the area is well-documented, including at upgradient and downgradient locations relative to the WBAP (Broom and Myers, 1966; ETTL, 2010). Additionally, the pond was not identified as the source of cobalt at AD-28 in the previous ASD based on the documented low mobility of cobalt under the pond conditions and lack of detectable cobalt in the pond itself.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSL is not due to a release from the Pirkey WBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of cobalt for AD-28 identified during assessment monitoring in . February 2019 was not due to a release from the WBAP. The identified SSL was, instead, attributed to natural variation in the underlying geology, including the presence of pyrite in the solid aquifer material. Therefore, no further action is warranted, and the Pirkey WBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment B.

SECTION 4

REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

Broom, M.E. and Myers, B.N., 1966. Ground-Water Resources of Harrison County, Texas. Texas Water Development Board Report 27. August.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.

ETTL, 2010. Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas, Geotechnical Investigation. October.

Geosyntec Consultants, 2019a. Statistical Analysis Summary, West Bottom Ash Pond. H.W. Pirkey Power Plant. Hallsville, Texas. July.

Geosyntec, 2019b. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, West Bottom Ash Pond. Hallsville, Texas. March.

Geosyntec, 2019c. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, East Bottom Ash Pond. Hallsville, Texas. July.

Harris, L. A, Kenik, E. A., and Yust, C. S. 1981. Reactions in pyrite framboids induced by electron beam heating in a HVEM. *Scanning Electron Microscopy*, 1, web.

Hitzman, M.W., Bookstrom, A.A., Slack, J.F., and Zientek, M.L., 2017. Cobalt – Styles of Deposits and the Search for Primary Deposits. USGS Open File Report 2017-1155.

Izquierdo, M. and Querol, X., 2012. Leaching Behaviour of Elements from Coal Combustion Fly Ash: An Overview. *International Journal of Coal Geology*, 94, 54-66.

Krupka, K. M. and Serne, R. J., 2002. Geochemical Factors Affecting the Behavior of Antimony, Cobalt, Europium, Technetium, and Uranium in Vadose Sediments. Pacific Northwest National Lab, PNNL-14126. December.

Sawlowicz, Z. 2000. *Framboids: From Their Origin to Application*. Pr. Mineral. (Mineralogical Transactions), 88, web.

United States Environmental Protection Agency (USEPA), 1994. Method 1312 – Synthetic Precipitation Leaching Procedure, Revision 0, September 1994, Final Update to the Third

Edition of the Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA publication SW-846.

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

TABLES

Table 1: Summary of Key Analytical Data
West Bottom Ash Pond - H.W. Pirkey Plant

Sample	Unit	Cobalt Concentration
Bottom Ash	mg/kg	5.8
SPLP Leachate	mg/L	<0.01
WBAP Pond Water	mg/L	<0.005
AD-28 - Average	mg/L	0.0147

Notes:
mg/kg - milligram per kilogram
mg/L - milligram per liter
AD-28 - Average value was calculated using all cobalt data collected under 40 CFR 257 Subpart D.

Table 2: Soil Cobalt and Mineralogy Data
West Bottom Ash Pond - H.W. Pirkey Plant

Geosyntec Consultants, Inc.

Location ID	Sample Depth (ft bgs)	Cobalt (mg/kg)	Pyrite/Marcasite (%)
Bulk Soil Samples			
AD-17	7	3.10	2
	15	1.50	0
AD-18	8	3.60	1
	22	2.90	0
AD-30	7	1.00	3
	23	15.0	1
AD-31	12	1.90	2
	26	0.83	0
AD-32	11	1.70	--
	20-25	9.10	--
AD-41	15	< 1.0	--
	35	23.5	---
	95	1.90	---
B-2	10	2.36	---
	16	3.62	---
	71	10.30	---
	82	7.21	---
	87	3.11	---
B-3	10	1.30	---
	20	0.59	---
	97	1.11	---
Solid Material Retained After Filtration			
AD-30	15-25	9.3 J	--
B-2	38-48	4.3 J	--
B-3	29-34	12.0	--
	VAP 40-45	18.0	3

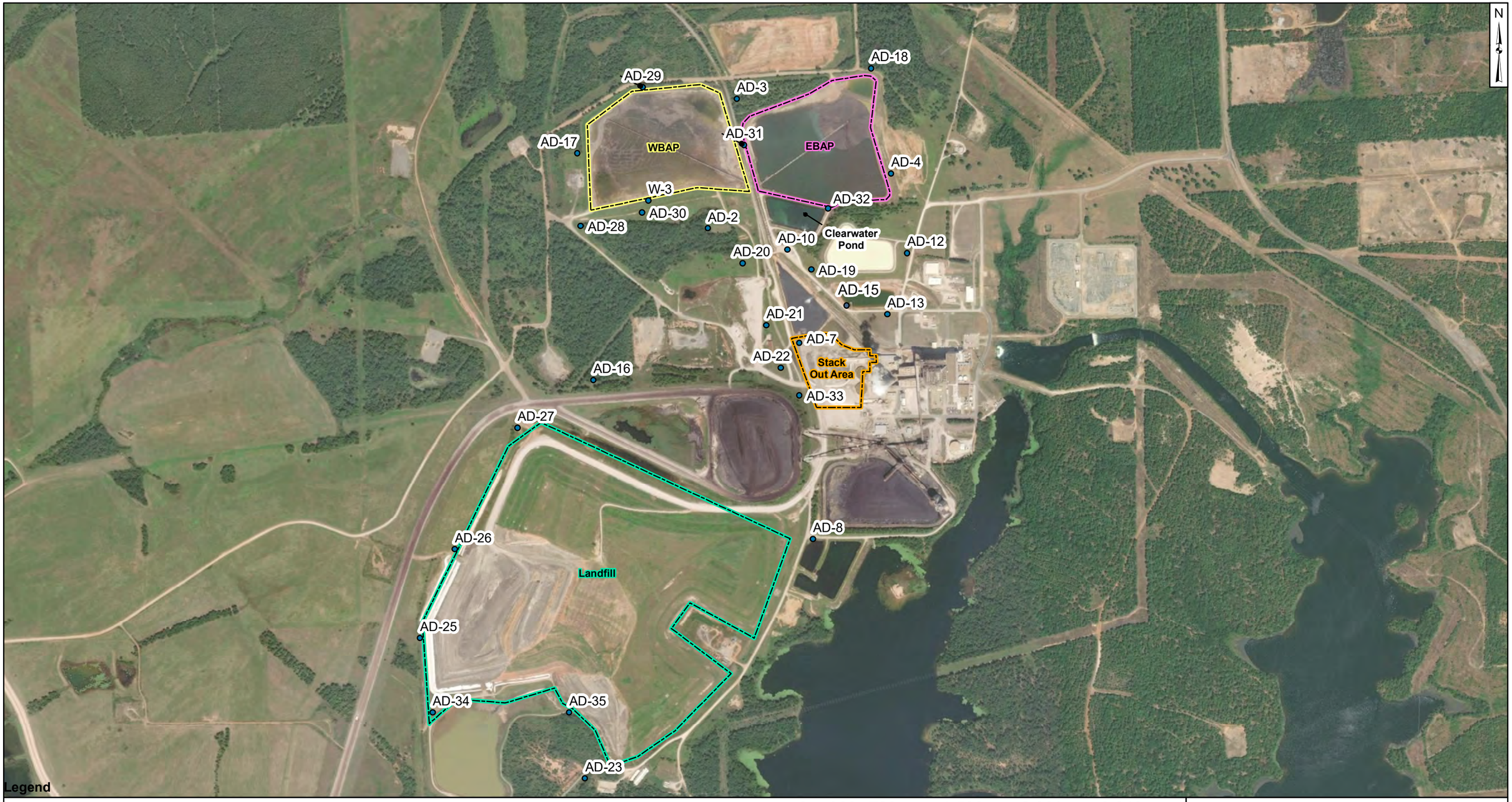
Notes:
'--' - analysis not completed
mg/kg- milligram per kilogram
ft bgs - feet below ground surface
J = estimated value
For AD-XX locations, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-X locations were collected from cores removed from the borehole during well lithology logging.
Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

Table 3: X-Ray Diffraction Results
West Bottom Ash Pond - H. W. Pirkey Plant

Constituent	VAP-B3-(40-45)
Quartz	15
Plagioclase Feldspar	0.5
Orthoclase	ND
Calcite	ND
Dolomite	ND
Siderite	0.5
Goethite	ND
Hematite	2
Pyrite	3
Kaolinte	42
Chlorite	4
Illite/Mica	6
Smectite	12
Amorphous	15

Notes:
ND: Not detected
VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

FIGURES



Legend

- AD-15
- Monitoring Wells

Location Boundaries

CCR Units

- EBAP
- Landfill
- Stack Out Area
- WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- AD-15 location is approximate.

0 380 760 1,520 2,280 3,040 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/03/25

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_20190322.mxd. HDuff. 3/25/2019. Project/Phase/Task.

Location	LCL (mg/L)
AD-31	0.0094

Location	Result (mg/L)
B-2	0.00814

Location	Result (mg/L)
AD-40	0.000799

Location	Result (mg/L)
AD-41	0.00801

Location	Result (mg/L)
B-3	0.0345

Location	LCL (mg/L)
AD-28	0.0132

Location	LCL (mg/L)
AD-2	0.010

Location	LCL (mg/L)
AD-32	0.033

AD-18
B-2
AD-29
WBAP
EBAP
AD-31
AD-40
AD-17
HPT-05
AD-4
AD-41
B-3
W-3
AD-32
AD-37
AD-30
AD-28
AD-2
AD-43
AD-42
AD-10
Clearwater Pond
AD-20
AD-12
AD-19
AD-44
AD-45
AD-15
HPT-09
AD-13
AD-38
AD-21
AD-7
Stack Out Area

N

Legend

- Out of Network
- EBAP
- WBAP
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- EBAP
- Stack Out Area
- WBAP

Notes
- Monitoring well coordinates, site features, and data provided by AEP.
- AD-15 location is approximated
- LCL: lower confidence limit
- Cobalt concentrations and LCL values displayed in milligrams per liter (mg/L).

400 200 0 400
Feet

Cobalt Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/09/17

Figure **2**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Pirkey_Cobalt_20190912.mxd. ARevezzo. 9/17/2019. Project/Phase/Task.

Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	B-2				
Depth (ft bgs)	10	16	71	82	87
Cobalt (mg/kg)	2.36	3.62	10.30	7.21	3.11
Pyrite/Marcasite (%)	-	-	-	-	-

Location	AD-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

Location	AD-41		
Depth (ft bgs)	15	35	95
Cobalt (mg/kg)	< 1.0	23.5	1.9
Pyrite/Marcasite (%)	-	-	-

Location	B-3		
Depth (ft bgs)	10	20	97
Cobalt (mg/kg)	1.30	0.59	1.11
Pyrite/Marcasite (%)	-	-	-

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

AD-29
AD-18
B-2
AD-40
AD-31
WBAP
EBAP
AD-17
HPT-05
AD-4
AD-41
B-3
W-3
AD-30
AD-37
AD-28
AD-2
AD-32
AD-10
Clearwater Pond
AD-12
AD-20
AD-19

N

Legend

- Monitoring Wells
- EBAP
- WBAP

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.

300 150 0 300
Feet

Soil Chemical and Mineralogical Analysis Results

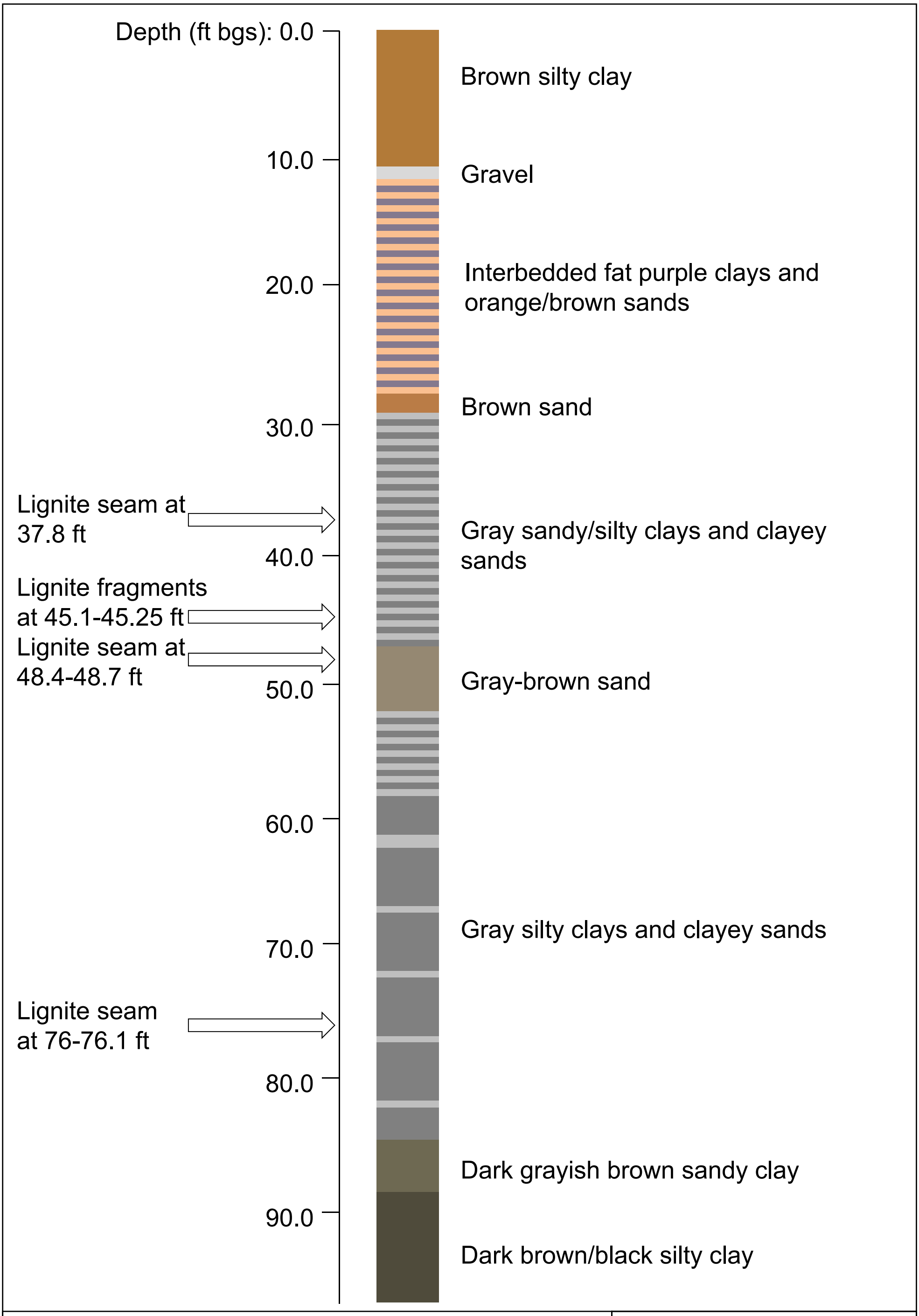
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/09/18

Figure 3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\Pirkey_SoilChem_minerals_March2019.mxd. hduff. 9/18/2019. Project/Phase/Task.



Notes:
- Ft = feet
- Bgs = below ground surface
- Boring completed May 2019
- Total depth of 97.5 ft bgs
- Well installed in offset boring screened at 29-34 ft bgs

Boring B-3 Visual Lithology Log

AEP Pirkey Powerplant
Hallsville, TX

Geosyntec consultants

CHA8462 | September 2019

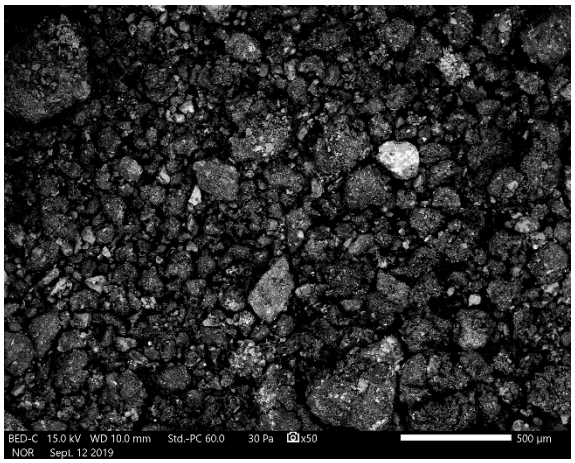
Figure 4

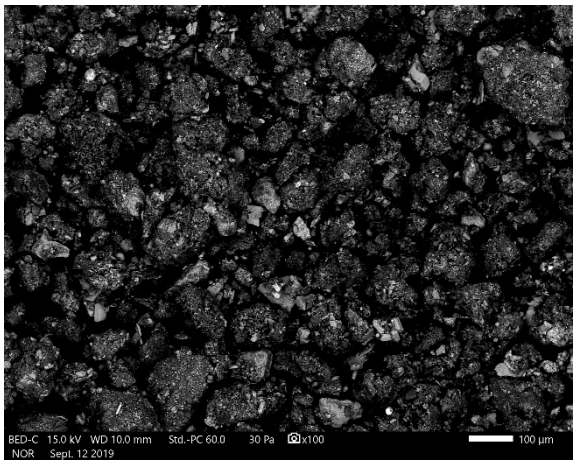
\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-05 Field Investigation\Field Forms\Compiled Boring Logs\Visual boring logs

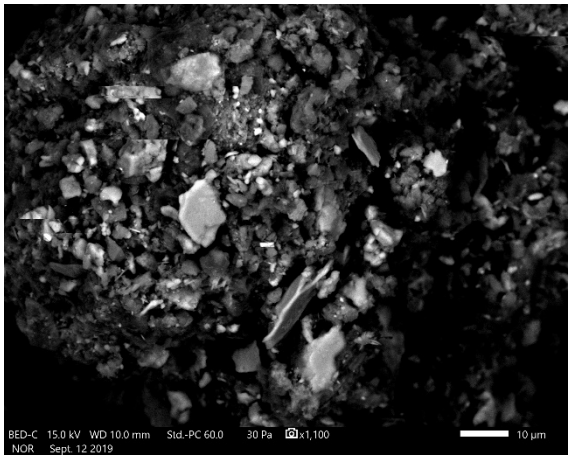
ATTACHMENT A
SEM/EDS Analysis

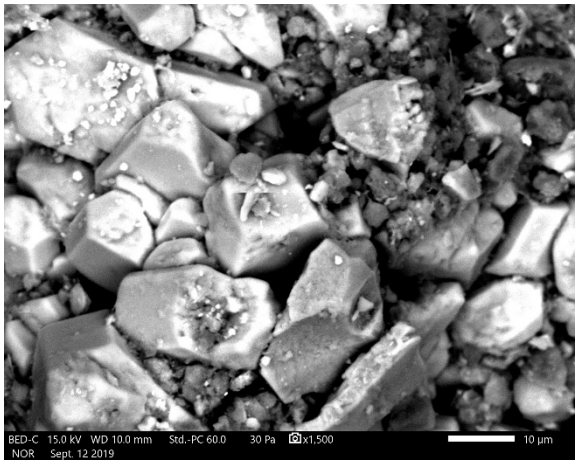
September 16, 2019

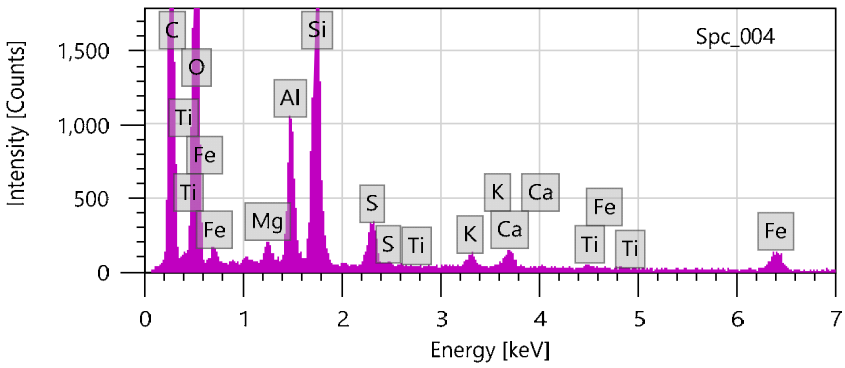
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221
via Email: BSass@geosyntec.com



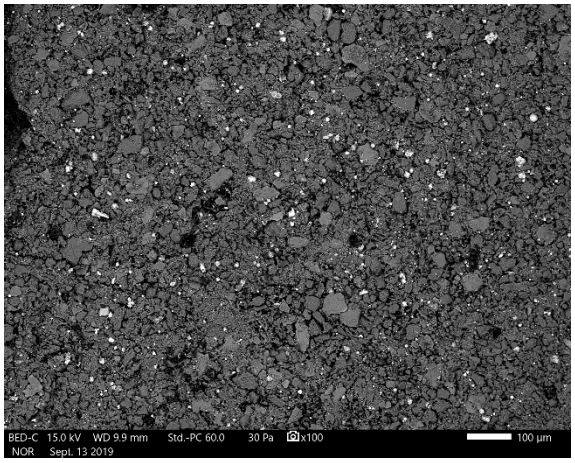


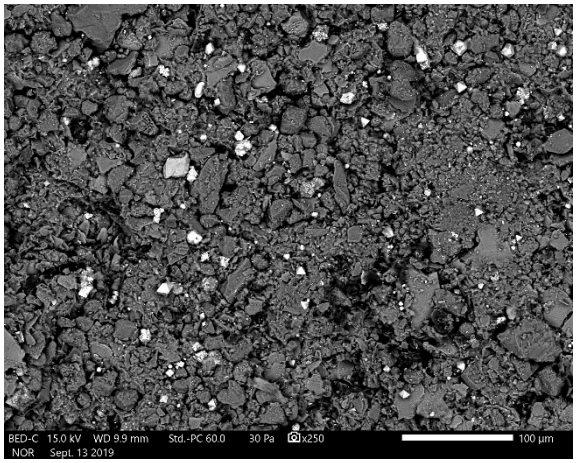


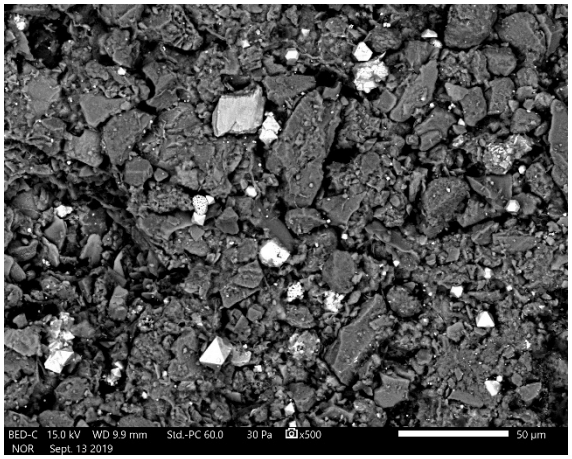


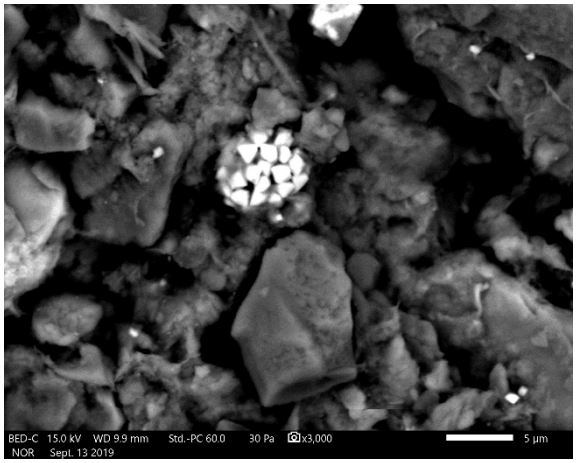


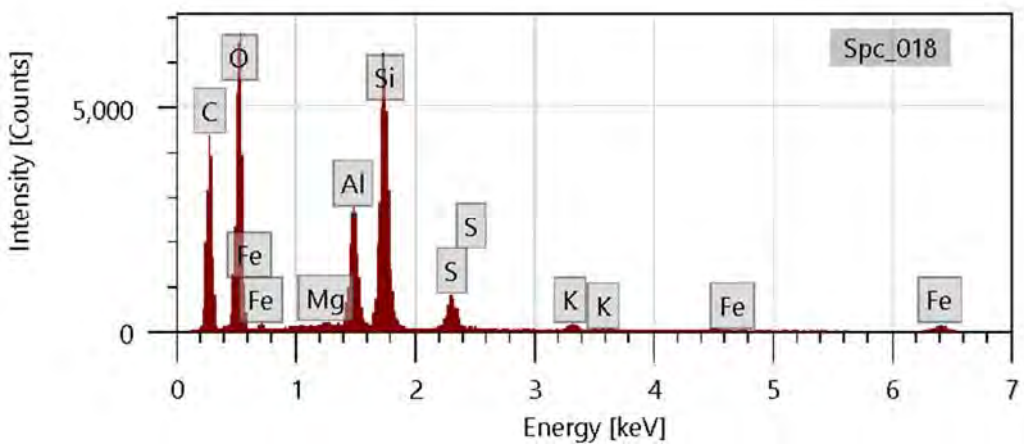
Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.





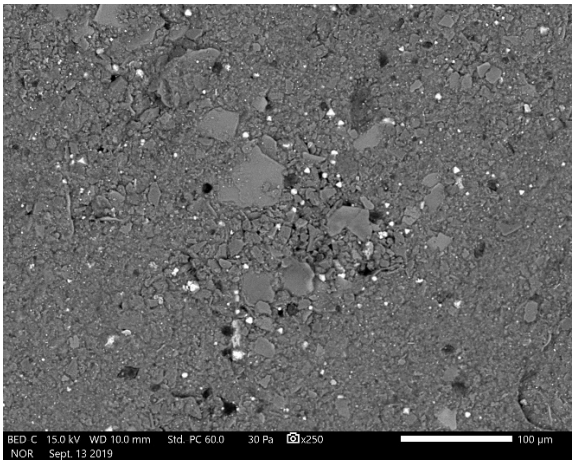


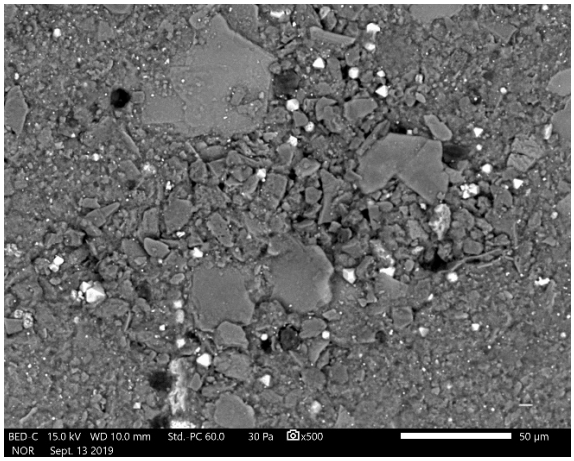


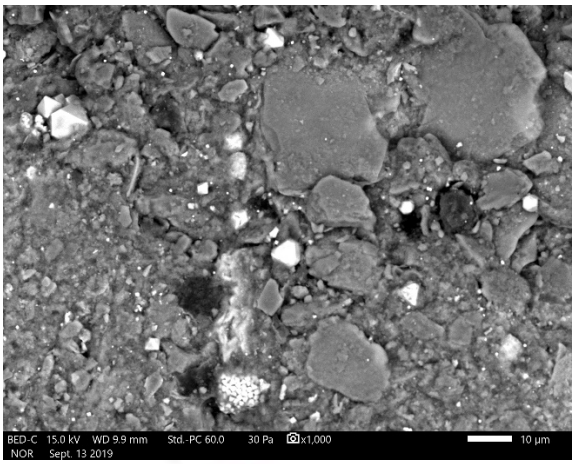


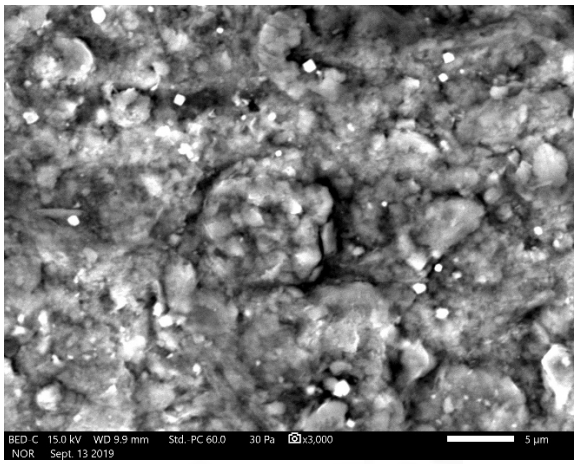
Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.

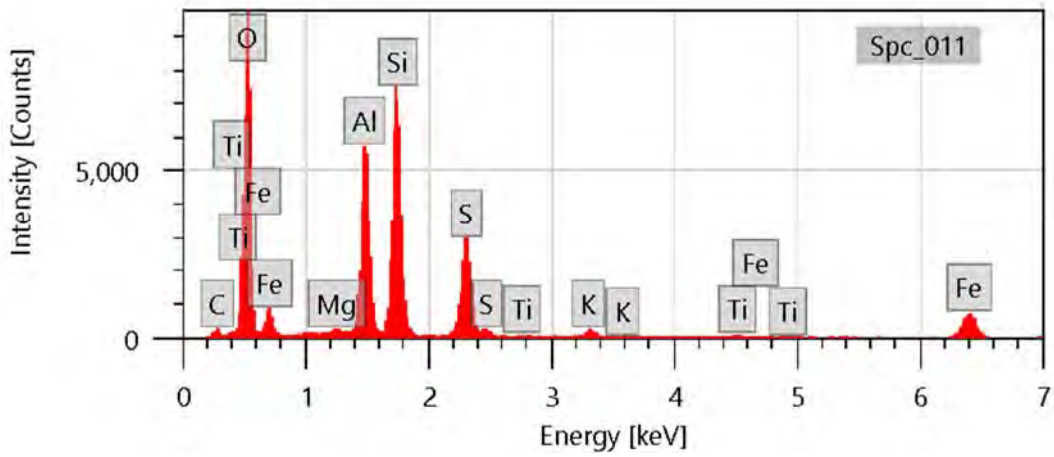
Geosyntec
CTLGroup 150350











Sample VAP B3 50-55. Backscattered electron micrographs show the sample at 250X, 500X, 1000X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 3000X. Bright particles are mostly pyrite (framboid in bottom left micrograph); occasional particles of Fe-Ti oxide are detected. Major peaks for oxygen, silicon, and aluminum suggest clay. Large blocky particles are mostly quartz, feldspar, and clay.

ATTACHMENT B
Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864	Texas	10/3/2019
License Number	Licensing State	Date

APPENDIX IV

Notices of groundwater monitoring program transitions are included in this appendix.

APPENDIX V

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #506035

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.08" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 58.82" W**
Well County:	**Harrison**	Elevation:	**No Data**
			****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #185184**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/19/2019** Drilling End Date: **2/20/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**31**	**38**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

	Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Plug Information:	**SAND**	**50**	**60**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**clay brown**
1	**5**	**silty sand**
5	**9.5**	**clay**
9.5	**11**	**sand**
11	**32**	**clay**
32	**39**	**sand and clay**
39	**55**	**sand**
55	**60**	**fine sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**40**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**40**	**50**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS PLUGGING REPORT for Tracking #185184

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.08" N**
		Longitude:	**094° 29' 58.82" W**
	LOCATED ON OWNERS PROPERTY	Elevation:	**No Data**
Well County:	**Harrison**		

Well Type: **Monitor**

Drilling Information

Company: **Plains Environmental Services** Date Drilled: **2/20/2019**

Driller: **Jesse Kalvig** License Number: **5025**

Well Report Tracking #506035

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Plugging Information

Date Plugged: **2/21/2019** Plugger: **Jesse Kalvig**

Plug Method: **Pour in 3/8 bentonite chips when standing water in well is less than 100 feet depth, cement top 2 feet**

Casing Left in Well:

DIa (in.)	*Top (ft.)*	*Bottom (ft.)*
2	**15**	**50**

Plug(s) Placed in Well:

Top (ft.)	*Bottom (ft.)*	*Description (number of sacks & material)*
1	**40**	**Bentonite 10 Bags/Sacks**

Certification Data: The driller certified that the driller plugged this well (or the well was plugged under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the reports(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

STATE OF TEXAS WELL REPORT for Tracking #506039

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD37**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Latitude:	**32° 27' 56.32" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 41.78" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**17**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**10**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**8.5**	**CLAYS WITH SOME SAND**
8.5	**10.5**	**SAND**
10.5	**13**	**CLAY SOME SAND**
13	**15**	**SAND WITH SOME CLAYS**
15	**17**	**CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**12**	**17**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506038

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD38**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 46.12" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 43.34" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/21/2019** Drilling End Date: **2/21/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**CLAY RED**
5	**7**	**CLAY GRAY/RED**
7	**11.5**	**SAND/CLAY**
11.5	**17.5**	**SAND SOME CLAYS**
17.5	**18**	**CLAY SLITS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506037

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD39**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.05" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 58.84" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/20/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**12**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**5**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**CLAY**
1	**5**	**CLAY/SAND**
5	**9.5**	**CLAY**
9.5	**12**	**SAND/CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**7**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**7**	**12**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508688

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**AD-40 (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/10/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**40**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
27	**40**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**13**	**Cement**
13	**27**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**40**	**red and grey sand with occasional clay intervals**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**30**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**30**	**40**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508686

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB(MW)-01A**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/9/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**100**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
86	**100**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**86**	**Bentonite 17 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**85**	**red and grey sand with occasional clay intervals**
85	**88**	**grey clay**
88	**100**	**grey sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**90**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**90**	**100**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508703

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**22**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**22**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**3**	**Cement**
3	**8**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**22**	**red and grey sand w/occ. lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**12**	**22**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508695

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**80**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
56	**80**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**56**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**36**	**red and grey sand w/occ. lignite layers**
36	**41**	**red and tan clay**
41	**69**	**red and grey sand with occasional clay iand lignite layers**
69	**80**	**grey sandy clay with lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**59**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**59**	**69**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508712

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/24/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**25**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
12	**25**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**12**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**25**	**brown sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**15**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**15**	**25**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508708

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
45	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**45**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**28**	**brown sand**
28	**41**	**brown and grey silty clay**
41	**70**	**grey sand with occasional lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506040

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6S**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 30.34" N**
		Longitude:	**094° 29' 27.76" W**
	LOCAATED ON OWNERS PROPERTY	Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**18**	**SANDS AND CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506041

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6D**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 30.28" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 27.75" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**65**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**53**	**Bentonite 19 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**24**	**SANDS AND CLAYS**
24	**29**	**CLAYS**
29	**42.5**	**SANDS AND CLAYS**
42.5	**48.5**	**SANDS WITH SOME CLAY**
48.5	**56**	**CLAYS WITH SOME SAND**
56	**65**	**SILY SANDS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508722

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/3/2019** Drilling End Date: **3/3/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**45**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
32	**45**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**32**	**Bentonite 6 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**45**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**35**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**35**	**45**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508720

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
57	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**57**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**70**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**60**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**60**	**70**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508724

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**35**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**35**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**23**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**35**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**25**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**25**	**35**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508729

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 medium (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**65**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
52	**65**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**53**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**65**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508777

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/26/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**93**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
77	**93**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**77**	**Bentonite 15 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**90**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**
90	**93**	**gray clay (old pit base?)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**80**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**80**	**90**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508781

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/5/2019** Drilling End Date: **3/5/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**30**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
17	**30**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**17**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**30**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**20**	**30**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508779

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/4/2019** Drilling End Date: **3/4/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**60**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
48	**60**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**48**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**60**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508718

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/8/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**15**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**15**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement**
1	**3**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**5**	**15**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508717

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/7/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**43**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
30	**43**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**30**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**
18	**43**	**red and grey sand w/occ. clay layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**33**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**33**	**43**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #525309

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**B-2**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 54.7" N**
		Longitude:	**094° 28' 25.01" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **5/13/2019** Drilling End Date: **5/17/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**49**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
36	**49**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**32**	**Concrete 1 Bags/Sacks**
32	**36**	**Bentonite 1 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEST DRILLING SERVICES, INC.**

P.O. BOX 845
FRIENDSWOOD, TX 77549

Driller Name: **Ali Firouzbakht** License Number: **4997**

Apprentice Name: **Ramon Gutierrez** Apprentice Number: **56591**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**0.5**	**SILTY SAND, black**
0.5	**2**	**SAND, red/brown**
2	**5**	**SANDY CLAY, alternating layers red + brown**
5	**5.5**	**NO RECOVERY**
5.5	**6.7**	**SANDY CLAY, gray + brown/red**
6.7	**8**	**CLAY, gray**
8	**11**	**CLAY, gray with brown striations**
11	**11.5**	**CLAY, gray**
11.5	**12**	**CLAYEY, gray SAND, red-brown**
12	**14**	**NO RECOVERY**
14	**14.75**	**SANDY CLAY, reddish brown + gray**
14.75	**16**	**CLAY, gray + red & trace brown fine grained SAND**
16	**18.5**	**NO RECOVERY**
18.5	**18.75**	**CLAY, red & gray, trace SILT**
18.75	**18.95**	**SAND, tan**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**38**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**38**	**48**
2	**SUMP**	**New Plastic (PVC)**	**40**	**48**	**48.5**

18.95	20	CLAY, red/drk. gray
20	21.1	NO RECOVERY
21.1	21.8	SANDY CLAY, lt. brown + red
21.8	24	CLAY, red + drk. gray
24	24.5	SANDY CLAY, lt. brown
24.5	24.8	SANDY CLAY, red-brown
24.8	28	CLAY, purple + gray
28	29.9	CLAY, drk. purple
29.9	30.7	CLAY, black/drk. gray
30.7	32	SILTY CLAY, black/drk. gray
32	33.5	SILTY CLAY, drk. gray
33.5	36	SILTY CLAY, black
36	36.5	NO RECOVERY
36.5	38.1	SAND, drk. green
38.1	38.3	SILTY SAND, drk. brown
38.3	38.4	CLAYEY SAND, very drk. brown
38.4	38.5	SILTY SAND, drk. green
38.5	39	SILTY SAND, drk. brown
39	39.2	Laminated SANDY CLAY/CLAYEY SANDS, gray to drk. gray
39.2	43.1	NO RECOVERY
43.1	44.5	Fine graded SAND w/trace SILT, greenish gray
44.5	47	CLAYEY SAND/SANDY CLAY, drk. brown
47	48.1	NO RECOVERY
48.1	49	CLAYEY SAND/SANDY CLAY, drk. brown

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #525308

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**B-3**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 54.7" N**
		Longitude:	**094° 28' 25.01" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **5/15/2019** Drilling End Date: **5/15/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8	**0**	**35**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
26.9	**35**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**22**	**Concrete 1 Bags/Sacks**
22	**26.9**	**Bentonite 1 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEST DRILLING SERVICES, INC.**

P.O. BOX 845
FRIENDSWOOD, TX 77549

Driller Name: **Ali Firouzbakht** License Number: **4997**

Apprentice Name: **Ramon Gutierrez** Apprentice Number: **56591**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**2**	**CLAY, medium red-brown**
2	**3**	**CLAY, lt. brown**
3	**4**	**Organic CLAY, gray to lt. brown**
4	**4.5**	**Organic CLAY, lt. brown**
4.5	**5**	**Organic CLAY, lt. brown to reddish brown**
5	**9.5**	**Organic CLAY, lt. brown to reddish brown**
9.5	**10.5**	**SILTY CLAY, reddish-orange**
10.5	**11**	**Poorly graded gravel**
11	**13**	**CLAYEY SAND,**
13	**13.9**	**SANDY CLAY, brown to orange**
13.9	**15**	**SAND, orange**
15	**16**	**SANDY CLAY**
16	**18**	**SAND, orange**
18	**18.5**	**Fat CLAY, grayish purple**
18.5	**19.5**	**SAND, orange to grayish orange**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**29.2**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**29.2**	**34**
2	**SUMP**	**New Plastic (PVC)**	**40 0.010**	**34**	**34.5**

19.5	20	Fat CLAY, grayish purple
20	22.1	SAND, lt. brown to orange
22.1	22.3	Lenes of fat CLAY, drk. gray to purple
22.3	22.6	SAND, lt. brown to orange
22.6	23	Gravelly SAND
23	24	SANDY CLAY, grayish purple
24	25.6	SAND, tan to lt. brown
25.6	26.4	CLAY, purple and gray
26.4	26.8	CLAYEY SAND, tan to lt. brown
26.8	27.3	CLAY, purple
27.3	28	CLAY, drk. gray
28	28.6	NO RECOVERY
28.6	29.2	SAND, lt. brown
29.2	29.5	SILTY CLAY, drk. gray
29.5	32	CLAY, drk. gray to black
32	32.7	CLAY, drk. gray
32.7	33.1	CLAYEY SILT, drk. gray
33.1	35	SAND, drk. gray

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #525304

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**B-6**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 54.7" N**
		Longitude:	**094° 28' 25.01" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **5/20/2019** Drilling End Date: **5/20/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
4	**0**	**40**

Drilling Method: **Direct Push**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
27	**40**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**25**	**Concrete 1 Bags/Sacks**
25	**27**	**Bentonite 1 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEST DRILLING SERVICES, INC.**

P.O. BOX 845
FRIENDSWOOD, TX 77549

Driller Name: **Ali Firouzbakht** License Number: **4997**

Apprentice Name: **Ramon Gutierrez** Apprentice Number: **56591**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**0.4**	**Topsoil with vegetation, black SILT**
0.4	**1.8**	**SILT, brown**
1.8	**7**	**SILTY CLAY, red & lt. gray**
2.3	**23.5**	**SILT, drk. red**
7	**7.2**	**SILT, brown**
7.2	**7.6**	**SILTY CLAY, red & lt. gray**
7.6	**8**	**CLAY, lt. gray**
8	**9**	**CLAY, lt. gray & lt. red**
9	**9.3**	**SILTY CLAY, lt. gray & brown**
9.3	**9.8**	**CLAY, lt. gray**
9.8	**12**	**CLAY, reddish-brown**
12	**12.8**	**SILTY CLAY, red & brown**
12.8	**16**	**SILTY CLAY, drk. brown**
16	**18.1**	**CLAY, red & brown**
18.1	**18.8**	**SILTY CLAY, brown**
18.8	**18.9**	**CLAY, brown**
18.9	**19.1**	**SILT, lt. gray & brown**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**29**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**29**	**39**
2	**SUMP**	**New Plastic (PVC)**	**40**	**39**	**39.5**

19.1	19.4	SILTY CLAY, brown
19.4	20	CLAYEY SILT, lt. gray & brown
20	20.9	CLAY, red/brown
20.9	22.1	CLAYEY SILT, lt. brown
22.1	23.2	SILTY CLAY, lt. brown & gray
23.5	24	SILTY CLAY, lt. brown & gray
24	25.9	NO RECOVERY
25.9	26.1	CLAYEY SILT, lt. brown
26.1	26.3	SILTY CLAY, brown
26.3	28	SILTY CLAY, black & drk. green
28	28.7	Trace CLAY, brown SILT
28.7	29.6	SILTY CLAY, drk. brown & green
29.6	29.9	CLAY, drk. brown
29.9	30.3	CLAYEY SAND, drk. green & drk. brown
30.3	32	Fine grained SAND, drk. green
32	34.4	Fine grained SAND, gray & brown
34.4	34.5	SILT w/gravel, tan/brown
34.5	34.7	CLAY, drk. brown
34.7	35.1	Fine grained SAND, drk. green
35.1	36	Fine grained SANDY SILT, drk. green & black
36	37.4	Fine grained SAND, drk. brown
37.4	38.5	Fine grained SILTY SAND, drk. gray & drk. green
38.5	40	SANDY SILT, drk. green & black

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Annual Groundwater Monitoring Report

Southwestern Electric Power Company

H. W. Pirkey Power Plant

FGD Stackout Area CCR Management Unit

Hallsville, Texas

January 2020

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY

An AEP Company

BOUNDLESS ENERGY

Page

Table of Contents

I. Summary

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2020.

In general, the following activities were completed:

- Groundwater samples were collected for AD-7, AD-12, AD-13, AD-22, and AD-33 in February, May, and August 2019 analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- The unit was in Assessment monitoring at the beginning and the end of 2019;
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for mercury at wells AD-22 on December 26, 2018. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on February 14, 2019.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-22 on July 11, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on October 3, 2019.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-7 and AD-22 and cobalt at AD-22 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;

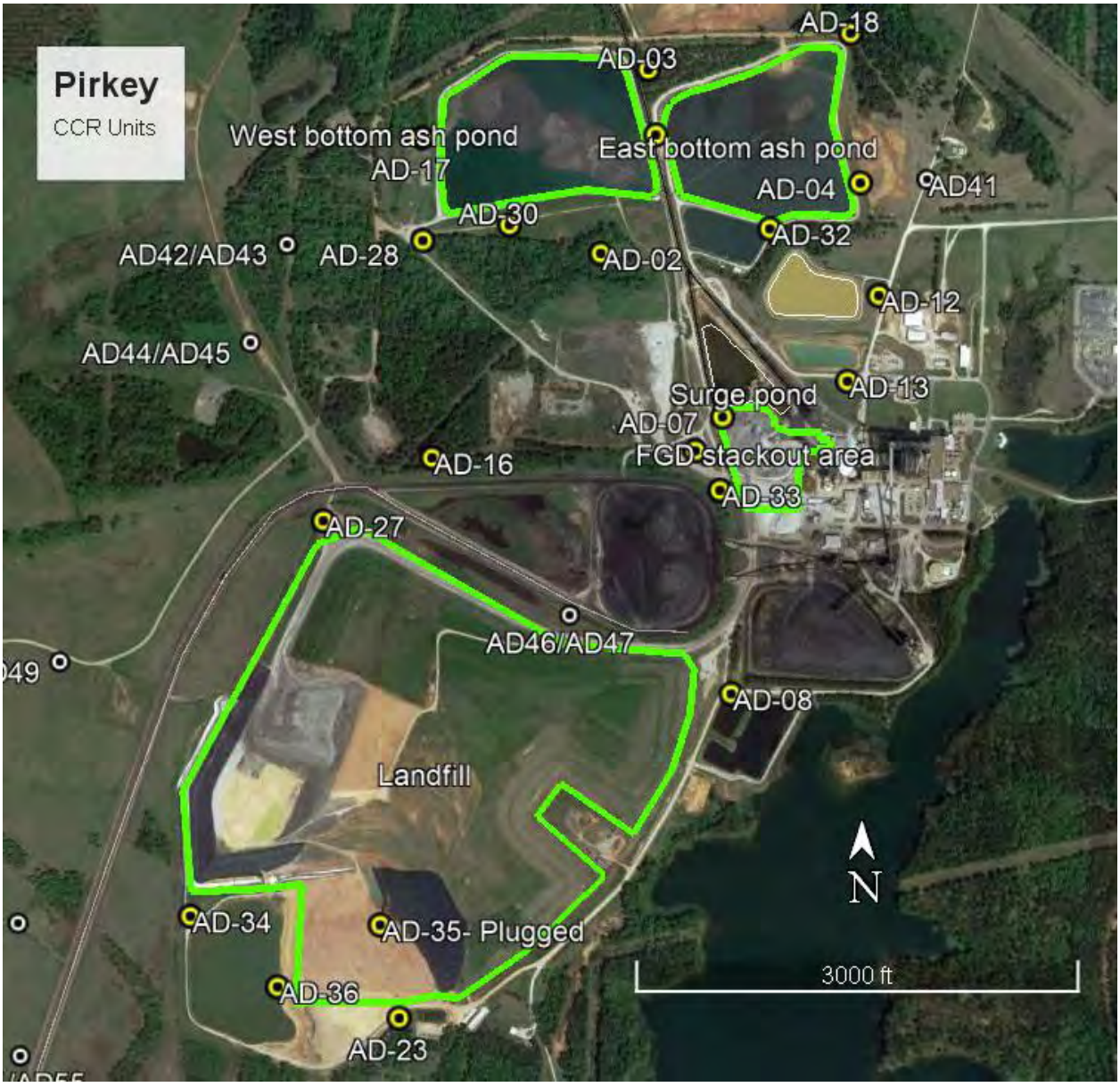
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in Appendix I;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations (Appendix IV).
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

FGD Stackout Area Monitoring Wells	
Up Gradient	Down Gradient
AD-12	AD-7
AD-13	AD-22
	AD-33



III. Monitoring Wells Installed or Decommissioned

Several monitoring wells were installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry in mine spoils. Please see the list below. Well installation reports can be found in Appendix V.

Soil Boring ID	Monitor Well ID
	AD-37
	AD-38
	AD-39
	AD-40
SB-01A	AD-41
SB-04	AD-42
SB-04	AD-43
SB-05	AD-44
SB-05	AD-45
SB-06	AD-46
SB-06	AD-47
SB-07	AD-48
SB-07	AD-49
SB-08	AD-50
SB-08	AD-52
SB-08	AD-53
SB-09	AD-54
SB-09	AD-55
SB-11	AD-56
SB-11	AD-57

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event also are shown in Appendix I, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., a one round of sampling in February in accordance with 40 CFR 257.95(d)(1). A May sampling event was conducted in accordance with 40 CFR 257.95(b) including all Appendix III parameters and those Appendix IV constituents parameters followed by an August round of sampling in accordance with 40 CFR 257.95(d)(1). Assessment monitoring will continue in 2020.

V. Statistical Evaluation of 2019 Events

The two statistical analysis reports are included in Appendix II.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-22 on July 11, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on October 3, 2019.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-7 and AD-22 and cobalt at AD-22 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the SSLs above GWPSs. SSLs above the GWPS at AD-22 were determined for mercury on December 26, 2018. An alternate source for mercury was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on February 14, 2019.

SSLs above the GWPS were determined for beryllium at wells AD-22 on July 10, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on October 3, 2019.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-7 and AD-22 and cobalt at well AD-22 on January 3, 2020. An alternate source investigation will be conducted for these SSLs.

The supporting information are found in Appendix III.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

The unit transitioned from detection monitoring to assessment monitoring transition on April 3, 2018.

Assessment monitoring will continue in 2020.

Regarding defining an alternate monitoring frequency, no modification of the twice-per-year detection monitoring effort is needed.

VIII. Other Information Required

No other information applies at this time.

IX. Description of Any Problems Encountered in 2019 and Actions Taken

No significant problems were encountered.

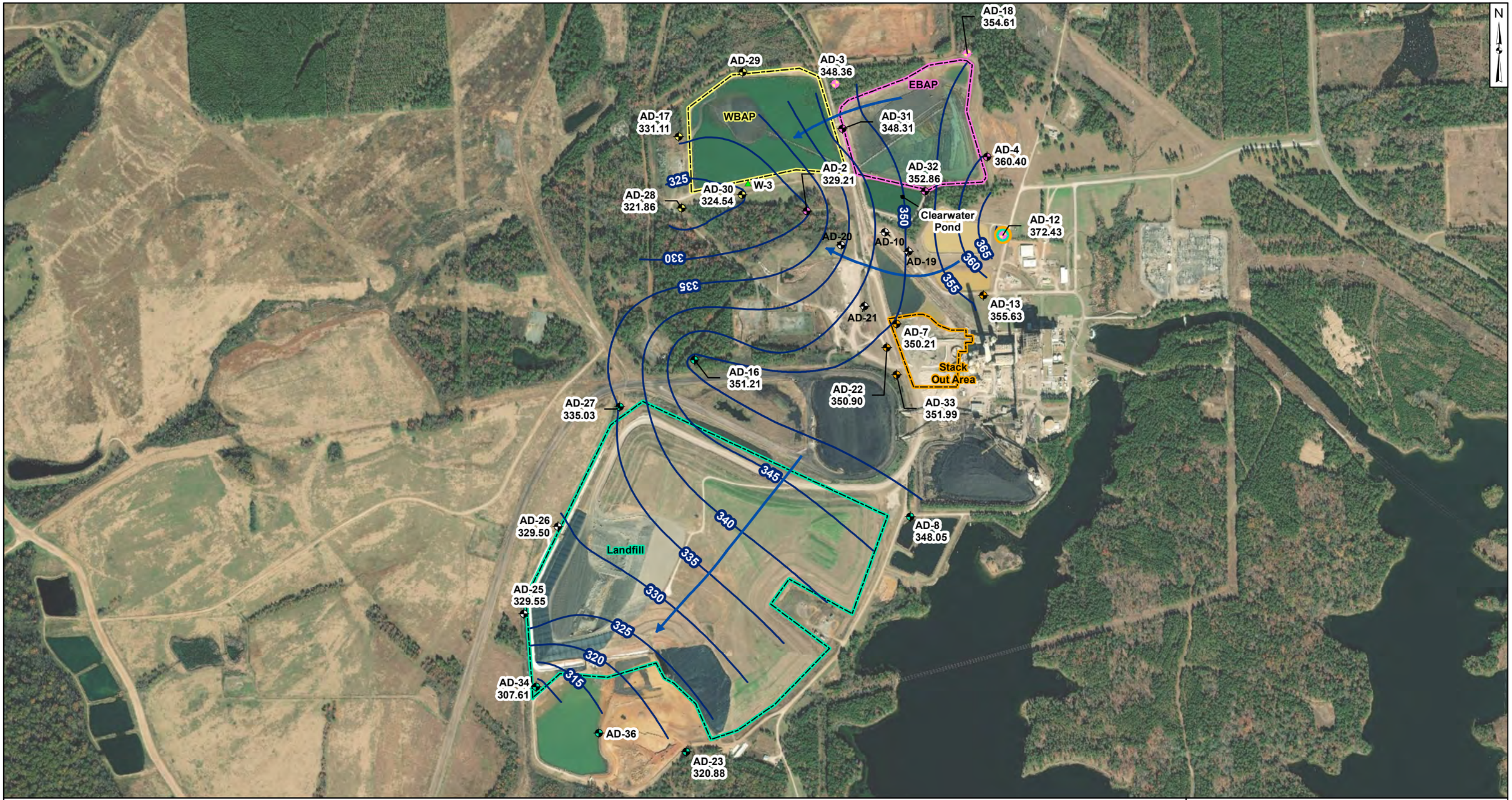
X. A Projection of Key Activities for the Upcoming Year

Key activities for 2020 include:

- Assessment monitoring sampling will be conducted;
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for any SSLs above GWPS;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the fourth annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on February 23-28, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in February 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer February 2019

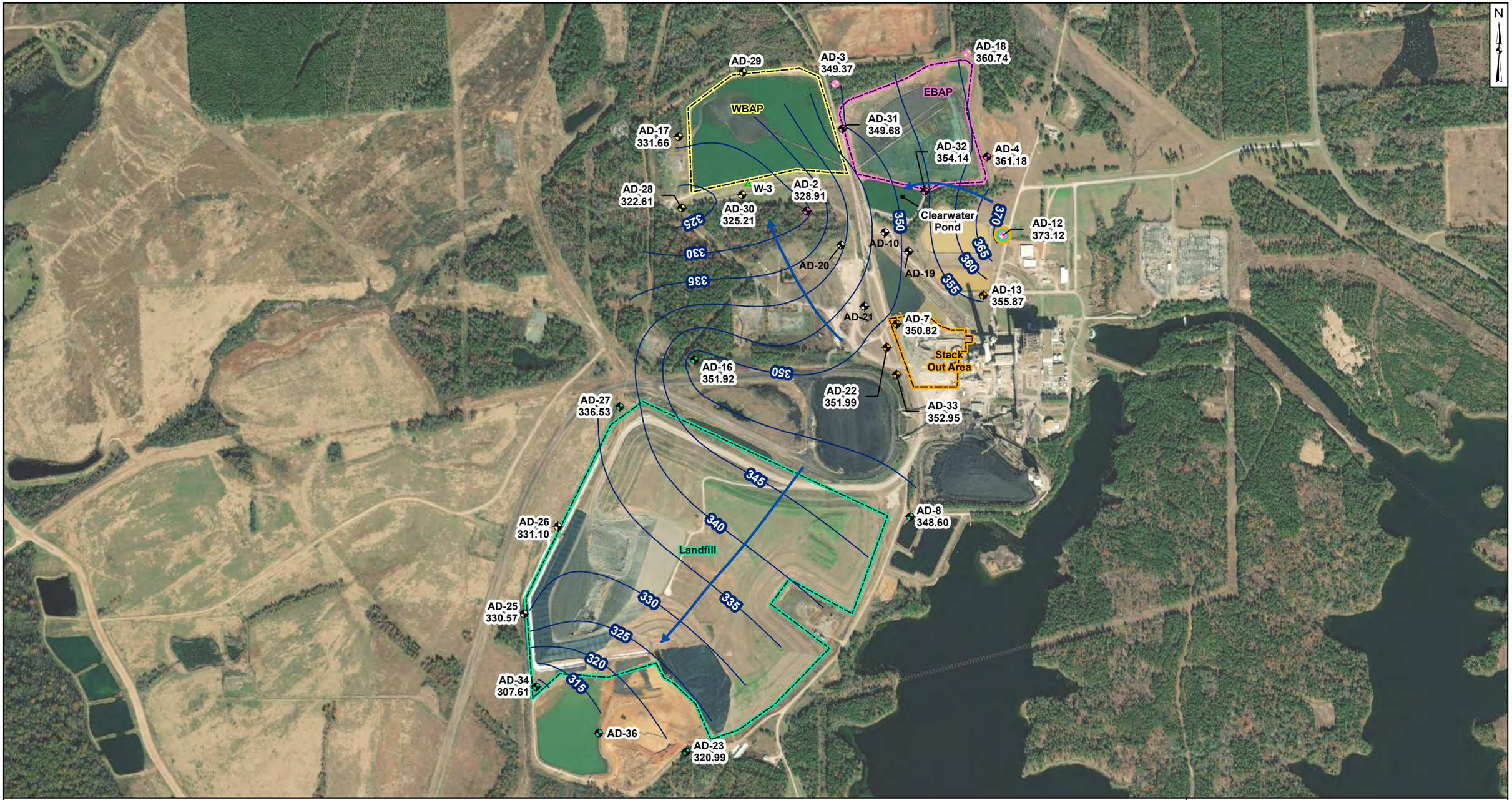
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201902-February.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 21-23, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in May 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer May 2019

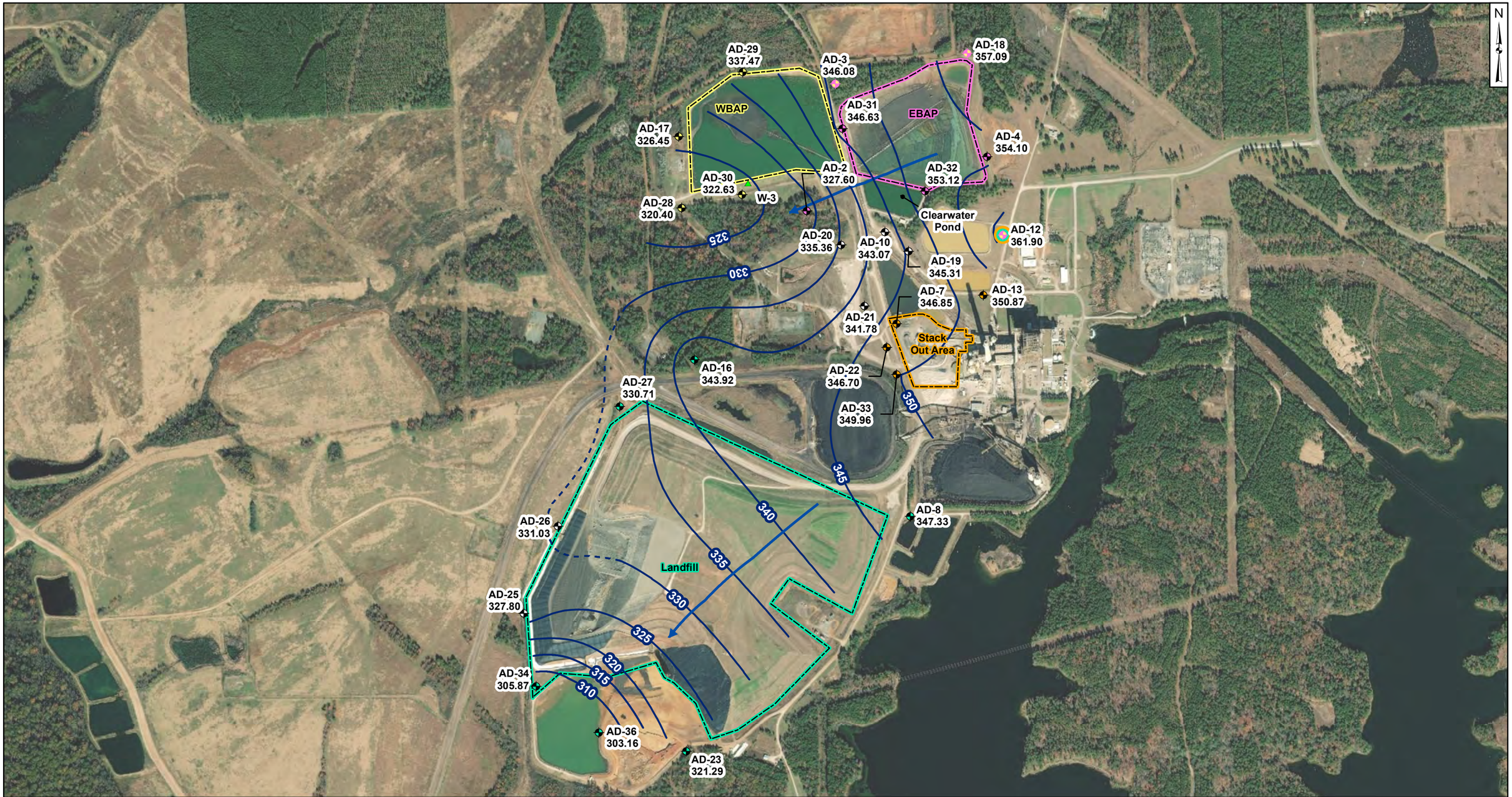
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure **2**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201905-May.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on August 12-16, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in August 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure 3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201908-August.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.

Table 1: Residence Time Calculation Summary
Pirkey Plant Stackout Area

Geosyntec Consultants, Inc.

			2019-02		2019-05		2019-08	
CCR Management Unit	Monitoring Well	Well Diameter (inches)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
Stack Out Area	AD-7 [2]	4.0	11.2	10.8	7.1	17.1	13.8	8.8
	AD-12 [1]	4.0	34.2	3.6	35.0	3.5	21.4	5.7
	AD-13 [1]	4.0	28.6	4.2	14.8	8.2	19.4	6.3
	AD-22 [2]	2.0	6.9	8.8	9.6	6.3	9.1	6.7
	AD-33 [2]	2.0	5.3	11.5	6.9	8.9	12.2	5.0

Notes:
[1] - Background Well
[2] - Downgradient Well

Table 1 - Groundwater Data Summary: AD-7
Pirkey - Stackout
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	2.39	6.58	28	0.6493 J	4.0	302	92
7/13/2016	Background	0.716	2.97	16	<0.083 U	3.6	204	40
9/7/2016	Background	0.978	3.15	18	<0.083 U	4.1	208	42
10/13/2016	Background	0.67	2.81	17	<0.083 U	3.8	212	38
11/14/2016	Background	0.682	2.63	16	<0.083 U	4.0	216	38
1/11/2017	Background	1.39	3.92	19	<0.083 U	3.5	204	46
2/28/2017	Background	1.51	4.78	20	<0.083 U	3.7	240	46
4/10/2017	Background	3.24	5.06	28	0.4117 J	3.6	322	65
8/24/2017	Detection	0.943	2.99	18	2.994	3.7	176	51
12/21/2017	Detection	0.718	3.26	19	<0.083 U	- -	176	39
3/21/2018	Assessment	2.47	5.37	20	<0.083 U	3.6	266	90
8/20/2018	Assessment	1.36	3.76	33	<0.083 U	4.3	180	54
2/27/2019	Assessment	2.10	5.2	29.9	0.50	2.9	268	69.1
5/22/2019	Assessment	0.195	5.77	28.0	0.58	3.4	334	91.6
8/12/2019	Assessment	3.54	4.20	36.7	0.30	4.0	266	59.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-7
Pirkey - Stackout
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	1.38216 J	37	8	0.87394 J	0.766043 J	52	4.344	0.6493 J	<0.68 U	0.044	0.309	<0.29 U	1.04661 J	<0.86 U
7/13/2016	Background	<0.93 U	1.18444 J	50	3	0.66774 J	1	24	0.942	<0.083 U	<0.68 U	0.099	0.261	<0.29 U	<0.99 U	1.03212 J
9/7/2016	Background	<0.93 U	<1.05 U	50	4	0.730872 J	0.316008 J	27	3.132	<0.083 U	<0.68 U	0.099	0.059	<0.29 U	<0.99 U	<0.86 U
10/13/2016	Background	<0.93 U	1.08028 J	61	4	0.858417 J	1	23	3.81	<0.083 U	<0.68 U	0.101	0.154	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	60	4	1	<0.23 U	22	3.538	<0.083 U	<0.68 U	0.099	0.039	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	<1.05 U	58	5	0.756968 J	<0.23 U	31	3.77	<0.083 U	<0.68 U	0.101	0.02275 J	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	<1.05 U	53	5	0.838869 J	<0.23 U	34	3.92	<0.083 U	<0.68 U	0.101	0.185	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	51	7	0.723565 J	0.295188 J	44	4.35	0.4117 J	<0.68 U	0.111	0.191	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	40.31	6.81	0.82 J	<0.23 U	45.34	3.99	<0.083 U	<0.68 U	0.108	0.117	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	0.01 J	0.47	51.6	2.07	0.68	0.075	25.6	0.787	<0.083 U	0.362	0.0877	0.006 J	<0.02 U	1.0	0.179
2/27/2019	Assessment	<0.4 U	2.12	42.9	7.01	0.73	0.225	41.0	4.75	0.50	1 J	0.106	0.201	<0.4 U	7.1	<2 U
5/22/2019	Assessment	<0.4 U	2 J	37.8	6.47	0.6 J	<0.8 U	46.0	4.72	0.58	0.8 J	0.0975	0.26	<8 U	3 J	<0.1 U
8/12/2019	Assessment	<0.02 U	0.64	41.9	3.24	0.75	0.1 J	29.7	3.278	0.30	0.529	0.102	0.09	<0.4 U	1.7	0.2 J

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - Stackout
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	<0.083 U	4.4	94	4
7/13/2016	Background	0.03	0.26	6	<0.083 U	3.1	75	4
9/7/2016	Background	0.04	0.343	6	<0.083 U	3.9	63	7
10/12/2016	Background	0.03	0.271	7	< 1 U	3.4	92	8
11/14/2016	Background	0.04	0.331	8	<0.083 U	2.6	80	6
1/11/2017	Background	0.03	0.315	7	<0.083 U	4.8	76	6
2/28/2017	Background	0.04	0.434	5	<0.083 U	3.6	50	4
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	72	7
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	52	6
3/21/2018	Assessment	0.01397	0.269	5	<0.083 U	4.2	<2 U	3
8/20/2018	Assessment	0.017	0.338	10	<0.083 U	4.4	94	4
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	36	3.6
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	80	4.0
8/12/2019	Assessment	<0.02 U	0.278	7.24	0.06 J	4.9	90	2.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - Stackout
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	26	0.219521 J	<0.07 U	0.710981 J	1.58207 J	0.2073	<0.083 U	<0.68 U	<0.00013 U	<0.005 U	<0.29 U	1.73953 J	<0.86 U
7/13/2016	Background	<0.93 U	<1.05 U	23	0.190337 J	<0.07 U	0.68835 J	1.29444 J	2.909	<0.083 U	<0.68 U	0.008	<0.005 U	<0.29 U	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	30	0.232192 J	<0.07 U	0.353544 J	1.66591 J	0.881	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	<1.05 U	27	0.149553 J	<0.07 U	0.529033 J	1.56632 J	0.257	< 1 U	<0.68 U	0.012	<0.005 U	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	28	0.152375 J	<0.07 U	0.32826 J	1.47282 J	0.767	<0.083 U	<0.68 U	0.013	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	<1.05 U	23	0.126621 J	<0.07 U	0.650158 J	1.09495 J	1.536	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	<1.05 U	26	0.149219 J	<0.07 U	0.325811 J	1.29984 J	0.416	<0.083 U	<0.68 U	0.009	<0.005 U	<0.29 U	<0.99 U	0.994913 J
4/11/2017	Background	<0.93 U	<1.05 U	24	0.159412 J	<0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	<0.68 U	0.008	0.01364 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	25.82	0.16 J	<0.07 U	1.05	1.49 J	0.784	<0.083 U	<0.68 U	0.00722	<0.005 U	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	<0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	<0.083 U	0.089	0.0143	<0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	<0.4 U	<0.6 U	22.5	<0.4 U	<0.2 U	<0.8 U	1.37	0.225	0.09	<0.4 U	0.00688	<0.005 U	<8 U	<0.6 U	<2 U
5/21/2019	Assessment	<0.4 U	<0.6 U	21.7	<0.4 U	<0.2 U	<0.8 U	1.15	0.201	0.09	<0.4 U	0.00576	<0.005 U	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.07 J	23.8	0.154	<0.01 U	0.204	1.3	0.237	0.06 J	0.08 J	0.00829	<0.005 U	<0.4 U	0.2 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-13
Pirkey - Stackout
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.06	8.77	28	0.748 J	5.6	236	52
7/13/2016	Background	0.06	9.08	32	0.3474 J	5.6	192	59
9/7/2016	Background	0.05	8.48	23	<0.083 U	5.2	228	41
10/13/2016	Background	0.06	7.53	26	0.6297 J	5.8	236	47
11/14/2016	Background	0.06	7.21	26	0.3114 J	6.1	250	47
1/11/2017	Background	0.04	6.14	22	<0.083 U	5.8	188	37
2/28/2017	Background	0.07	7.88	28	<0.083 U	5.9	172	56
4/11/2017	Background	0.08	9.11	32	0.4278 J	5.2	200	58
8/23/2017	Detection	0.07408	9.5	21	0.344 J	6.0	160	38
3/21/2018	Assessment	0.07169	10.3	25	<0.083 U	5.9	176	48
8/20/2018	Assessment	0.065	8.40	39	0.0845 J	5.9	210	66
2/27/2019	Assessment	0.08 J	11.0	40.8	0.25	5.2	176	80.8
5/21/2019	Assessment	0.061	10.1	34.8	0.40	5.3	190	69.5
8/12/2019	Assessment	0.064	8.68	42.3	0.39	5.9	310	73.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-13
Pirkey - Stackout
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	4.25914 J	38	0.586539 J	0.293832 J	<0.23 U	42	0.989	0.748 J	<0.68 U	0.081	0.00969 J	<0.29 U	<0.99 U	1.11268 J
7/13/2016	Background	<0.93 U	9	44	2	0.0875208 J	<0.23 U	47	2.332	0.3474 J	<0.68 U	0.158	0.01928 J	<0.29 U	3.63671 J	0.928756 J
9/7/2016	Background	<0.93 U	<1.05 U	47	0.631177 J	0.219799 J	<0.23 U	38	1.219	<0.083 U	<0.68 U	0.139	<0.005 U	<0.29 U	<0.99 U	1.44332 J
10/13/2016	Background	<0.93 U	7	43	0.963478 J	<0.07 U	<0.23 U	42	2.422	0.6297 J	<0.68 U	0.142	<0.005 U	<0.29 U	2.59885 J	<0.86 U
11/14/2016	Background	<0.93 U	2.07189 J	39	0.717704 J	0.310257 J	<0.23 U	42	1.723	0.3114 J	<0.68 U	0.136	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	2.73936 J	39	0.302907 J	0.11238 J	<0.23 U	32	1.844	<0.083 U	<0.68 U	0.133	0.00732 J	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	1.64435 J	34	0.290018 J	<0.07 U	<0.23 U	44	1.728	<0.083 U	<0.68 U	0.153	<0.005 U	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	4.43115 J	45	0.736525 J	2	<0.23 U	56	1.309	0.4278 J	<0.68 U	0.156	<0.005 U	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	3.23 J	42.23	0.46 J	0.86 J	<0.23 U	39.91	2.093	<0.083 U	<0.68 U	0.145	<0.005 U	<0.29 U	3.86 J	<0.86 U
8/20/2018	Assessment	0.01 J	5.79	40.9	0.648	<0.005 U	0.103	48.8	1.735	0.0845 J	0.01 J	0.146	<0.005 U	<0.02 U	0.2	0.03 J
2/27/2019	Assessment	<0.4 U	2.17	38.5	<0.4 U	<0.2 U	<0.8 U	48.7	0.909	0.25	<0.4 U	0.165	<0.005 U	<8 U	<0.6 U	<2 U
5/21/2019	Assessment	<0.4 U	2 J	35.0	<0.4 U	<0.2 U	<0.8 U	44.7	0.875	0.40	<0.4 U	0.153	<0.005 U	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	1.64	35.0	0.235	<0.01 U	0.06 J	44.5	1.642	0.39	<0.05 U	0.139	<0.005 U	<0.4 U	<0.03 U	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-22
Pirkey - Stackout
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.08	15.3	76	1.266	4.0	672	284
7/14/2016	Background	0.04	9.5	52	0.3891 J	3.9	412	162
9/7/2016	Background	0.04	6.95	42	<0.083 U	4.1	341	114
10/12/2016	Background	0.03	7.68	52	0.473 J	4.7	388	148
11/14/2016	Background	0.04	7.55	48	0.2834 J	4.4	362	177
1/12/2017	Background	0.02	6.47	51	<0.083 U	4.2	344	137
3/1/2017	Background	0.05	13.6	69	<0.083 U	4.1	624	266
4/11/2017	Background	0.04	10.8	72	0.5041 J	4.1	446	215
8/23/2017	Detection	0.05075	7.77	54	1.196	4.6	350	121
12/21/2017	Detection	0.06278	7.29	61	<0.083 U	- -	344	120
3/21/2018	Assessment	0.0818	15.2	79	<0.083 U	3.9	656	377
8/20/2018	Assessment	0.031	9.43	92	<0.083 U	4.2	476	184
2/27/2019	Assessment	0.07 J	15.2	76.7	1.33	4.9	584	337
5/22/2019	Assessment	0.073	16.5	63.3	1.06	5.1	506	360
8/12/2019	Assessment	0.03 J	8.96	79.6	0.45	4.8	484	198

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-22
Pirkey - Stackout
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	23	71	13	2	24	129	6.994	1.266	0.97266 J	0.139	13.41	<0.29 U	1.97127 J	1.16089 J
7/14/2016	Background	<0.93 U	12	48	6	0.674427 J	12	67	2.325	0.3891 J	<0.68 U	0.169	17	<0.29 U	<0.99 U	0.895409 J
9/7/2016	Background	<0.93 U	23	108	5	0.833408 J	33	54	3.412	<0.083 U	2.72959 J	0.131	19.829	<0.29 U	<0.99 U	1.25036 J
10/12/2016	Background	<0.93 U	10	54	4	0.333745 J	7	54	3.39	0.473 J	<0.68 U	0.14	7.984	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	3.69822 J	66	4	0.596378 J	2	47	3.63	0.2834 J	<0.68 U	0.115	8.634	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	6	67	4	0.385609 J	2	43	3.173	<0.083 U	<0.68 U	0.104	13.32	<0.29 U	1.09664 J	<0.86 U
3/1/2017	Background	<0.93 U	1.61319 J	29	10	1	<0.23 U	105	4.385	<0.083 U	<0.68 U	0.218	0.22	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	11	130	6	2	5	78	3.045	0.5041 J	1.89388 J	0.176	7.201	<0.29 U	1.86563 J	<0.86 U
3/21/2018	Assessment	<0.93 U	3.56 J	24.13	12.1	1.87	<0.23 U	121	6.22	<0.083 U	<0.68 U	0.277	1.206	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	0.02 J	5.18	22.7	3.30	0.46	0.829	62.9	3.088	<0.083 U	0.386	0.132	1.448	0.07 J	2.5	0.162
2/27/2019	Assessment	<0.4 U	6.3	17.0	13.3	1.55	0.8 J	123	5.99	1.33	0.5 J	0.269	0.642	<8 U	16.7	<2 U
5/22/2019	Assessment	<0.4 U	5.89	16.7	12.5	1.52	<0.8 U	129	6.71	1.06	<0.4 U	0.288	0.837	<8 U	5.9	0.2 J
8/12/2019	Assessment	<0.02 U	2.19	15.3	3.38	0.44	0.2 J	57.5	3.088	0.45	0.1 J	0.151	0.325	<0.4 U	2.0	0.2 J

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-33
Pirkey - Stackout
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.126	2.44	8	<0.083 U	4.1	326	56
7/14/2016	Background	0.173	1.69	16	<0.083 U	3.1	176	108
9/7/2016	Background	0.152	1.81	10	<0.083 U	3.6	176	64
10/12/2016	Background	0.162	1.39	9	0.357 J	3.4	180	46
11/14/2016	Background	0.182	1.63	8	<0.083 U	3.1	190	54
1/12/2017	Background	0.144	1.26	10	<0.083 U	4.3	168	58
2/28/2017	Background	0.14	1.25	7	<0.083 U	3.9	146	51
4/10/2017	Background	0.114	1.29	9	<0.083 U	3.4	178	49
8/23/2017	Detection	0.07952	1.06	9	0.670 J	4.4	132	40
12/21/2017	Detection	0.09993	0.946	- -	- -	- -	- -	- -
3/21/2018	Assessment	0.115	1.42	7	<0.083 U	4.4	160	58
8/21/2018	Assessment	0.098	1.09	12	<0.083 U	3.6	156	48
2/27/2019	Assessment	0.134	1.73	8.89	0.25	3.3	146	62.8
5/22/2019	Assessment	0.111	1.65	8.57	0.23	4.1	204	60.4
8/12/2019	Assessment	0.097	1.03	8.85	0.19	4.2	156	44.3

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-33
Pirkey - Stackout
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	2.53645 J	60	2	<0.07 U	4	12	1.303	<0.083 U	<0.68 U	<0.00013 U	0.288	<0.29 U	<0.99 U	<0.86 U
7/14/2016	Background	<0.93 U	4.91616 J	64	2	<0.07 U	9	12	4.28	<0.083 U	<0.68 U	0.029	0.707	<0.29 U	<0.99 U	1.19199 J
9/7/2016	Background	<0.93 U	67	163	4	0.984692 J	125	33	3.461	<0.083 U	14	0.048	1.826	0.736517 J	1.61343 J	<0.86 U
10/12/2016	Background	<0.93 U	2.15866 J	59	1	<0.07 U	4	10	2.208	0.357 J	<0.68 U	0.027	0.145	<0.29 U	<0.99 U	1.56738 J
11/14/2016	Background	<0.93 U	1.46353 J	52	1	<0.07 U	1	9	1.953	<0.083 U	<0.68 U	0.024	0.197	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	1.12979 J	56	1	<0.07 U	2	9	2.596	<0.083 U	<0.68 U	0.027	0.36	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	1.069 J	55	1	<0.07 U	<0.23 U	9	0.942	<0.083 U	<0.68 U	0.026	0.41	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	55	1	<0.07 U	3	10	9.024	<0.083 U	<0.68 U	0.027	0.341	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	1.78 J	57.26	1.4	0.15 J	4.64	10.42	1.643	<0.083 U	<0.68 U	0.02669	0.825	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	0.01 J	0.65	43.8	0.905	0.04	0.147	7.72	6.32	<0.083 U	0.151	0.0178	0.745	<0.02 U	1.7	0.05 J
2/27/2019	Assessment	<0.4 U	1 J	49.5	1 J	<0.2 U	<0.8 U	10.5	2.235	0.25	<0.4 U	0.0262	0.464	<8 U	3 J	<2 U
5/22/2019	Assessment	<0.4 U	<0.6 U	52.4	1 J	<0.2 U	<0.8 U	10.5	1.178	0.23	<0.4 U	0.0245	0.481	<8 U	1 J	<0.1 U
8/12/2019	Assessment	<0.02 U	0.41	38.6	1.00	0.04 J	0.1 J	7.02	1.141	0.19	0.1 J	0.0233	0.564	<0.4 U	1.1	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
FLUE GAS DESULFERIZATION (FGD)
STACKOUT AREA
H.W. Pirkey Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

July 11, 2019

CHA8473

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
FGD	Flue Gas Desulfurization
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the Flue Gas Desulfurization (FGD) Stackout Area, an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, chloride, and sulfate at the FGD Stackout Area. An alternative source was not identified at the time, so two assessment monitoring events were conducted at the FGD Stackout Area in 2018, in accordance with 40 CFR 257.95. An SSL was identified for mercury at well AD-22. An ASD was successfully completed which resulted in a revision to the dataset for mercury at well AD-22 (Geosyntec, 2019). Thus, the unit remained in assessment monitoring.

A semi-annual assessment monitoring event was also completed in February 2019, with the results of the February 2019 event documented in this report. The groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The February 2019 monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. An SSL was identified for beryllium. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

FGD STACKOUT AREA EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, one set of samples was collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(d)(1). Although antimony, fluoride, lead, molybdenum, and thallium were not detected at any locations during the March 2018 screening event, samples from the February 2019 semi-annual sampling event were analyzed for all Appendix III and Appendix IV parameters. A summary of data collected during this assessment monitoring event may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.14 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the FGD Stackout Area were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained to meet the requirements of 40 CFR 257.95(d)(1) were screened for potential outliers. Non-detect values for molybdenum at AD-12, AD-13, AD-22, and AD-33 were flagged as outliers because the reporting limit during the February 2019 sampling event for these wells 0.04 mg/L compared to a historical reporting limit of 0.002 mg/L. Well AD-7 had a reporting limit of 0.002 mg/L during this event. The removal of these values as outliers did not affect the statistical evaluation of this event, as molybdenum was not detected during the March 2018 screening event.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-

based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for arsenic, cadmium, chromium, cobalt, fluoride, lithium, selenium, and thallium due to apparent non-normal distributions and for antimony, lead, mercury, and molybdenum due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSL was identified at the Pirkey FGD Stackout Area:

- The LCL for beryllium exceeded the GWPS of 0.004 mg/L at AD-22 (0.00413).

As a result, the Pirkey FGD Stackout Area will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Evaluation of Potential Appendix III SSIs

While an SSLs was identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations. Prediction limits were calculated for the Appendix III parameters to represent background values. As described in the January 2018 *Statistical Analysis Summary* report (Geosyntec, 2018), intrawell tests were used to evaluate potential SSIs for calcium, pH, and TDS, whereas interwell tests were used to evaluate potential SSIs for boron, chloride, fluoride, and sulfate.

Prediction limits for the interwell tests were recalculated using data collected during the February 2019 assessment monitoring event. Three data points (i.e., one sample from three background wells) were added to the background dataset for each interwell test. New data were tested for outliers prior to being added to the background dataset. The updated prediction limits were calculated for a one-of-two retesting procedure, as during detection monitoring. The values of the updated prediction limits were similar to the values of the prediction limits calculated during detection monitoring. The revised interwell prediction limits were used to evaluate potential SSIs for boron, chloride, fluoride, and sulfate.

For the intrawell tests, limited data made it possible to add only one data point (i.e., one sample from each compliance well) to each background dataset. Because one sample result is insufficient to compare against the existing background dataset, the prediction limits were not updated for the intrawell tests at this time. The intrawell prediction limits calculated during detection monitoring were used to evaluate potential SSIs for calcium, pH, and TDS.

Data collected during the February 2019 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0840 mg/L at AD-33 (0.134 mg/L) and AD-7 (2.1 mg/L).
- The chloride concentration exceeded the interwell UPL of 40.8 mg/L at AD-22 (76.7 mg/L).
- The fluoride concentration exceeded the interwell UPL or 1.0 mg/L at AD-22 (1.33 mg/L).
- The reported pH values exceeded the intrawell UPL of 4.8 SU at AD-22 (4.9 SU) and were below the intrawell lower prediction limit (LPL) of 3.2 SU at AD-7 (2.9 SU).
- The sulfate concentration exceeded the interwell UPL of 80.8 mg/L at AD-22 (337 mg/L).

While the prediction limits were calculated assuming a 1-of-2 testing procedure, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the UPL based on previous results. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey FGD Stackout Area during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. Following a review of outliers in the February 2019 data the non-detect molybdenum results from AD-12, AD-13, AD-22, and AD-33, which were replaced with the reporting limit, were removed as outliers. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. An SSLs was identified for beryllium. Appendix III parameters were also evaluated, with exceedances identified for boron, chloride, fluoride, pH, and sulfate.

Based on this evaluation, the Pirkey FGD Stackout Area unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – Pirkey Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Flue Gas Desulfurization Stackout Area, H.W. Pirkey Power Plant, Hallsville, Texas. January 3, 2018.

Geosyntec. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant Flue Gas Desulfurization (FGD) Stackout Area. February 13, 2019.

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09-007. March 2009.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - Stackout

Geosyntec Consultants

Parameter	Unit	AD-7	AD-12	AD-13	AD-22	AD-33
		2/27/2019	2/27/2019	2/27/2019	2/27/2019	2/27/2019
Antimony	µg/L	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
Arsenic	µg/L	2.12	2.00 U	2.17	6.30	1.00 J
Barium	µg/L	42.9	22.5	38.5	17.0	49.5
Beryllium	µg/L	7.01	2.00 U	2.00 U	13.3	1.00 J
Boron	mg/L	2.10	0.0300 J	0.0800 J	0.0700 J	0.134
Cadmium	µg/L	0.730	1.00 U	1.00 U	1.55	1.00 U
Calcium	mg/L	5.20	0.400 J	11.0	15.2	1.73
Chloride	mg/L	29.9	6.08	40.8	76.7	8.89
Chromium	µg/L	0.225	4.00 U	4.00 U	0.800 J	4.00 U
Cobalt	µg/L	41.0	1.37	48.7	123	10.5
Combined Radium	pCi/L	4.75	0.225	0.909	5.99	2.24
Fluoride	mg/L	0.500	0.0900	0.250	1.33	0.250
Lead	µg/L	1.00 J	2.00 U	2.00 U	0.500 J	2.00 U
Lithium	mg/L	0.106	0.00688	0.165	0.269	0.0262
Mercury	mg/L	0.000201	0.0000250 U	0.0000250 U	0.000642	0.000464
Molybdenum	µg/L	2.00 U	40.0 U	40.0 U	40.0 U	40.0 U
Selenium	µg/L	7.10	4.00 U	4.00 U	16.7	3.00 J
Total Dissolved Solids	mg/L	268	36.0	176	584	146
Sulfate	mg/L	69.1	3.60	80.8	337	62.8
Thallium	µg/L	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
pH	SU	2.90	5.17	5.16	4.85	3.30

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.
J: Estimated value. Parameter was detected in concentrations below the reporting limit.

Table 2: Groundwater Protection Standards
Pirkey Plant - Stackout

Geosyntec Consultants, Inc.

Constituent Name	MCL	CCR Rule-Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.002
Arsenic, Total (mg/L)	0.01		0.007
Barium, Total (mg/L)	2		0.053
Beryllium, Total (mg/L)	0.004		0.0019
Cadmium, Total (mg/L)	0.005		0.002
Chromium, Total (mg/L)	0.1		0.004
Cobalt, Total (mg/L)	n/a	0.006	0.056
Combined Radium, Total (pCi/L)	5		3.18
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.002
Lithium, Total (mg/L)	n/a	0.04	0.17
Mercury, Total (mg/L)	0.002		0.000025
Molybdenum, Total (mg/L)	n/a	0.1	0.002
Selenium, Total (mg/L)	0.05		0.004
Thallium, Total (mg/L)	0.002		0.002

Notes:
Grey cell indicates calculated UTL is higher than MCL.
MCL = Maximum Contaminant Level
RSL = Regional Screening Level
Calculated UTL (Upper Tolerance Limit) represents site-specific background values.
The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3: Appendix III Data Summary
Pirkey Plant - FGD Stackout Area

Geosyntec Consultants, Inc.

Parameter	Units	Description	AD-22	AD-33	AD-7
			2/27/2019	2/27/2019	2/27/2019
Boron	mg/L	Interwell Background Value (UPL)	0.0840		
		Detection Monitoring Result	0.07	**0.134**	**2.1**
Calcium	mg/L	Intrawell Background Value (UPL)	17.75	2.59	7.40
		Detection Monitoring Result	15.2	1.73	5.20
Chloride	mg/L	Interwell Background Value (UPL)	40.8		
		Detection Monitoring Result	**76.7**	8.89	29.9
Fluoride	mg/L	Interwell Background Value (UPL)	1.0		
		Detection Monitoring Result	**1.33**	0.25	0.5
pH	SU	Intrawell Background Value (UPL)	4.8	4.7	4.3
		Intrawell Background Value (LPL)	3.5	2.6	3.2
		Detection Monitoring Result	**4.9**	3.3	**2.9**
Sulfate	mg/L	Interwell Background Value (UPL)	80.8		
		Detection Monitoring Result	**337**	62.8	69.1
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	765	210	354
		Detection Monitoring Result	584	146	268

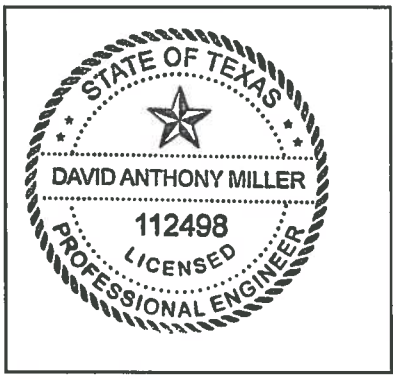
Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD Stackout Area CCR management area and that the requirements of 40 CFR 257.93(f) have been met.



DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

112498	TEXAS	07.11.19
License Number	Licensing State	Date

ATTACHMENT B
Statistical Analysis Output

July 10, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey Stackout
Assessment Monitoring Event – February 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis of the groundwater data for the February 2019 sample event for American Electric Power Inc.'s Pirkey Stackout. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-12 and AD-13; and
- **Downgradient wells:** AD-22, AD-33, and AD-7.

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS;
- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Values flagged as outliers may be seen in a lighter font and disconnected symbol on the time series graphs. A summary of flagged values also follows this letter (Figure B).

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, chloride, fluoride, and sulfate; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for calcium, pH and TDS (Figures C & D, respectively). The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data are screened for any newly suspected outliers or obvious trending patterns using time series plots. All values flagged as outliers may be seen on the Outlier Summary report following this letter. No obvious trending patterns were observed in the upgradient wells.

Intrawell prediction limits utilize the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the background data set will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is

considered a false positive result and, therefore, no further action is necessary. Prediction limit exceedances were noted for boron in wells AD-33 and AD-7; calcium in well AD-13; chloride, fluoride and sulfate in well AD-22; and pH in wells AD-22 and AD-7. The results of those findings may be found in the Prediction Limit Summary tables following this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable (Figure E). Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site which is an indication of natural variability in groundwater unrelated to practices at the site.

No statistically significant increasing or decreasing trends were found for any of the downgradient well/parameter pairs with prediction limit exceedances.

Evaluation of Appendix IV Parameters

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure F). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure G).

Note that the reporting limit during the February 2019 event for molybdenum at wells AD-12, AD-13, AD-22 and AD-33 was 0.04 mg/L compared to a historical reporting limit of 0.002 mg/L. Well AD-7, however, had a reporting limit of 0.002 mg/L during this event. The resulting nondetects reported at 0.04 mg/L are censored at much higher levels than the rest of the data; therefore, contain little or no useful information and are flagged as outliers.

The reporting limit (or practical quantitation limit) for this event for thallium also increased from the historical reporting limit of 0.002 mg/L to 0.01 mg/L for all wells. However, since no detections were present above the method detection limit of 0.002

mg/L for this event, the historical reporting limit of 0.002 mg/L was substituted for these nondetects.

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, CCR-Rule specified levels, or ACL as discussed above (Figure H). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No confidence interval exceedances were noted except for beryllium in well AD-22. The lower confidence interval of 0.0041 mg/L is slightly higher than the MCL of 0.004 mg/L. A summary of the confidence interval results follows this letter.

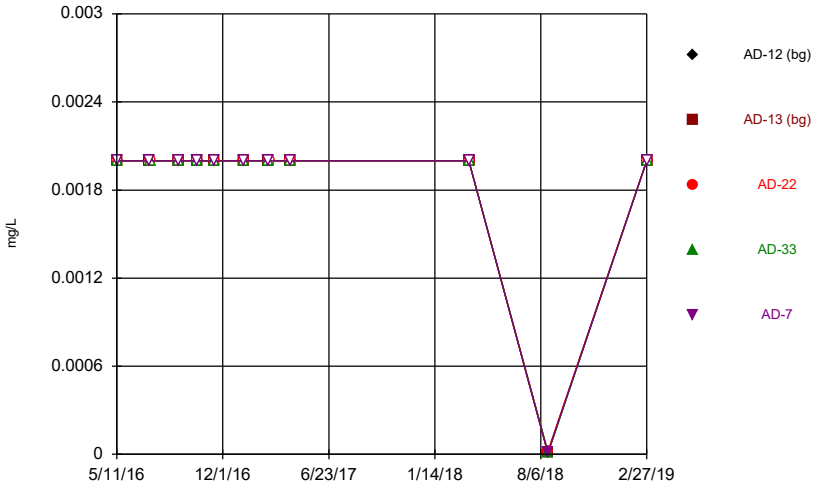
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Stackout. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

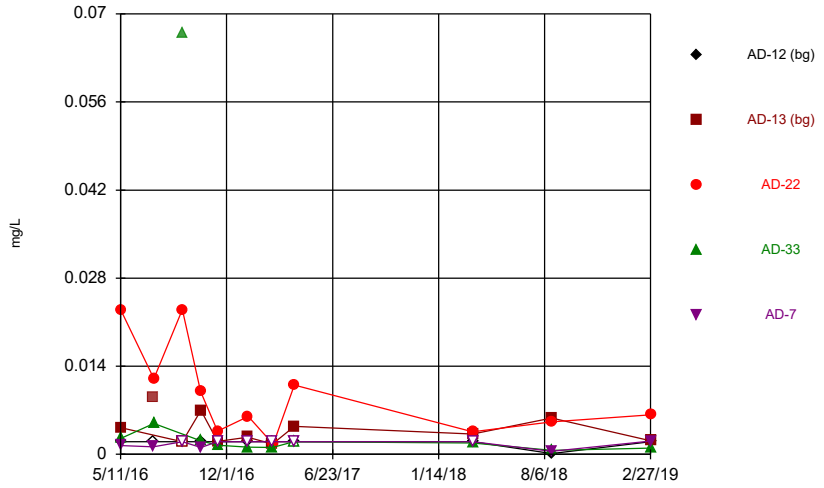
Time Series



Constituent: Antimony, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

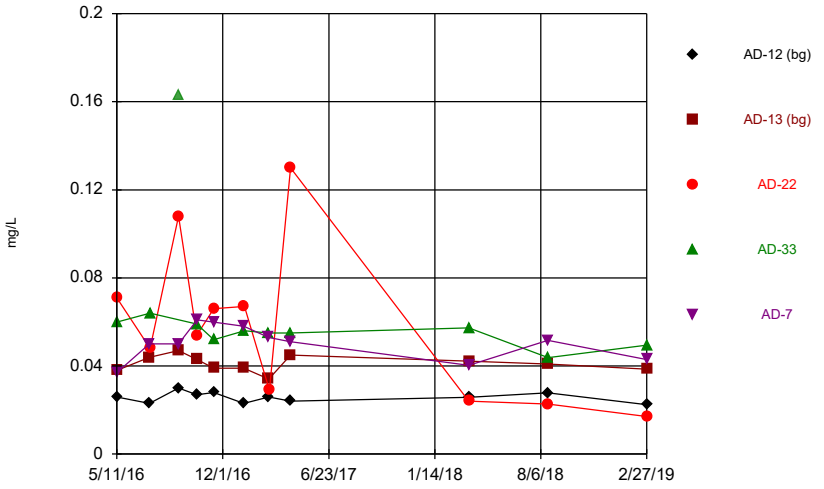
Time Series



Constituent: Arsenic, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

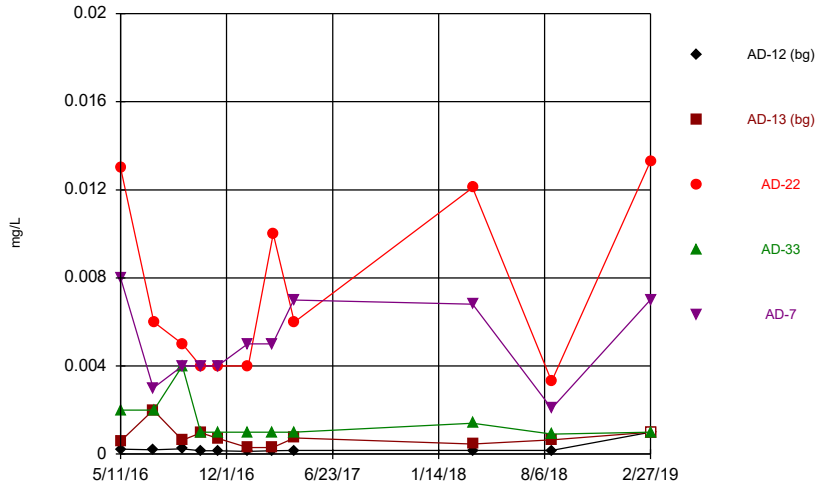
Time Series



Constituent: Barium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

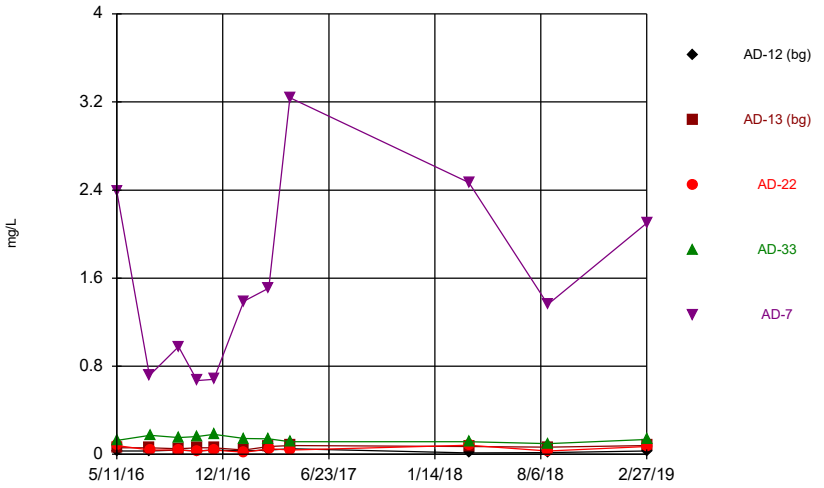
Time Series



Constituent: Beryllium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

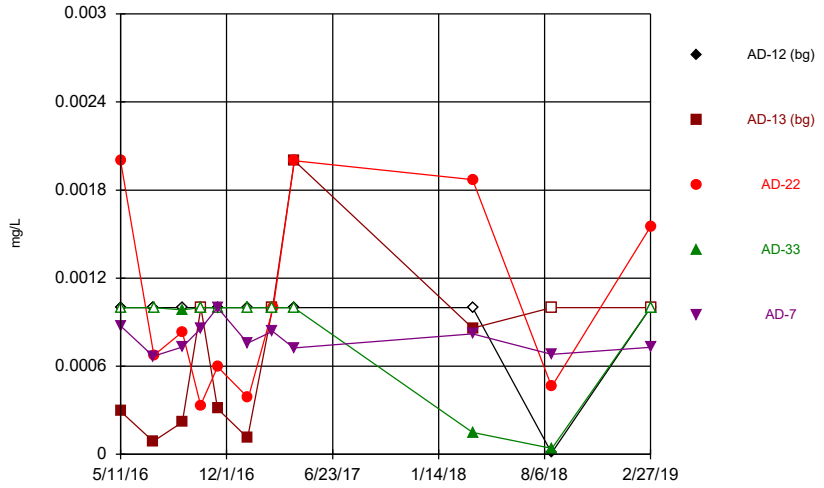
Time Series



Constituent: Boron, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

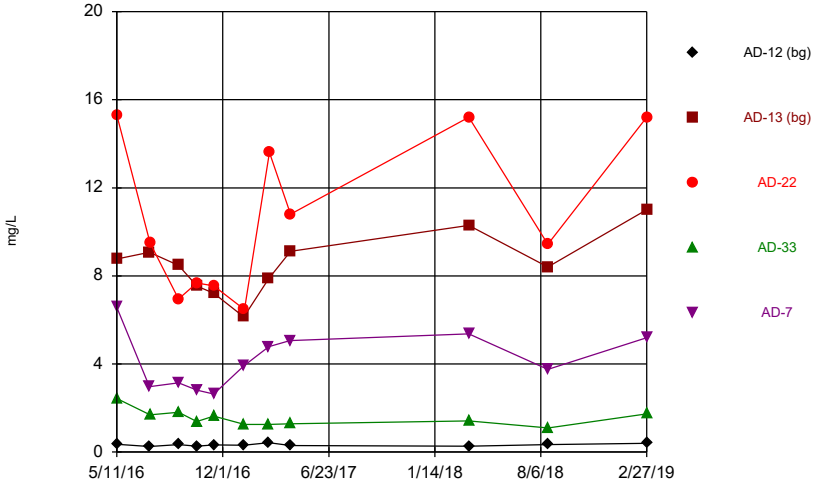
Time Series



Constituent: Cadmium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

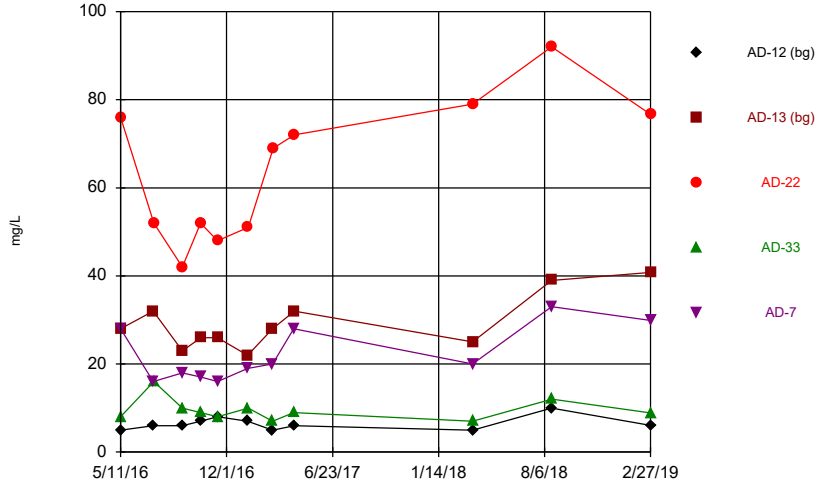
Time Series



Constituent: Calcium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

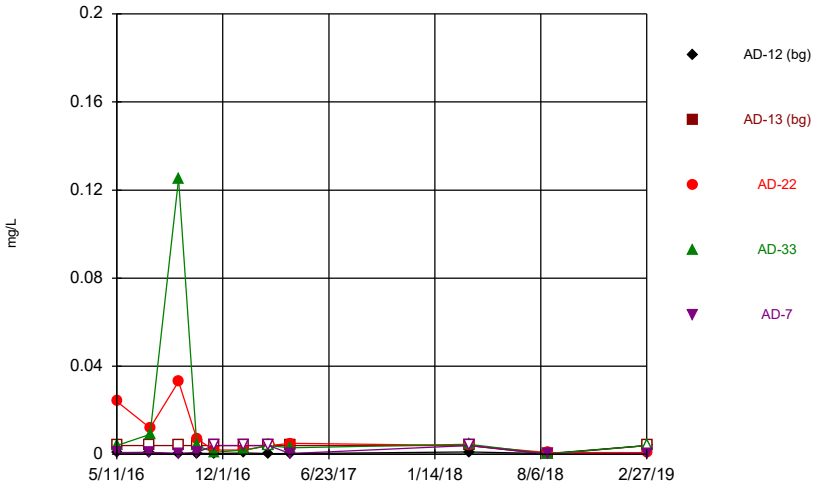
Time Series



Constituent: Chloride, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

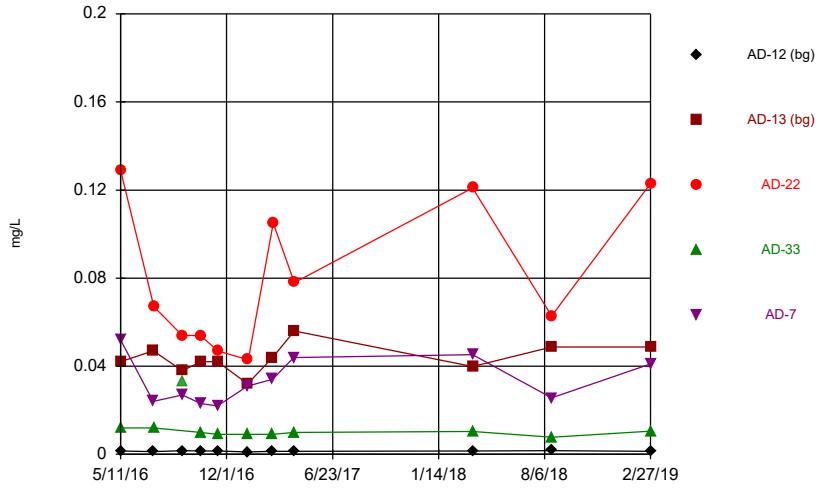
Time Series



Constituent: Chromium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

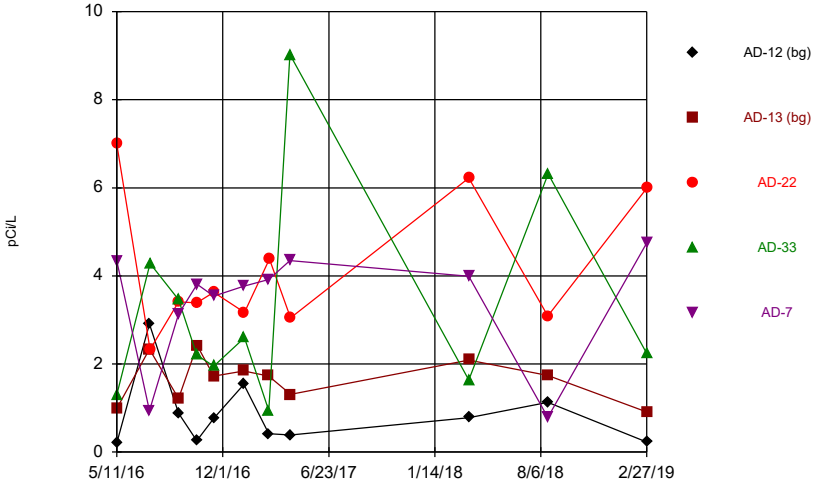
Time Series



Constituent: Cobalt, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

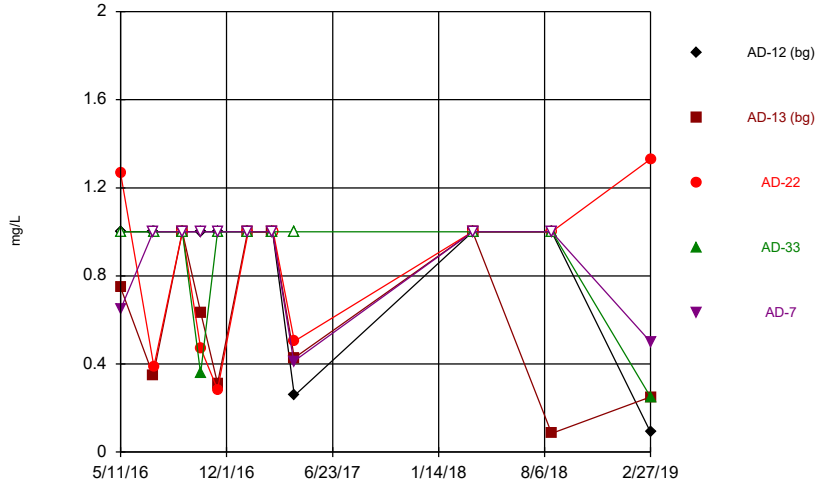
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

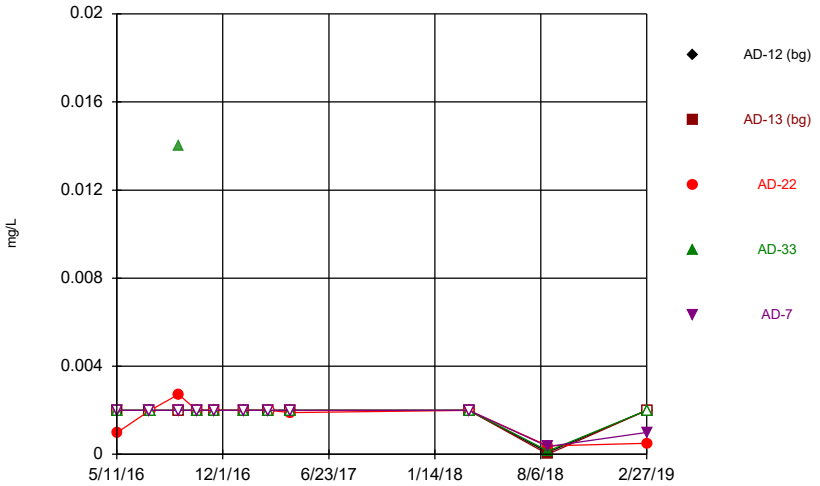
Time Series



Constituent: Fluoride, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

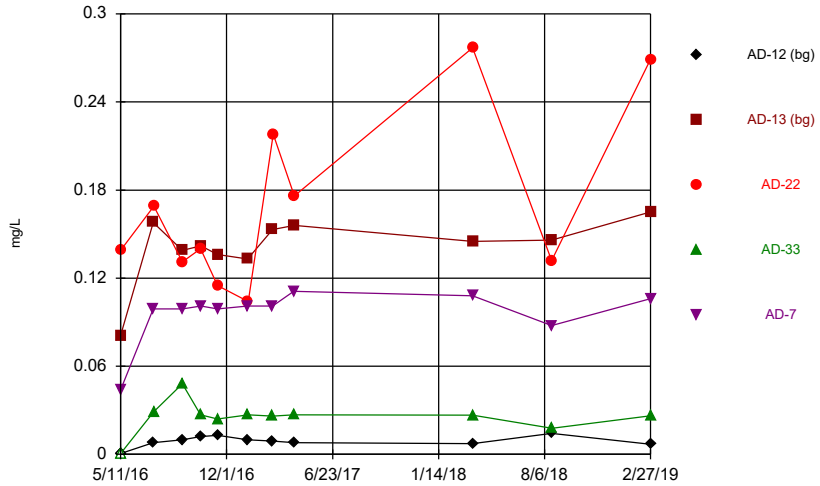
Time Series



Constituent: Lead, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

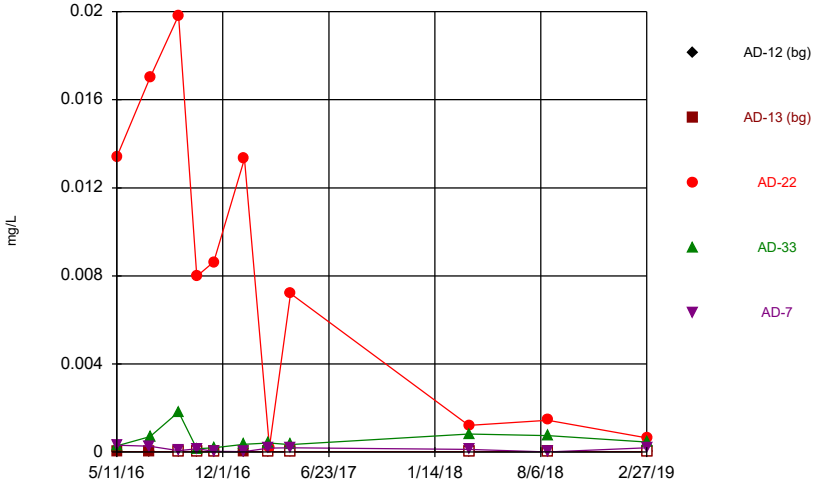
Time Series



Constituent: Lithium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

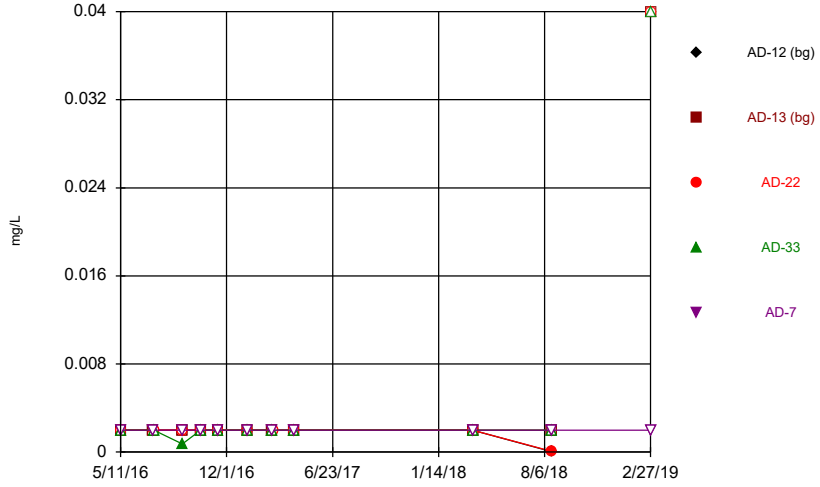
Time Series



Constituent: Mercury, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

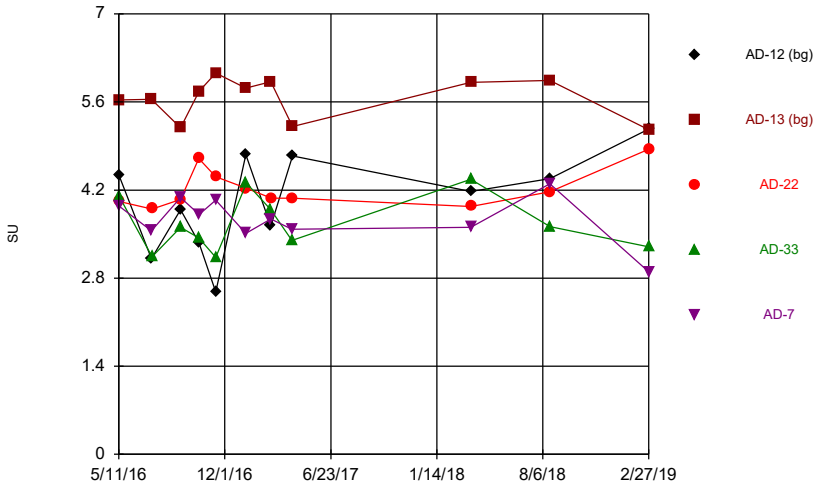
Time Series



Constituent: Molybdenum, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

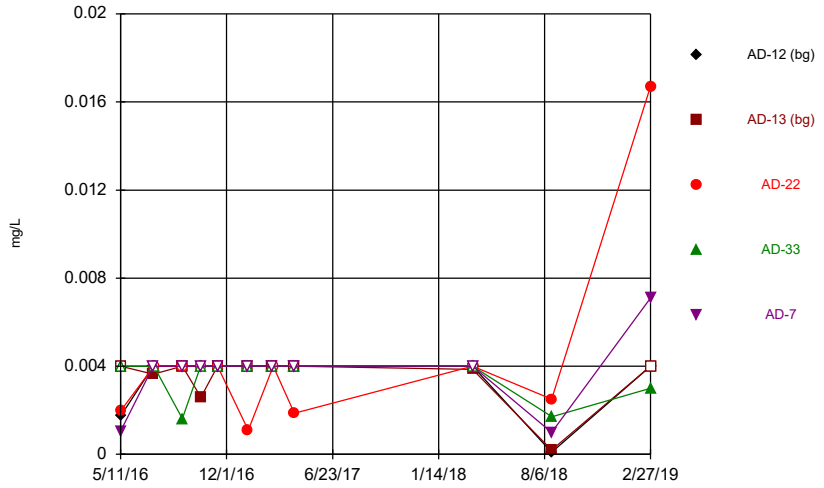
Time Series



Constituent: pH, field Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

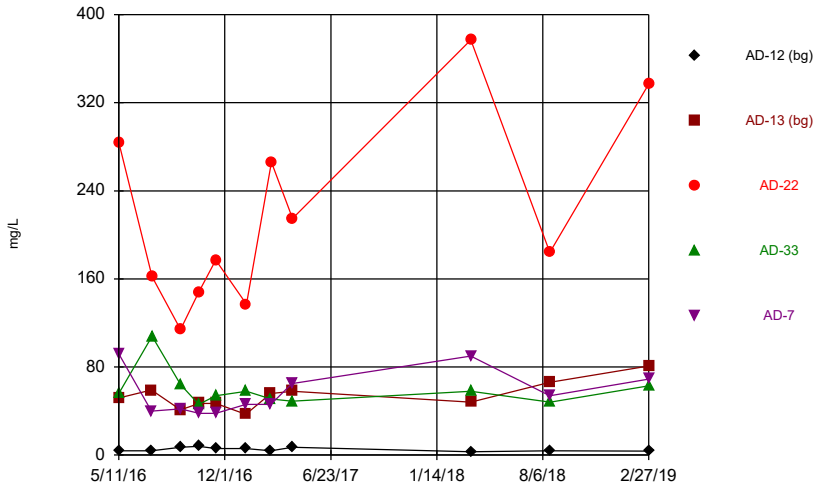
Time Series



Constituent: Selenium, total Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

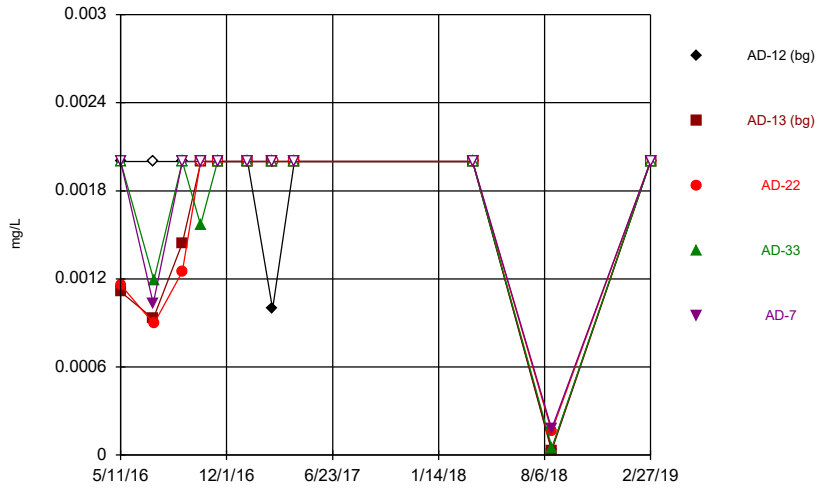
Time Series



Constituent: Sulfate, total Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

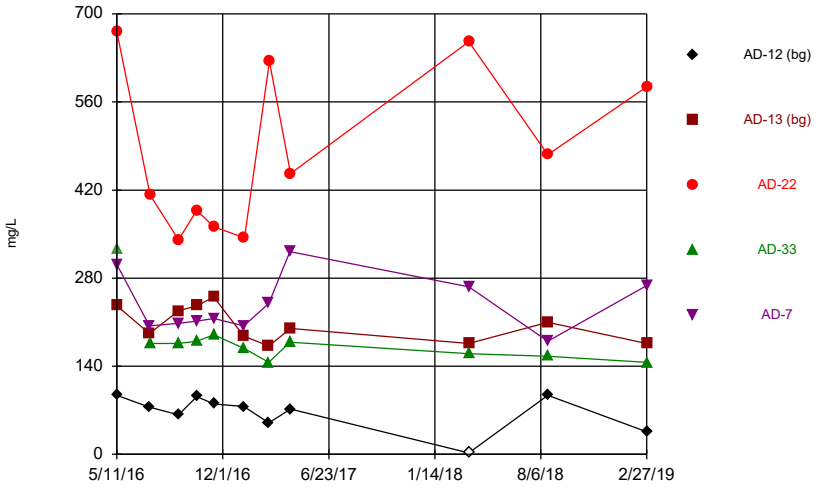
Time Series



Constituent: Thallium, total Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Total Dissolved Solids [TDS] Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Outlier Summary

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/8/2019, 9:14 AM

	AD-13 Arsenic, total (mg/L)	AD-33 Arsenic, total (mg/L)	AD-33 Barium, total (mg/L)	AD-33 Cobalt, total (mg/L)	AD-33 Lead, total (mg/L)	AD-12 Molybdenum, total (mg/L)	AD-13 Molybdenum, total (mg/L)	AD-22 Molybdenum, total (mg/L)	AD-33 Molybdenum, total (mg/L)	AD-33 Total Dissolved Solids [TDS] (mg/L)
5/11/2016										326 (o)
7/13/2016	0.009 (o)									
9/7/2016		0.067 (o)	0.163 (o)	0.033 (o)	0.014 (o)					
2/27/2019						<0.04 (o)	<0.04 (o)	<0.04 (o)	<0.04 (o)	

Interwell Prediction Limit Summary - Significant Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 2:49 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-33**	**0.08395**	**n/a**	**2/27/2019**	**0.134**	**Yes**	**22**	**0.04762**	**0.01946**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-7**	**0.08395**	**n/a**	**2/27/2019**	**2.1**	**Yes**	**22**	**0.04762**	**0.01946**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-22**	**40.8**	**n/a**	**2/27/2019**	**76.7**	**Yes**	**22**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.003586**	**NP Inter (normality) 1 of 2**
Fluoride, total (mg/L)	**AD-22**	**1**	**n/a**	**2/27/2019**	**1.33**	**Yes**	**22**	**n/a**	**n/a**	**59.09**	**n/a**	**n/a**	**0.003586**	**NP Inter (NDs) 1 of 2**
Sulfate, total (mg/L)	**AD-22**	**80.8**	**n/a**	**2/27/2019**	**337**	**Yes**	**22**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.003586**	**NP Inter (normality) 1 of 2**

Interwell Prediction Limit Summary - All Results

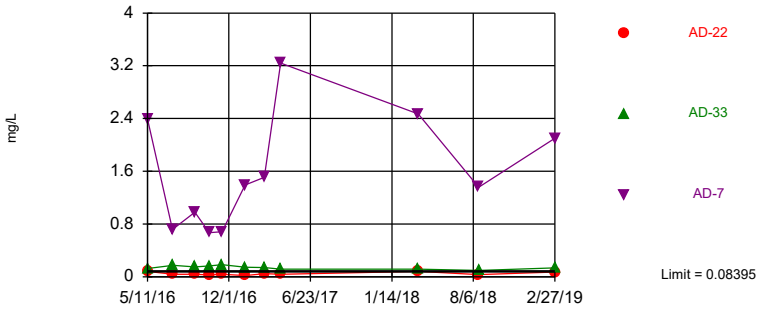
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 2:49 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-22	0.08395	n/a	2/27/2019	0.07	No	22	0.04762	0.01946	0	None	No	0.002505	Param Inter 1 of 2
Boron, total (mg/L)	**AD-33**	**0.08395**	**n/a**	**2/27/2019**	**0.134**	**Yes**	**22**	**0.04762**	**0.01946**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-7**	**0.08395**	**n/a**	**2/27/2019**	**2.1**	**Yes**	**22**	**0.04762**	**0.01946**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-22**	**40.8**	**n/a**	**2/27/2019**	**76.7**	**Yes**	**22**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.003586**	**NP Inter (normality) 1 of 2**
Chloride, total (mg/L)	AD-33	40.8	n/a	2/27/2019	8.89	No	22	n/a	n/a	0	n/a	n/a	0.003586	NP Inter (normality) 1 of 2
Chloride, total (mg/L)	AD-7	40.8	n/a	2/27/2019	29.9	No	22	n/a	n/a	0	n/a	n/a	0.003586	NP Inter (normality) 1 of 2
Fluoride, total (mg/L)	**AD-22**	**1**	**n/a**	**2/27/2019**	**1.33**	**Yes**	**22**	**n/a**	**n/a**	**59.09**	**n/a**	**n/a**	**0.003586**	**NP Inter (NDs) 1 of 2**
Fluoride, total (mg/L)	AD-33	1	n/a	2/27/2019	0.25	No	22	n/a	n/a	59.09	n/a	n/a	0.003586	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-7	1	n/a	2/27/2019	0.5	No	22	n/a	n/a	59.09	n/a	n/a	0.003586	NP Inter (NDs) 1 of 2
Sulfate, total (mg/L)	**AD-22**	**80.8**	**n/a**	**2/27/2019**	**337**	**Yes**	**22**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.003586**	**NP Inter (normality) 1 of 2**
Sulfate, total (mg/L)	AD-33	80.8	n/a	2/27/2019	62.8	No	22	n/a	n/a	0	n/a	n/a	0.003586	NP Inter (normality) 1 of 2
Sulfate, total (mg/L)	AD-7	80.8	n/a	2/27/2019	69.1	No	22	n/a	n/a	0	n/a	n/a	0.003586	NP Inter (normality) 1 of 2

Exceeds Limit: AD-33, AD-7

Prediction Limit

Interwell Parametric



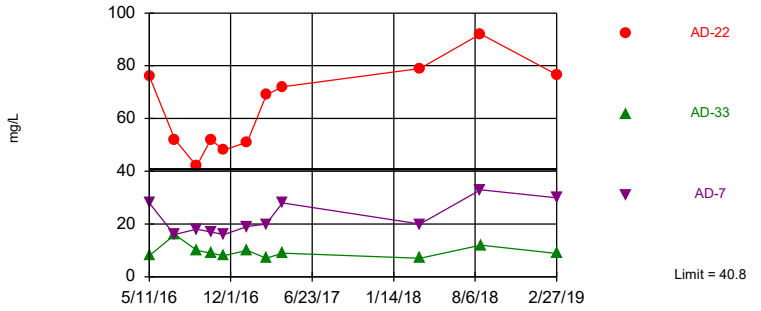
Background Data Summary: Mean=0.04762, Std. Dev.=0.01946, n=22. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9482, critical = 0.878. Kappa = 1.866 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

Constituent: Boron, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Exceeds Limit: AD-22

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 22 background values. Annual per-constituent alpha = 0.02133. Individual comparison alpha = 0.003586 (1 of 2). Comparing 3 points to limit.

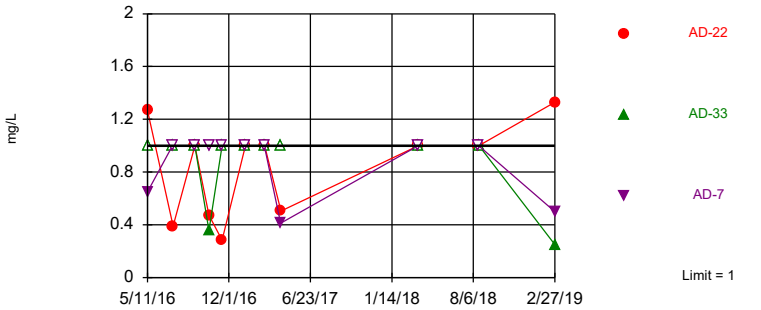
Constituent: Chloride, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Hollow symbols indicate censored values.

Exceeds Limit: AD-22

Prediction Limit

Interwell Non-parametric



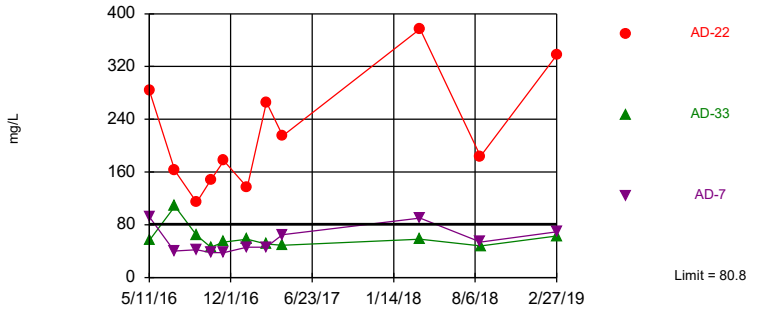
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 22 background values. 59.09% NDs. Annual per-constituent alpha = 0.02133. Individual comparison alpha = 0.003586 (1 of 2). Comparing 3 points to limit.

Constituent: Fluoride, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Exceeds Limit: AD-22

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 22 background values. Annual per-constituent alpha = 0.02133. Individual comparison alpha = 0.003586 (1 of 2). Comparing 3 points to limit.

Constituent: Sulfate, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Intrawell Prediction Limit Summary - Significant Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 2:56 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	**AD-13**	**10.58**	**n/a**	**2/27/2019**	**11**	**Yes**	**8**	**8.025**	**1.038**	**0**	**None**	**No**	**0.002505**	Param 1 of 2
pH, field (SU)	**AD-22**	**4.819**	**3.544**	**2/27/2019**	**4.85**	**Yes**	**8**	**4.181**	**0.2594**	**0**	**None**	**No**	**0.001253**	Param 1 of 2
pH, field (SU)	**AD-7**	**4.336**	**3.229**	**2/27/2019**	**2.9**	**Yes**	**8**	**3.783**	**0.2251**	**0**	**None**	**No**	**0.001253**	Param 1 of 2

Intrawell Prediction Limit Summary - All Results

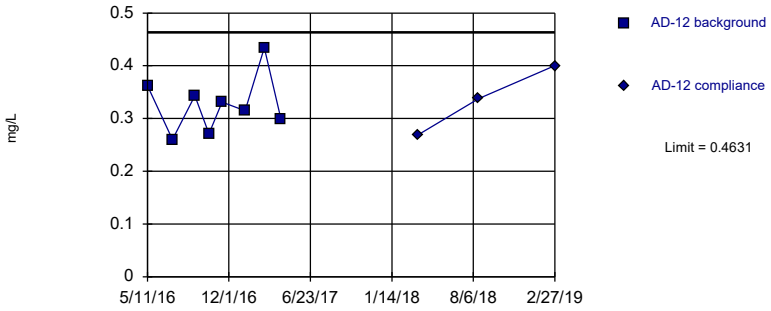
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 2:56 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-12	0.4631	n/a	2/27/2019	0.4	No	8	0.3269	0.05542	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	**AD-13**	**10.58**	**n/a**	**2/27/2019**	**11**	**Yes**	**8**	**8.025**	**1.038**	**0**	**None**	**No**	**0.002505**	Param 1 of 2
Calcium, total (mg/L)	AD-22	17.75	n/a	2/27/2019	15.2	No	8	9.731	3.263	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-33	2.586	n/a	2/27/2019	1.73	No	8	1.595	0.403	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-7	7.397	n/a	2/27/2019	5.2	No	8	3.988	1.387	0	None	No	0.002505	Param 1 of 2
pH, field (SU)	AD-12	5.764	1.866	2/27/2019	5.17	No	8	3.815	0.7928	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-13	6.427	4.883	2/27/2019	5.16	No	8	5.655	0.3139	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	**AD-22**	**4.819**	**3.544**	**2/27/2019**	**4.85**	**Yes**	**8**	**4.181**	**0.2594**	**0**	**None**	**No**	**0.001253**	Param 1 of 2
pH, field (SU)	AD-33	4.704	2.553	2/27/2019	3.3	No	8	3.629	0.4375	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	**AD-7**	**4.336**	**3.229**	**2/27/2019**	**2.9**	**Yes**	**8**	**3.783**	**0.2251**	**0**	**None**	**No**	**0.001253**	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	110.7	n/a	2/27/2019	36	No	8	75.25	14.41	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-13	282.1	n/a	2/27/2019	176	No	8	212.8	28.2	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-22	764.6	n/a	2/27/2019	584	No	8	448.6	128.6	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-33	210.3	n/a	2/27/2019	146	No	7	173.4	13.75	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-7	354.3	n/a	2/27/2019	268	No	8	238.5	47.1	0	None	No	0.002505	Param 1 of 2

Within Limit

Prediction Limit

Intrawell Parametric



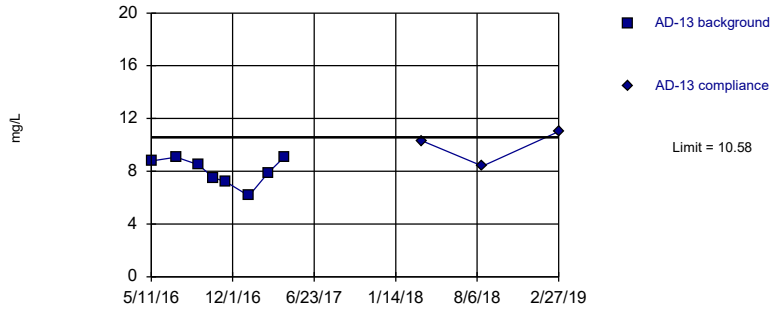
Background Data Summary: Mean=0.3269, Std. Dev.=0.05542, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9467, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Exceeds Limit

Prediction Limit

Intrawell Parametric



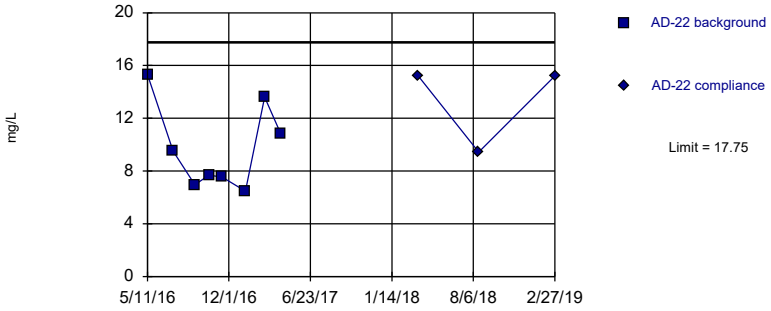
Background Data Summary: Mean=8.025, Std. Dev.=1.038, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9241, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit

Intrawell Parametric



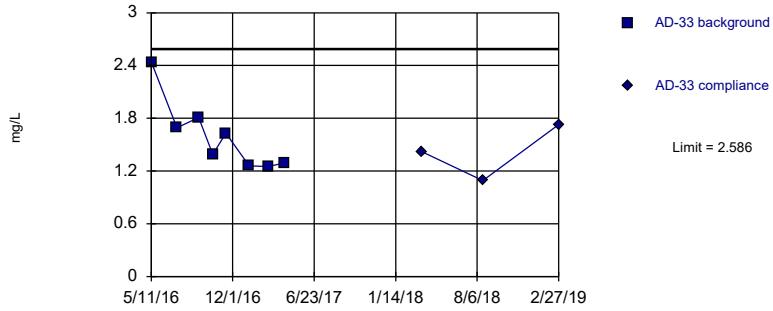
Background Data Summary: Mean=9.731, Std. Dev.=3.263, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8841, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit

Intrawell Parametric



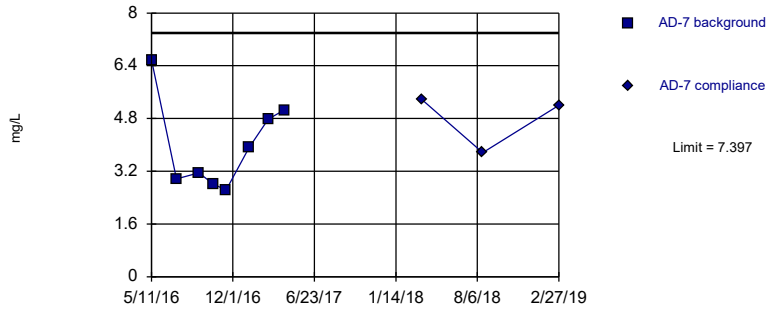
Background Data Summary: Mean=1.595, Std. Dev.=0.403, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8403, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit

Intrawell Parametric



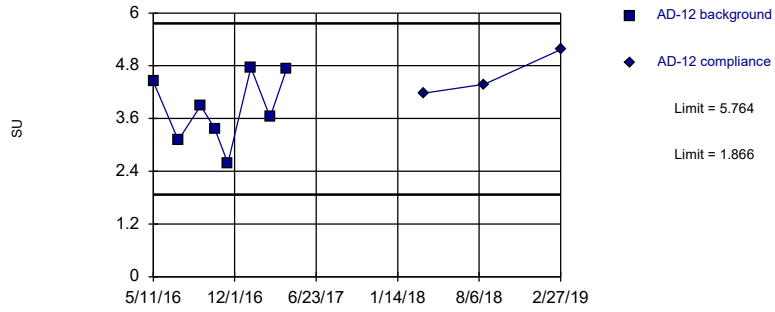
Background Data Summary: Mean=3.988, Std. Dev.=1.387, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8893, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limits

Prediction Limit

Intrawell Parametric



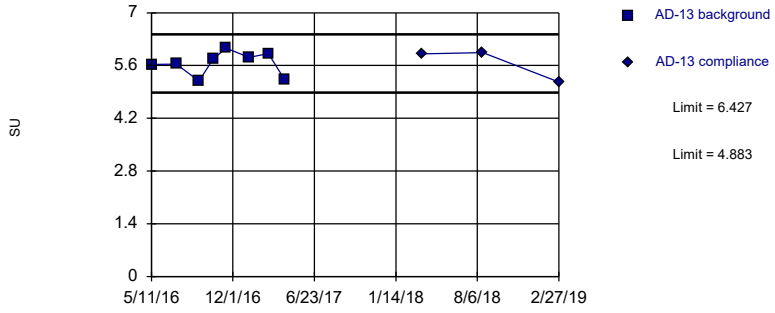
Background Data Summary: Mean=3.815, Std. Dev.=0.7928, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limits

Prediction Limit

Intrawell Parametric



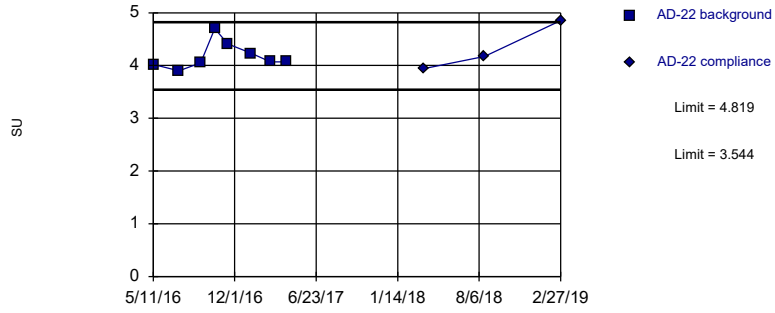
Background Data Summary: Mean=5.655, Std. Dev.=0.3139, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9084, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Exceeds Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.181, Std. Dev.=0.2594, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8669, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

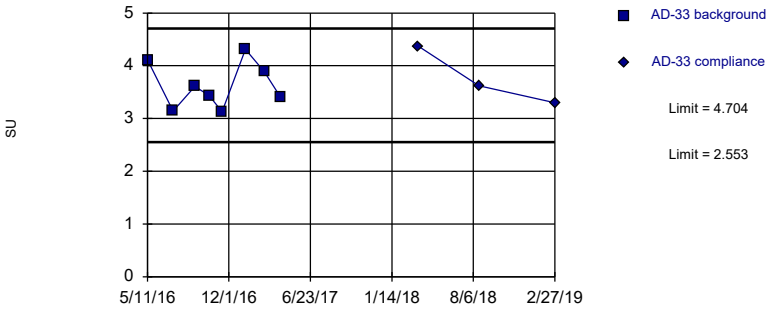
Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.629, Std. Dev.=0.4375, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9295, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

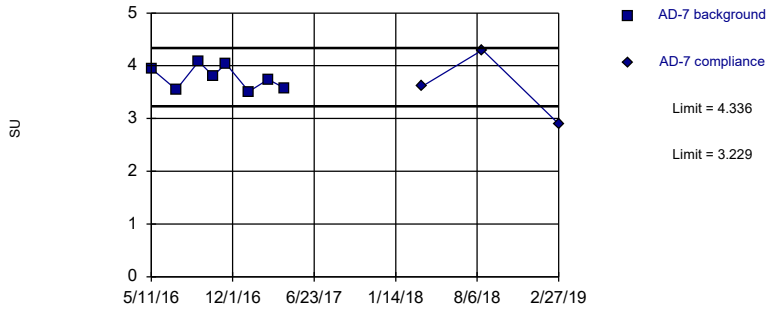
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.783, Std. Dev.=0.2251, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9108, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

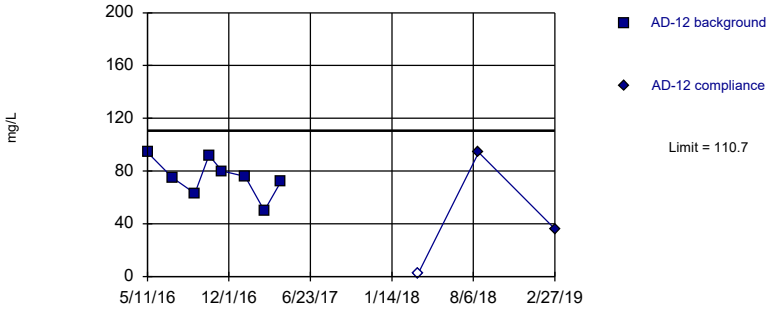
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=75.25, Std. Dev.=14.41, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9549, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

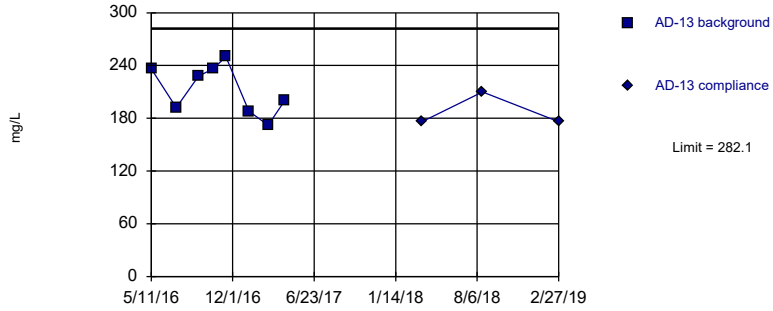
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=212.8, Std. Dev.=28.2, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9216, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

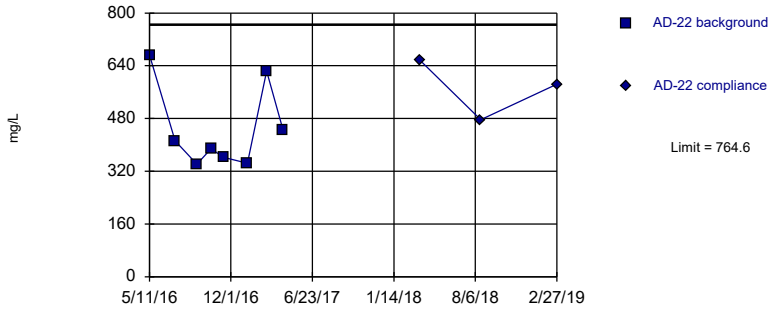
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=448.6, Std. Dev.=128.6, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8034, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

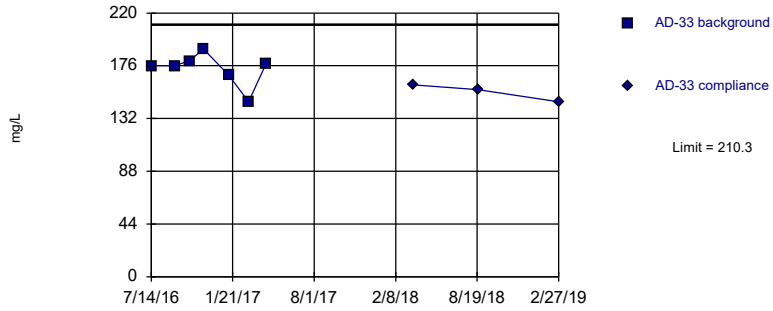
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=173.4, Std. Dev.=13.75, n=7. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8665, critical = 0.73. Kappa = 2.685 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

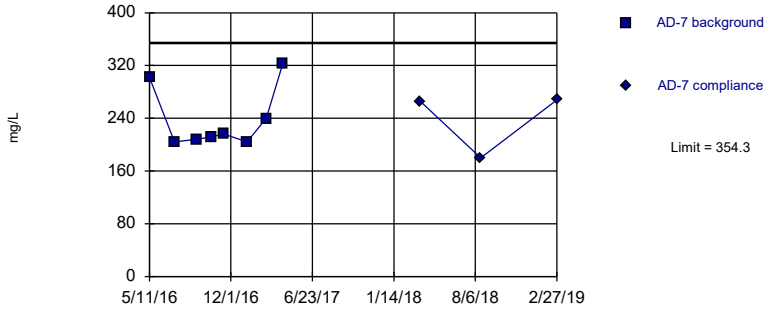
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=238.5, Std. Dev.=47.1, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7544, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

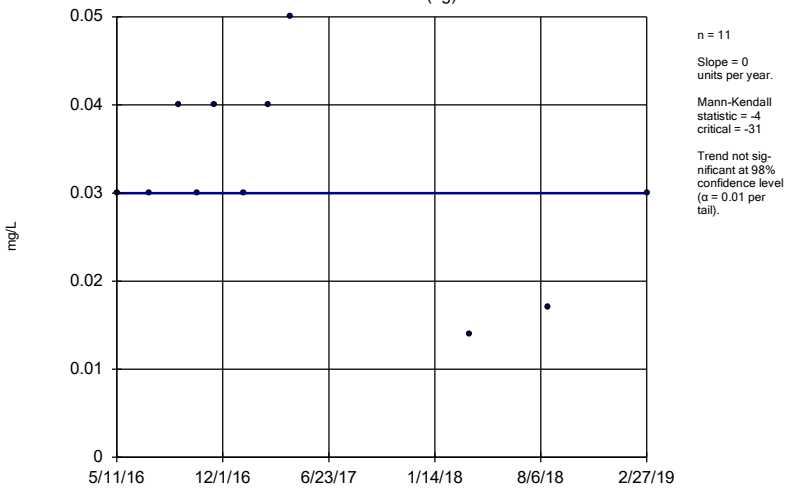
Trend Test Summary Table - All Results (No Significant)

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 3:15 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-12 (bg)	0	-4	-31	No	11	0	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-13 (bg)	0.007612	26	31	No	11	0	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-33	-0.02412	-25	-31	No	11	0	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-7	0.4535	17	31	No	11	0	n/a	n/a	0.02	NP
Calcium, total (mg/L)	AD-12 (bg)	0.01357	5	31	No	11	0	n/a	n/a	0.02	NP
Calcium, total (mg/L)	AD-13 (bg)	0.7229	11	31	No	11	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-12 (bg)	0.03234	10	31	No	11	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-13 (bg)	4.571	16	31	No	11	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-22	14.72	26	31	No	11	0	n/a	n/a	0.02	NP
Fluoride, total (mg/L)	AD-12 (bg)	0	-15	-31	No	11	81.82	n/a	n/a	0.02	NP
Fluoride, total (mg/L)	AD-13 (bg)	-0.09446	-11	-31	No	11	36.36	n/a	n/a	0.02	NP
Fluoride, total (mg/L)	AD-22	0.06272	13	31	No	11	45.45	n/a	n/a	0.02	NP
pH, field (SU)	AD-12 (bg)	0.5174	19	31	No	11	0	n/a	n/a	0.02	NP
pH, field (SU)	AD-13 (bg)	0.07474	9	31	No	11	0	n/a	n/a	0.02	NP
pH, field (SU)	AD-22	0.06308	14	31	No	11	0	n/a	n/a	0.02	NP
pH, field (SU)	AD-7	-0.2147	-11	-31	No	11	0	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.5376	-15	-31	No	11	0	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-13 (bg)	8.297	20	31	No	11	0	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-22	64.82	19	31	No	11	0	n/a	n/a	0.02	NP

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -4 critical = -31

Trend not significant at 98% confidence level (α = 0.01 per tail).

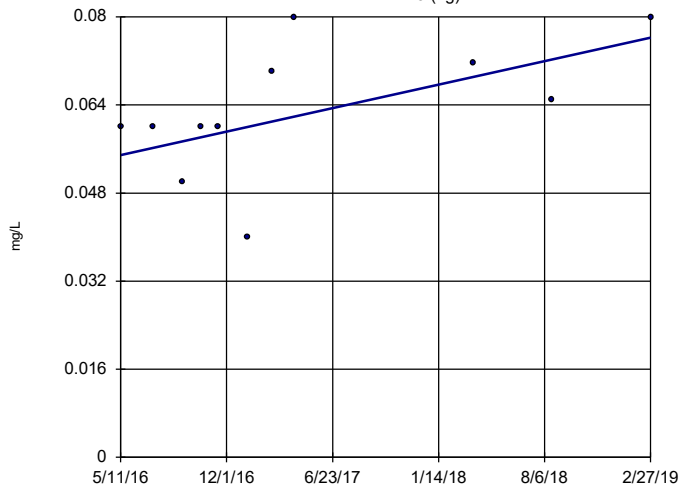
Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = 0.007612 units per year.

Mann-Kendall statistic = 26 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

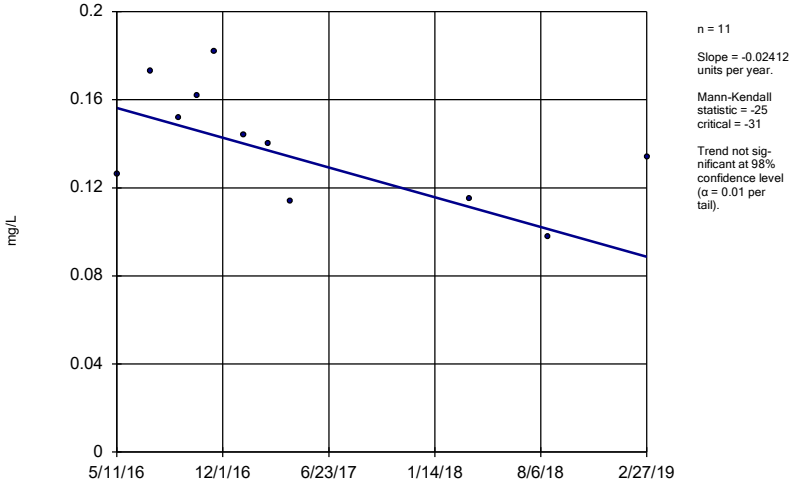
Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-33



n = 11

Slope = -0.02412 units per year.

Mann-Kendall statistic = -25 critical = -31

Trend not significant at 98% confidence level (α = 0.01 per tail).

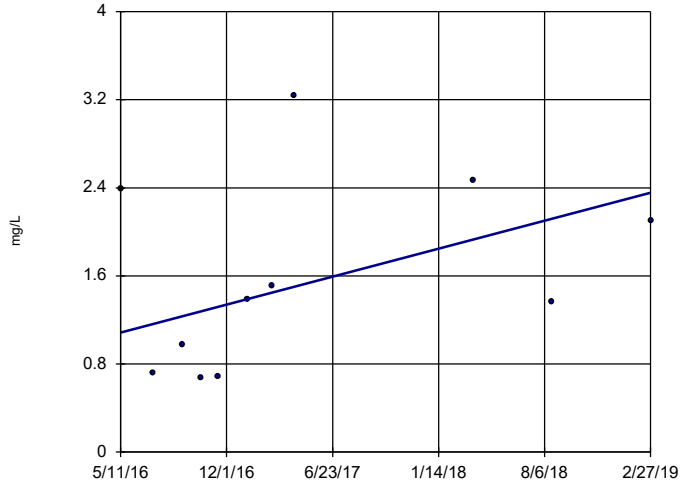
Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-7



n = 11

Slope = 0.4535 units per year.

Mann-Kendall statistic = 17 critical = 31

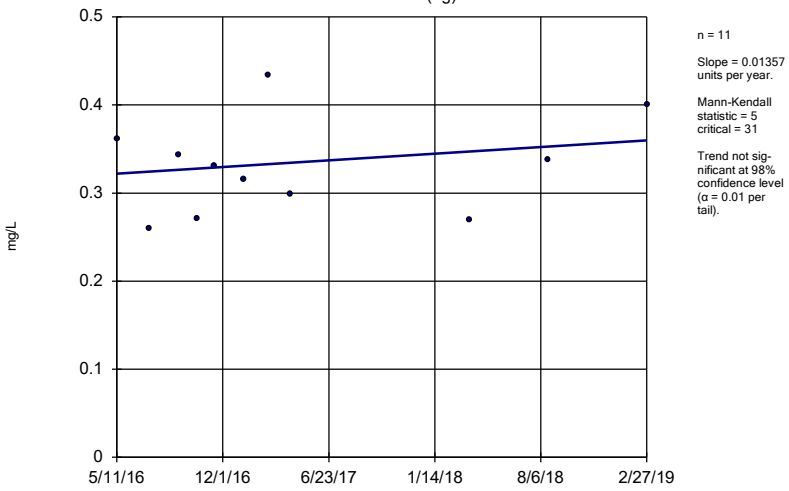
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.01357 units per year.

Mann-Kendall statistic = 5 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

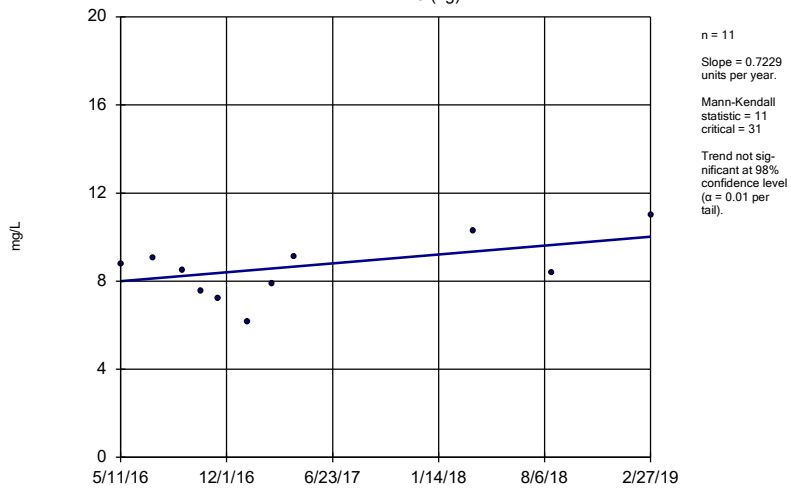
Constituent: Calcium, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = 0.7229 units per year.

Mann-Kendall statistic = 11 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

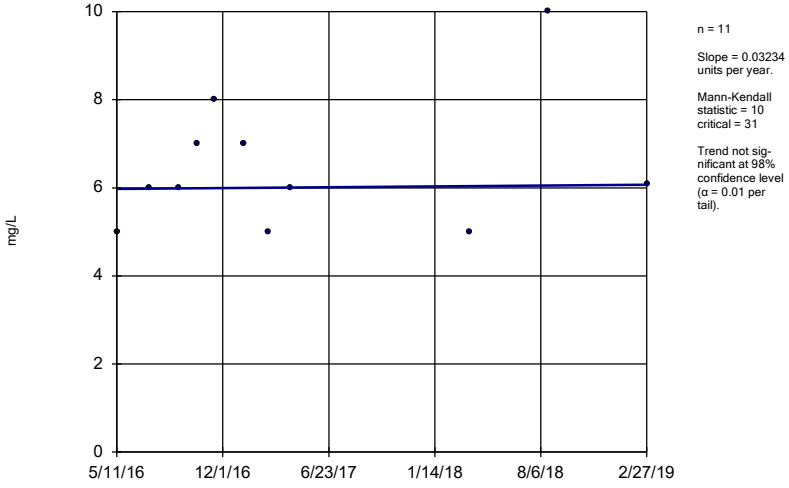
Constituent: Calcium, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.03234 units per year.

Mann-Kendall statistic = 10 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

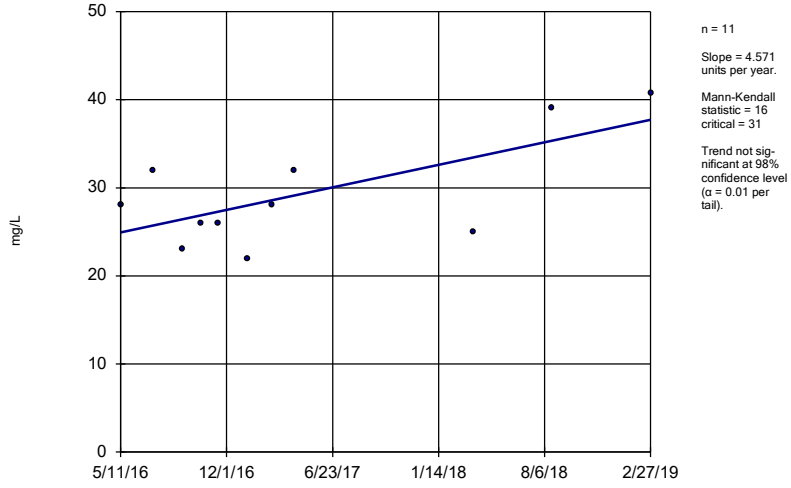
Constituent: Chloride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = 4.571 units per year.

Mann-Kendall statistic = 16 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

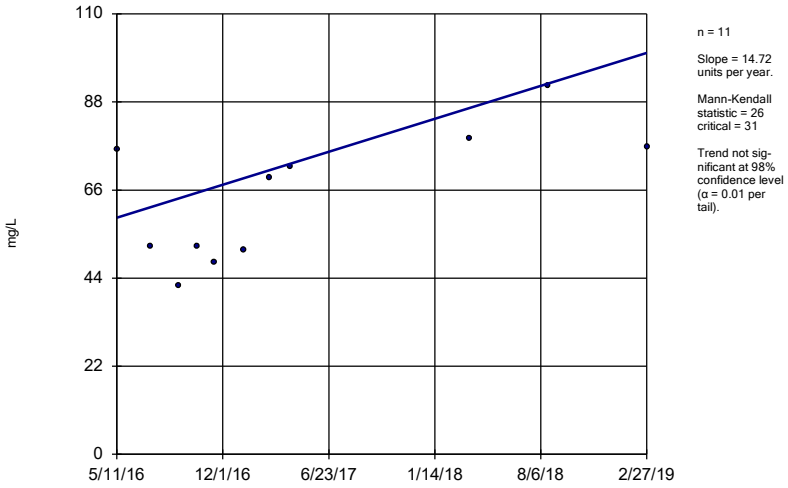
Constituent: Chloride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-22



n = 11

Slope = 14.72 units per year.

Mann-Kendall statistic = 26
critical = 31

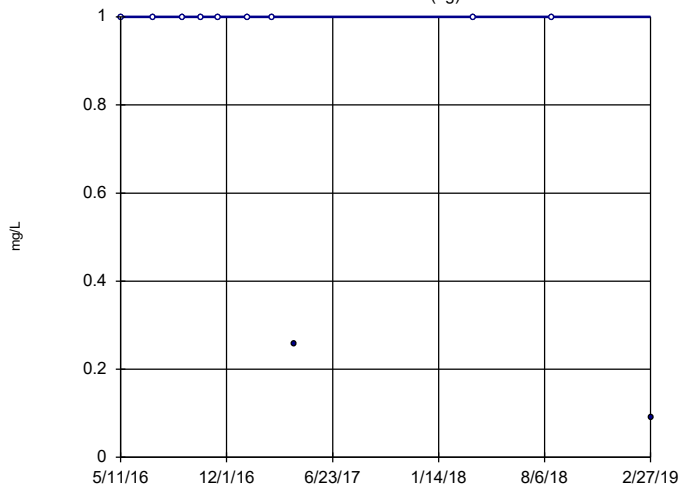
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Chloride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -15
critical = -31

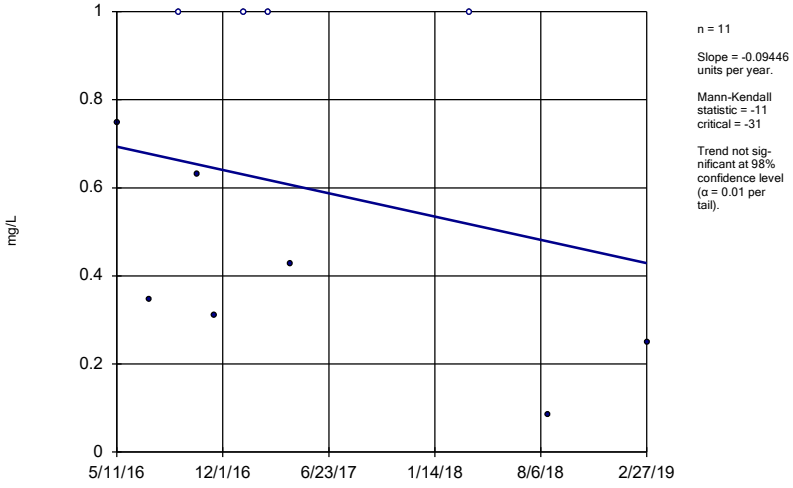
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = -0.09446 units per year.

Mann-Kendall statistic = -11
critical = -31

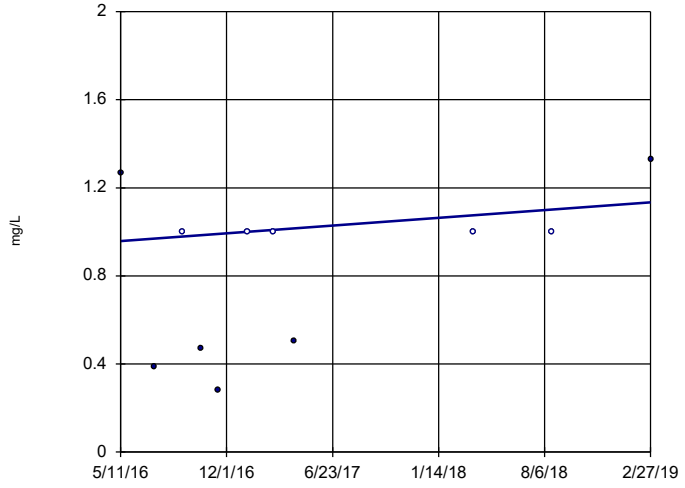
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-22



n = 11

Slope = 0.06272 units per year.

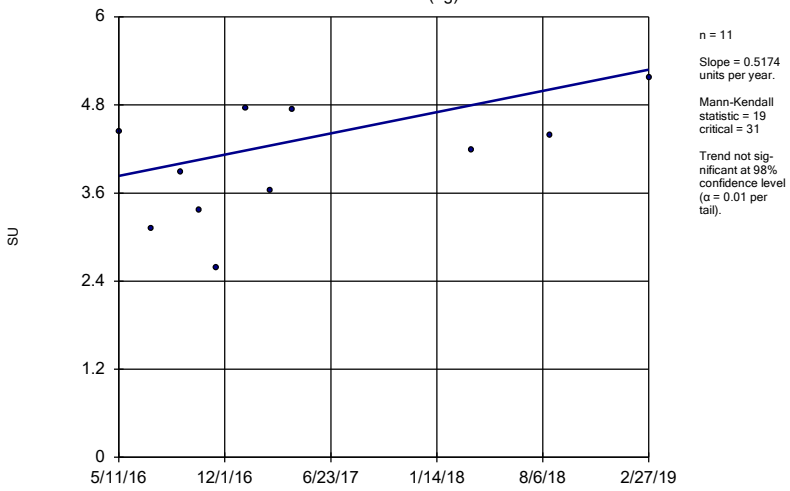
Mann-Kendall statistic = 13
critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.5174 units per year.

Mann-Kendall statistic = 19
critical = 31

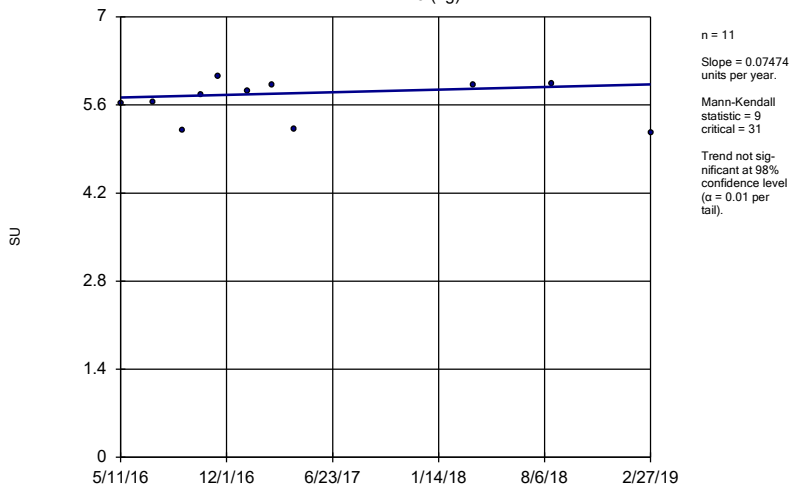
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = 0.07474 units per year.

Mann-Kendall statistic = 9
critical = 31

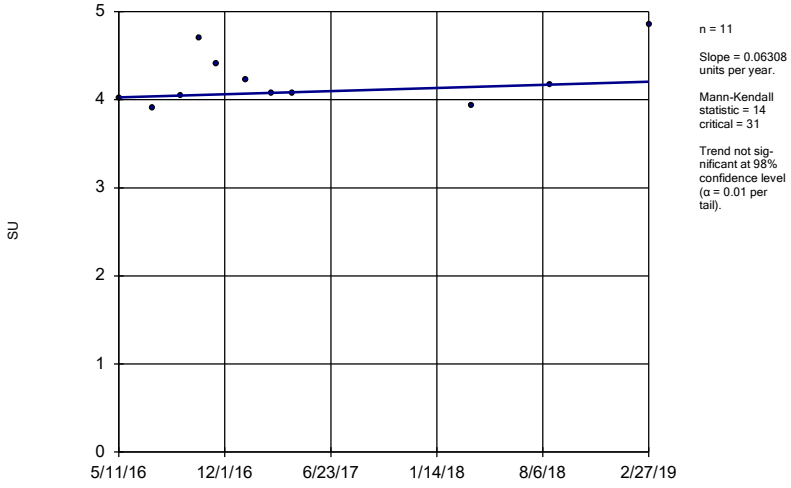
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-22



n = 11

Slope = 0.06308 units per year.

Mann-Kendall statistic = 14
critical = 31

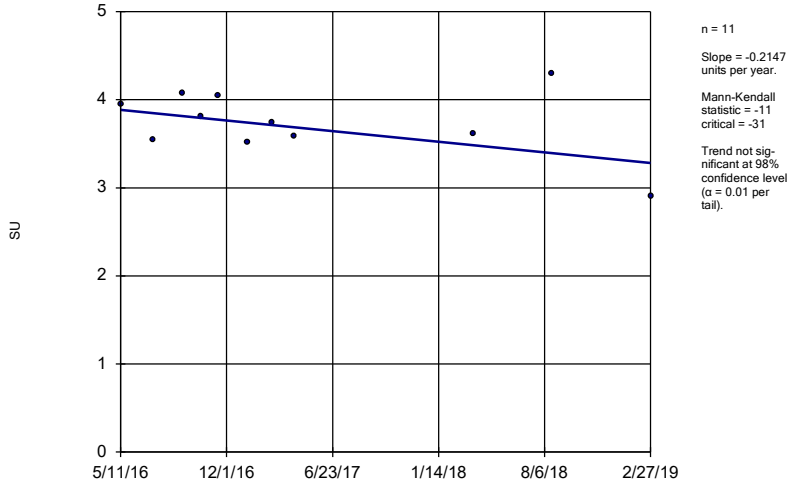
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-7



n = 11

Slope = -0.2147 units per year.

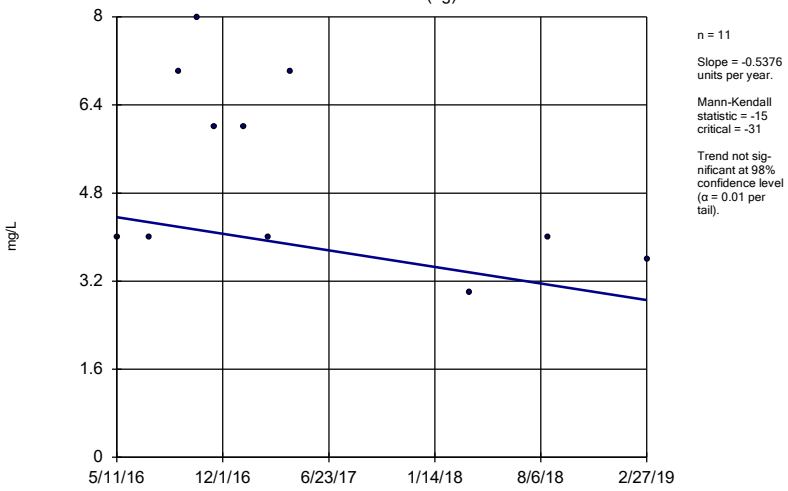
Mann-Kendall statistic = -11
critical = -31

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = -0.5376 units per year.

Mann-Kendall statistic = -15 critical = -31

Trend not significant at 98% confidence level (α = 0.01 per tail).

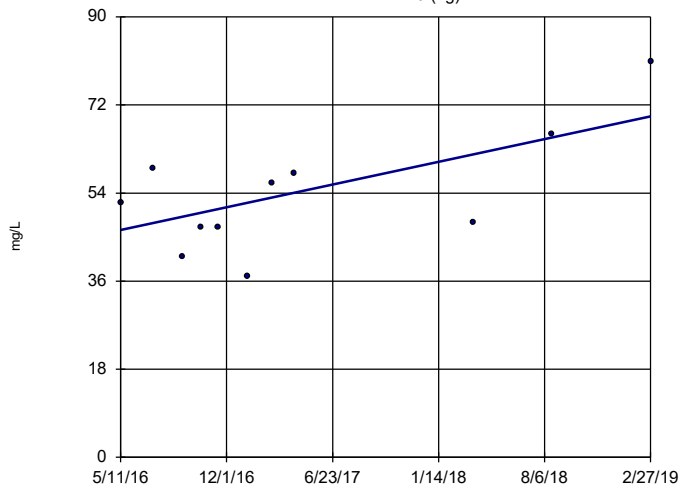
Constituent: Sulfate, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = 8.297 units per year.

Mann-Kendall statistic = 20 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

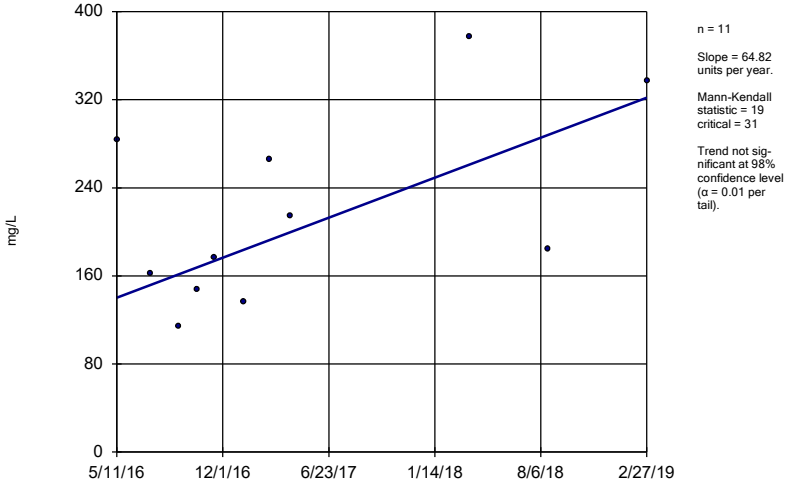
Constituent: Sulfate, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-22



n = 11

Slope = 64.82 units per year.

Mann-Kendall statistic = 19 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Sulfate, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit Summary Table - Appendix IV Parameters

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 3:07 PM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.002	22	n/a	n/a	90.91	n/a	n/a	0.3235	NP Inter(NDs)
Arsenic, total (mg/L)	n/a	0.007	21	n/a	n/a	52.38	n/a	n/a	0.3406	NP Inter(normality)
Barium, total (mg/L)	n/a	0.05302	22	0.03335	0.008372	0	None	No	0.05	Inter
Beryllium, total (mg/L)	n/a	0.001876	22	0.07377	0.02109	9.091	None	x^(1/3)	0.05	Inter
Cadmium, total (mg/L)	n/a	0.002	22	n/a	n/a	63.64	n/a	n/a	0.3235	NP Inter(normality)
Chromium, total (mg/L)	n/a	0.004	22	n/a	n/a	50	n/a	n/a	0.3235	NP Inter(normality)
Cobalt, total (mg/L)	n/a	0.056	22	n/a	n/a	0	n/a	n/a	0.3235	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	n/a	3.075	22	1.264	0.7707	0	None	No	0.05	Inter
Fluoride, total (mg/L)	n/a	1	22	n/a	n/a	59.09	n/a	n/a	0.3235	NP Inter(normality)
Lead, total (mg/L)	n/a	0.002	22	n/a	n/a	90.91	n/a	n/a	0.3235	NP Inter(NDs)
Lithium, total (mg/L)	n/a	0.165	22	n/a	n/a	4.545	n/a	n/a	0.3235	NP Inter(normality)
Mercury, total (mg/L)	n/a	0.000025	22	n/a	n/a	81.82	n/a	n/a	0.3235	NP Inter(NDs)
Molybdenum, total (mg/L)	n/a	0.002	22	n/a	n/a	95.45	n/a	n/a	0.3235	NP Inter(NDs)
Selenium, total (mg/L)	n/a	0.004	22	n/a	n/a	72.73	n/a	n/a	0.3235	NP Inter(normality)
Thallium, total (mg/L)	n/a	0.002	22	n/a	n/a	72.73	n/a	n/a	0.3235	NP Inter(normality)

Confidence Interval Summary Table - Significant Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/9/2019, 9:05 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Beryllium, total (mg/L)	**AD-22**	**0.01023**	**0.004131**	**0.004**	**n/a**	**Yes**	**11**	**0**	**x^(1/3)**	**0.01**	**Param.**

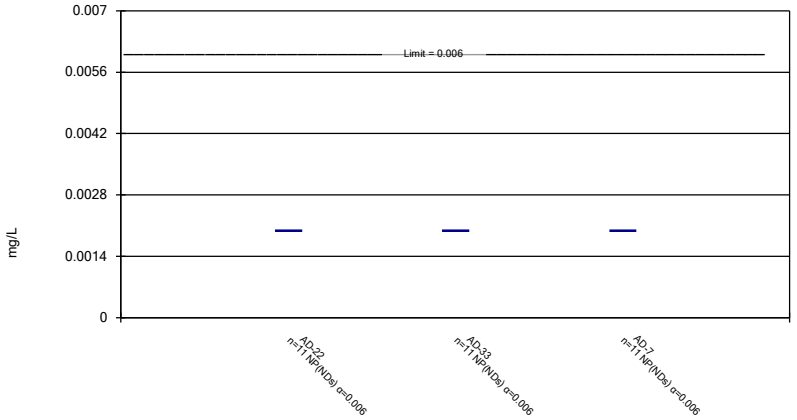
Confidence Interval Summary Table - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/9/2019, 9:05 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-22	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-33	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-7	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Arsenic, total (mg/L)	AD-22	0.01483	0.003766	0.01	n/a	No	11	0	sqrt(x)	0.01	Param.
Arsenic, total (mg/L)	AD-33	0.003379	0.0009104	0.01	n/a	No	10	10	sqrt(x)	0.01	Param.
Arsenic, total (mg/L)	AD-7	0.005	0.00108	0.01	n/a	No	11	54.55	No	0.006	NP (normality)
Barium, total (mg/L)	AD-22	0.08797	0.02781	2	n/a	No	11	0	No	0.01	Param.
Barium, total (mg/L)	AD-33	0.06025	0.05007	2	n/a	No	10	0	No	0.01	Param.
Barium, total (mg/L)	AD-7	0.05694	0.04393	2	n/a	No	11	0	No	0.01	Param.
Beryllium, total (mg/L)	**AD-22**	**0.01023**	**0.004131**	**0.004**	**n/a**	**Yes**	**11**	**0**	**x^(1/3)**	**0.01**	**Param.**
Beryllium, total (mg/L)	AD-33	0.002	0.001	0.004	n/a	No	11	0	No	0.006	NP (normality)
Beryllium, total (mg/L)	AD-7	0.006658	0.003504	0.004	n/a	No	11	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-22	0.001618	0.0005097	0.005	n/a	No	11	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-33	0.001	0.00015	0.005	n/a	No	11	72.73	No	0.006	NP (normality)
Cadmium, total (mg/L)	AD-7	0.0008719	0.0007063	0.005	n/a	No	11	0	No	0.01	Param.
Chromium, total (mg/L)	AD-22	0.01336	0.0007646	0.1	n/a	No	11	18.18	sqrt(x)	0.01	Param.
Chromium, total (mg/L)	AD-33	0.009869	0.000489	0.1	n/a	No	11	18.18	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-7	0.0006464	0.0001661	0.1	n/a	No	11	36.36	x^(1/3)	0.01	Param.
Cobalt, total (mg/L)	AD-22	0.1078	0.05293	0.056	n/a	No	11	0	No	0.01	Param.
Cobalt, total (mg/L)	AD-33	0.01117	0.00875	0.056	n/a	No	10	0	No	0.01	Param.
Cobalt, total (mg/L)	AD-7	0.04224	0.02483	0.056	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-22	5.437	2.864	5	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-33	4.932	1.447	5	n/a	No	11	0	sqrt(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-7	4.352	2.698	5	n/a	No	11	0	x^2	0.01	Param.
Fluoride, total (mg/L)	AD-22	0.8655	0.2814	4	n/a	No	11	45.45	No	0.01	Param.
Fluoride, total (mg/L)	AD-33	1	0.357	4	n/a	No	11	81.82	No	0.006	NP (NDs)
Fluoride, total (mg/L)	AD-7	1	0.5	4	n/a	No	11	72.73	No	0.006	NP (normality)
Lead, total (mg/L)	AD-22	0.002	0.0005	0.015	n/a	No	11	54.55	No	0.006	NP (normality)
Lead, total (mg/L)	AD-33	0.002	0.002	0.015	n/a	No	10	90	No	0.011	NP (NDs)
Lead, total (mg/L)	AD-7	0.002	0.001	0.015	n/a	No	11	81.82	No	0.006	NP (NDs)
Lithium, total (mg/L)	AD-22	0.2199	0.1201	0.17	n/a	No	11	0	No	0.01	Param.
Lithium, total (mg/L)	AD-33	0.029	0.0178	0.17	n/a	No	11	9.091	No	0.006	NP (normality)
Lithium, total (mg/L)	AD-7	0.107	0.08978	0.17	n/a	No	11	0	x^4	0.01	Param.
Mercury, total (mg/L)	AD-22	0.01023	-0.00006233	0.002	n/a	No	8	0	No	0.01	Param.
Mercury, total (mg/L)	AD-33	0.0008791	0.0002363	0.002	n/a	No	11	0	sqrt(x)	0.01	Param.
Mercury, total (mg/L)	AD-7	0.0002241	0.00005679	0.002	n/a	No	11	0	No	0.01	Param.
Molybdenum, total (mg/L)	AD-22	0.002	0.002	0.1	n/a	No	10	90	No	0.011	NP (NDs)
Molybdenum, total (mg/L)	AD-33	0.002	0.002	0.1	n/a	No	10	90	No	0.011	NP (NDs)
Molybdenum, total (mg/L)	AD-7	0.002	0.002	0.1	n/a	No	11	100	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-22	0.003928	0.001214	0.05	n/a	No	11	54.55	ln(x)	0.01	Param.
Selenium, total (mg/L)	AD-33	0.005	0.0017	0.05	n/a	No	11	72.73	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-7	0.005	0.001047	0.05	n/a	No	11	72.73	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-22	0.002	0.0008954	0.002	n/a	No	11	63.64	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-33	0.002	0.001192	0.002	n/a	No	11	72.73	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-7	0.002	0.001032	0.002	n/a	No	11	81.82	No	0.006	NP (NDs)

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

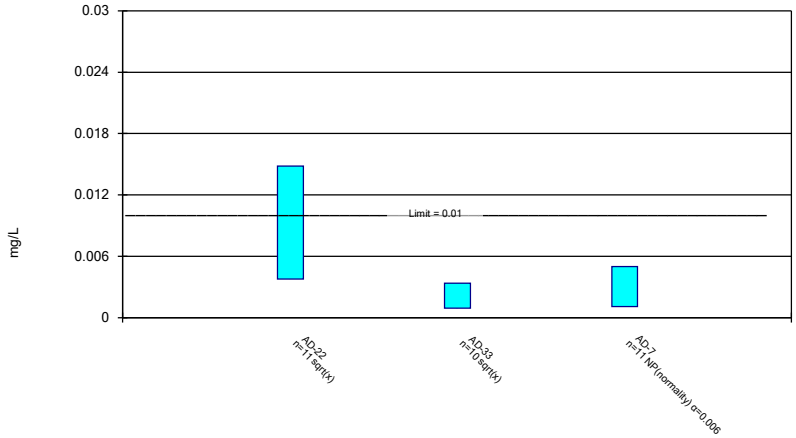


Constituent: Antimony, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

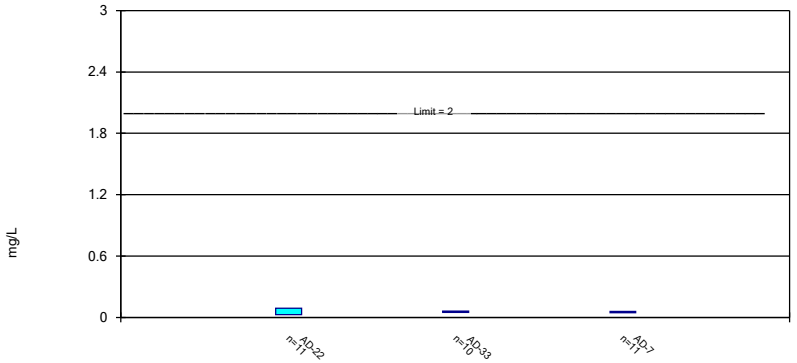


Constituent: Arsenic, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

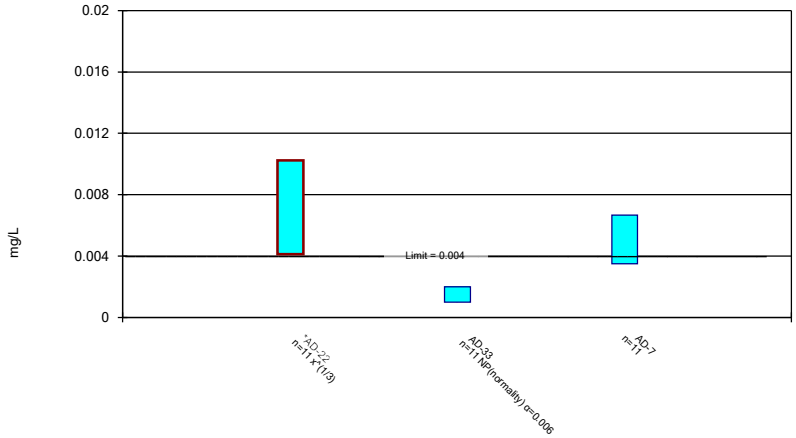


Constituent: Barium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

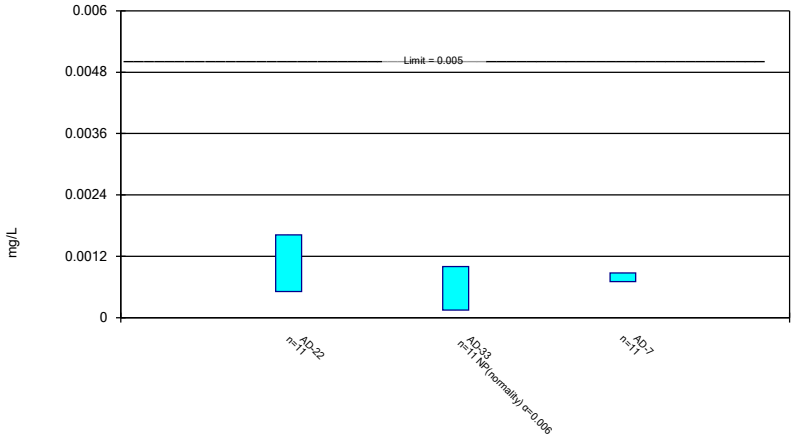
Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Beryllium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

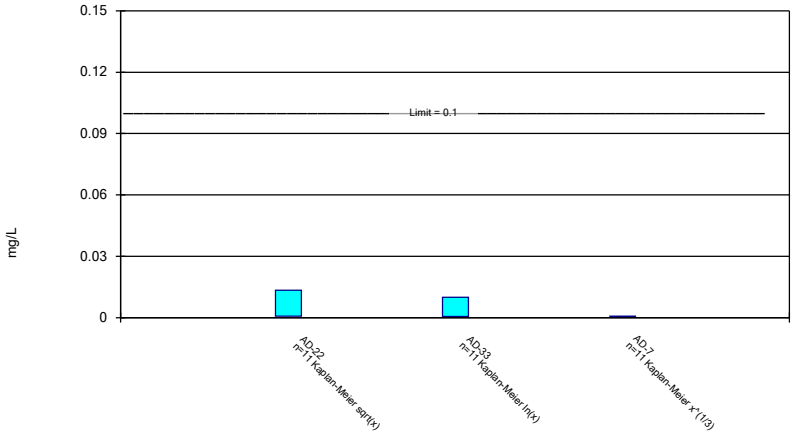


Constituent: Cadmium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

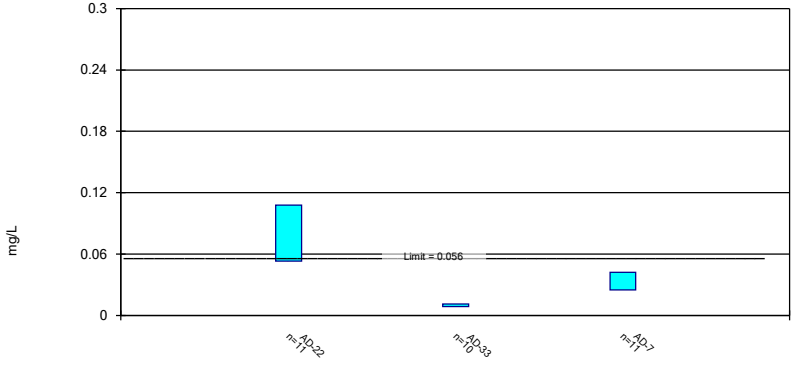


Constituent: Chromium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

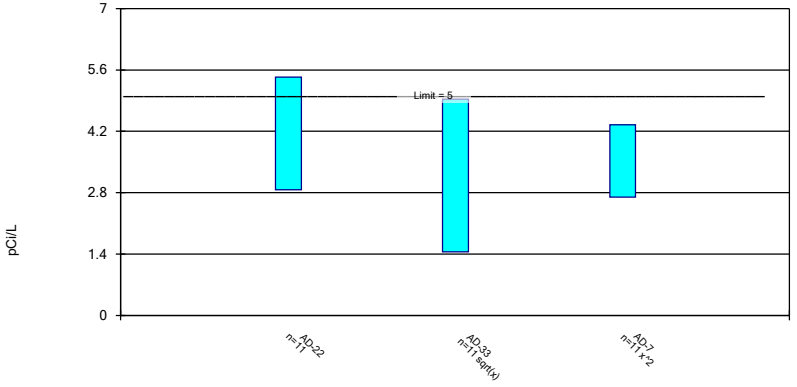


Constituent: Cobalt, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

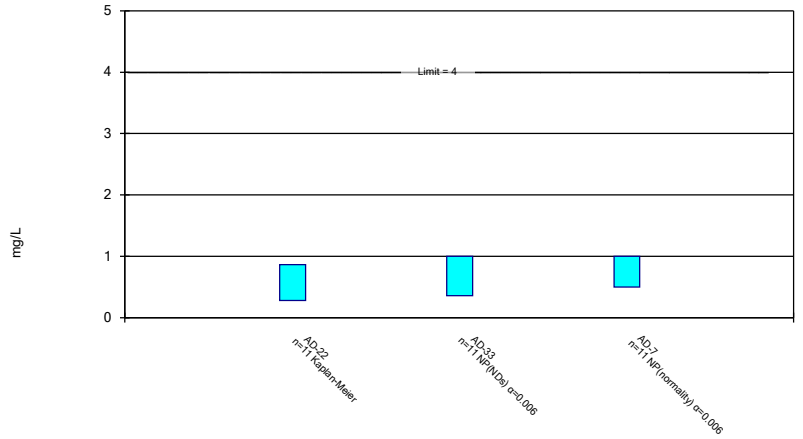
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - A
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

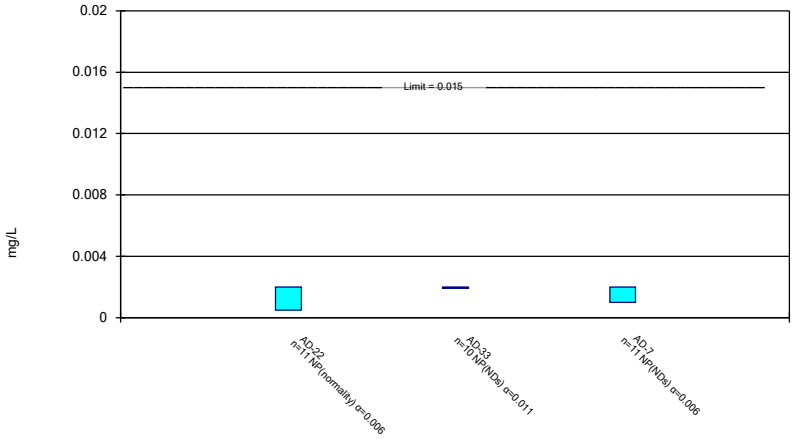


Constituent: Fluoride, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

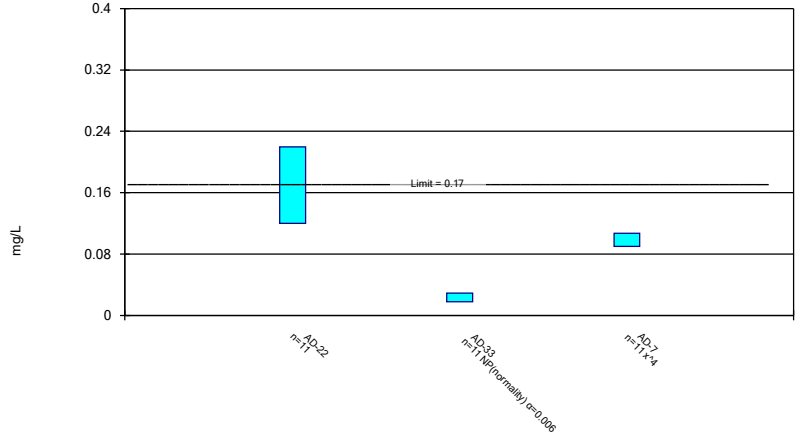


Constituent: Lead, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

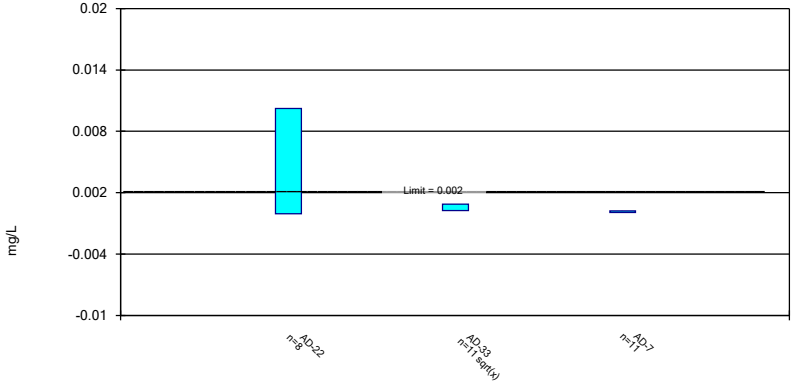


Constituent: Lithium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

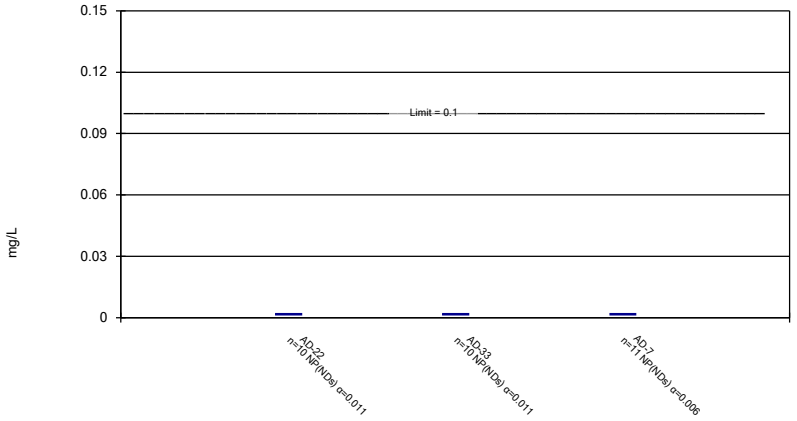
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Mercury, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

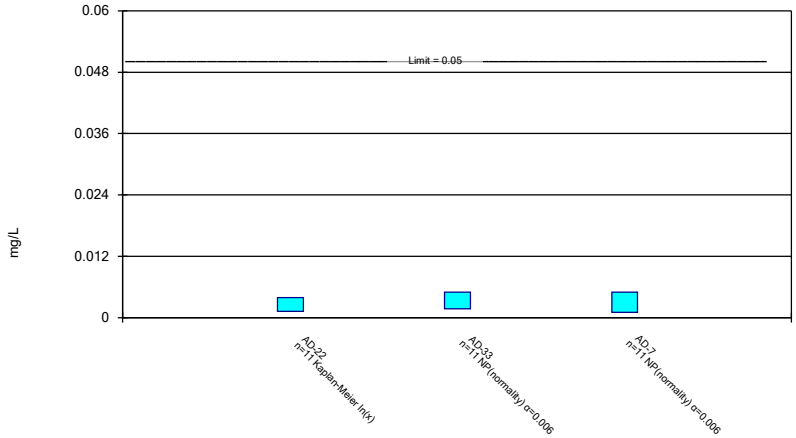


Constituent: Molybdenum, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

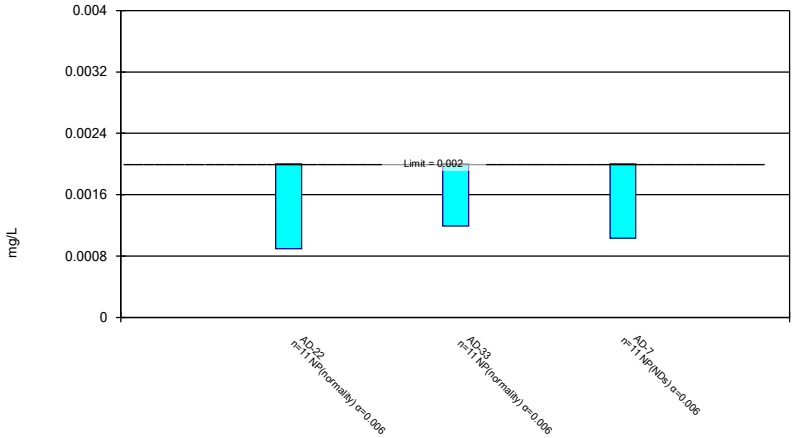


Constituent: Selenium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



Constituent: Thallium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

STATISTICAL ANALYSIS SUMMARY
FLUE GAS DESULFURIZATION (FGD) STACKOUT AREA
H.W. Pirkey Plant
Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

January 2, 2020

CHA8473

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
FGD	Flue Gas Desulfurization
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
SU	Standard Units
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the Flue Gas Desulfurization (FGD) Stackout Area, an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, chloride, and sulfate at the FGD Stackout Area. An alternative source was not identified at the time, so the FGD Stackout Area has been in assessment monitoring since. During the most recent assessment monitoring event, completed in February 2019, an SSL for beryllium was identified at AD-22. An ASD was successfully prepared for beryllium (Geosyntec, 2019); thus, the unit remained in assessment monitoring. Two assessment monitoring events were conducted at the FGD Stackout Area in May and August 2019, in accordance with 40 CFR 257.95. The results of these events are documented in this report.

Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. SSL were identified for beryllium and cobalt. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

FLUE GAS DESULFURIZATION (FGD) STACKOUT AREA EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, two sets of samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) (May 2019) and 257.95(d)(1) (August 2019). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during these assessment monitoring events may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.23 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the FGD Stackout Area were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained in May and August 2019 were screened for potential outliers. Outliers were identified for molybdenum at AD-7, AD-12, AD-13, AD-22, and AD-33. At these locations, molybdenum was not detected and was replaced with the reporting limit of 0.04 mg/L, which is higher than previous reporting limits.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring

events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for beryllium, cadmium, cobalt, fluoride, lithium, selenium, and thallium due to apparent non-normal distributions and for antimony, mercury, and molybdenum due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). Seasonal patterns were observed for beryllium and cobalt at AD-7 and AD-22 and for combined radium at AD-7. The data for these well/parameter pairs was deseasonalized so that the resulting confidence limits correctly account for seasonality as a predictable pattern rather than random variation or a release.

An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey FGD Stackout Area:

- The deseasonalized LCL for beryllium exceeded the GWPS of 0.00400 mg/L at AD-7 (0.00603 mg/L) and AD-22 (0.00447 mg/L).

- The deseasonalized LCL for cobalt exceeded the GWPS of 0.0560 mg/L at AD-22 (0.0727 mg/L).

As a result, the Pirkey FGD Stackout Area will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Establishment of Appendix III Prediction Limits

Upper prediction limits (UPL) were previously established for all Appendix III parameters following the background monitoring period (Geosyntec, 2018). Intrawell tests were used to evaluate potential SSIs for calcium, pH, and TDS, whereas interwell tests were used to evaluate potential SSIs for boron, chloride, fluoride, and sulfate. While interwell prediction limits have been updated periodically during the assessment monitoring period as sufficient data became available, this represents the first update to the background dataset for parameters evaluated using intrawell tests.

Mann-Whitney (Wilcoxon rank-sum) tests were performed to determine whether the newer data are affected by a release from the FGD Stackout Area. Because the interwell Appendix III limits and the Appendix IV GWPSs are based on data from upgradient wells which we would not expect

to have been impacted by a release, these tests were used for intrawell Appendix III tests only. Mann-Whitney tests were used to compare the medians of historical data (May 2016 - April 2017) to the new compliance samples (August 2017 – February2019) for calcium, pH, and TDS. Results were evaluated to determine if the medians of the two groups were similar at the 99% confidence level. Where no significant difference was found, the new compliance data were added to the background dataset. Where a statistically significant difference was found between the medians of the two groups, the data were reviewed to evaluate the cause of the difference and to determine if adding newer data to the background dataset, replacing the background dataset with the newer data, or continuing to use the existing background dataset was most appropriate. If the differences appeared to have been caused by a release, then the previous background dataset continued to be used.

The complete Mann-Whitney test results and a summary of the significant findings can be found in Attachment B. No significant differences were found between the two groups for calcium, pH, or TDS.

After the revised background set was established, a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., "J-flagged" data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets (either transformed or untransformed) that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or non-parametric) and transformation (where applicable) for each background dataset are shown in Attachment B.

UPLs were updated using all the historical data through May 2019 to represent background values. LPLs were also updated for pH. The updated prediction limits are summarized in Table 3. Intrawell tests continued to be used to evaluate potential SSIs for calcium, pH, and TDS, whereas interwell tests continued to be used to evaluate potential SSIs for boron, chloride, fluoride, and sulfate. The intrawell UPLs were calculated for a one-of-two retesting procedure; i.e., if at least one sample in a series of two does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, where the initial result did not exceed the UPL, a second sample was not collected. The retesting procedures allowed achieving an acceptably high statistical power to detect changes at downgradient wells for constituents evaluated using intrawell prediction limits.

2.2.4 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations.

Data collected during the May and August 2019 assessment monitoring events from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 4. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0845 mg/L at AD-33 (0.111 mg/L and 0.0970 mg/L) and AD-7 (0.195 mg/L and 3.54 mg/L).
- Calcium concentrations exceeded the intrawell UPL of 15.2 mg/L at AD-22 (16.5 mg/L) and the intrawell UPL of 5.32 mg/L at AD-7 (5.77 mg/L).
- Chloride concentrations exceeded the interwell UPL of 40.8 mg/L AD-22 (63.3 mg/L and 79.6 mg/L).
- The fluoride concentration exceeded the interwell UPL of 1.00 mg/L at AD-22 (1.06 mg/L).
- The May 2019 pH measurement at AD-22 (5.1 SU) exceeded the GWPS of 4.9 SU.
- Sulfate concentrations exceeded the interwell UPL of 80.8 mg/L at AD-22 (360 mg/L and 198 mg/L) and AD-7 (91.6 mg/L).
- TDS concentrations exceeded the intrawell UPL of 203 mg/L at AD-33 (204 mg/L) and the intrawell UPL of 291 mg/L at AD-7 (334 mg/L).

Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey FGD Stackout Area during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified potential outliers for molybdenum in the May data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. SSLs were identified for beryllium and cobalt. Appendix III parameters were compared to recalculated prediction limits, with exceedances identified for boron, calcium, chloride, fluoride, pH, sulfate, and TDS.

Based on this evaluation, the Pirkey FGD Stackout Area CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H.W. Pirkey Plant. January 2017.

Geosyntec Consultants. 2018. Statistical Analysis Summary – Flue Gas Desulfurization (FGD) Stackout Area, H.W. Pirkey Plant, Hallsville, Texas. January.

Geosyntec Consultants. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Power Plant Flue Gas Desulfurization (FGD) Stackout Area, Hallsville, Texas. October.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - Stackout Pad

Component	Unit	AD-7		AD-12		AD-13		AD-22		AD-33	
		5/22/2019	8/12/2019	5/21/2019	8/12/2019	5/21/2019	8/12/2019	5/22/2019	8/12/2019	5/22/2019	8/12/2019
Antimony	µg/L	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U
Arsenic	µg/L	2.00 J	0.640	2.00 U	0.0700 J	2.00 J	1.64	5.89	2.19	2.00 U	0.410
Barium	µg/L	37.8	41.9	21.7	23.8	35.0	35.0	16.7	15.3	52.4	38.6
Beryllium	µg/L	6.47	3.24	2.00 U	0.154	2.00 U	0.235	12.5	3.38	1.00 J	1.00
Boron	mg/L	0.195	3.54	0.0200	0.0500 U	0.0610	0.0640	0.0730	0.0300 J	0.111	0.0970
Cadmium	µg/L	0.600 J	0.750	1.00 U	0.0500 U	1.00 U	0.0500 U	1.52	0.440	1.00 U	0.0400 J
Calcium	mg/L	5.77	4.20	0.300 J	0.278	10.1	8.68	16.5	8.96	1.65	1.03
Chloride	mg/L	28.0	36.7	6.30	7.24	34.8	42.3	63.3	79.6	8.57	8.85
Chromium	µg/L	4.00 U	0.100 J	4.00 U	0.204	4.00 U	0.0600 J	4.00 U	0.200 J	4.00 U	0.100 J
Cobalt	µg/L	46.0	29.7	1.15	1.30	44.7	44.5	129	57.5	10.5	7.02
Combined Radium	pCi/L	4.72	3.28	0.201	0.237	0.875	1.64	6.71	3.09	1.18	1.14
Fluoride	mg/L	0.580	0.300	0.0900	0.0600 J	0.400	0.390	1.06	0.450	0.230	0.190
Lead	µg/L	0.800 J	0.529	2.00 U	0.0800 J	2.00 U	0.200 U	2.00 U	0.100 J	2.00 U	0.100 J
Lithium	mg/L	0.0975	0.102	0.00576	0.00829	0.153	0.139	0.288	0.151	0.0245	0.0233
Mercury	mg/L	0.000260	0.0000900	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.000837	0.000325	0.000481	0.000564
Molybdenum	µg/L	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U
Selenium	µg/L	3.00 J	1.70	4.00 U	0.200 J	4.00 U	0.200 U	5.90	2.00	1.00 J	1.10
Total Dissolved Solids	mg/L	334	266	80.0	90.0	190	310	506	484	204	156
Sulfate	mg/L	91.6	59.6	4.00	2.60	69.5	73.6	360	198	60.4	44.3
Thallium	µg/L	0.500 U	0.200 J	0.500 U	0.500 U	0.500 U	0.500 U	0.200 J	0.200 J	0.500 U	0.500 U
pH	SU	3.37	4.01	4.09	4.94	5.32	5.94	5.06	4.76	4.12	4.16

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above the method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit

Table 2: Groundwater Protection Standards
Pirkey Plant - Stackout

Geosyntec Consultants, Inc.

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL
Antimony, Total (mg/L)	0.006		0.005
Arsenic, Total (mg/L)	0.01		0.006
Barium, Total (mg/L)	2		0.051
Beryllium, Total (mg/L)	0.004		0.002
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.002
Cobalt, Total (mg/L)	n/a	0.006	0.056
Combined Radium, Total (pCi/L)	5		2.94
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.17
Mercury, Total (mg/L)	0.002		0.000025
Molybdenum, Total (mg/L)	n/a	0.1	0.005
Selenium, Total (mg/L)	0.05		0.005
Thallium, Total (mg/L)	0.002		0.002

Notes:
Grey cell indicates calculated UTL is higher than MCL or CCR Rule-specified value.
MCL = Maximum Contaminant Level
Calculated UTL (Upper Tolerance Limit) represents site-specific background values.
The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3: Revised Prediction Limits
Pirkey Plant - Stackout Pad

Parameter	Unit	Description	AD-22	AD-33	AD-7
Boron	mg/L	Interwell Background Value (UPL)	0.0845		
Calcium	mg/L	Intrawell Background Value (UPL)	15.2	2.29	5.32
Chloride	mg/L	Interwell Background Value (UPL)	40.8		
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
pH	SU	Intrawell Background Value (UPL)	4.9	4.7	4.5
		Intrawell Background Value (LPL)	3.6	2.7	3.0
Sulfate	mg/L	Interwell Background Value (UPL)	80.8		
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	651	203	291

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

Table 4: Appendix III Data Summary
Pirkey Plant - Stackout Pad

Geosyntec Consultants, Inc.

Parameter	Unit	Description	AD-22		AD-33		AD-7	
			5/22/2019	8/12/2019	5/22/2019	8/12/2019	5/22/2019	8/12/2019
Boron	mg/L	Interwell Background Value (UPL)	0.0845					
		Detection Monitoring Result	0.0730	0.0300	**0.111**	**0.0970**	**0.195**	**3.54**
Calcium	mg/L	Intrawell Background Value (UPL)	15.2		2.29		5.32	
		Detection Monitoring Result	**16.5**	8.96	1.65	1.03	**5.77**	4.20
Chloride	mg/L	Interwell Background Value (UPL)	40.8					
		Detection Monitoring Result	**63.3**	**79.6**	8.57	8.85	28.0	36.7
Fluoride	mg/L	Interwell Background Value (UPL)	1.00					
		Detection Monitoring Result	**1.06**	0.450	0.230	0.190	0.580	0.300
pH	SU	Intrawell Background Value (UPL)	4.9		4.7		4.5	
		Intrawell Background Value (LPL)	3.6		2.7		3.0	
		Detection Monitoring Result	**5.1**	4.8	4.1	4.2	3.4	4.0
Sulfate	mg/L	Interwell Background Value (UPL)	80.8					
		Detection Monitoring Result	**360**	**198**	60.4	44.3	**91.6**	59.6
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	651		203		291	
		Detection Monitoring Result	506	484	**204**	156	**334**	266

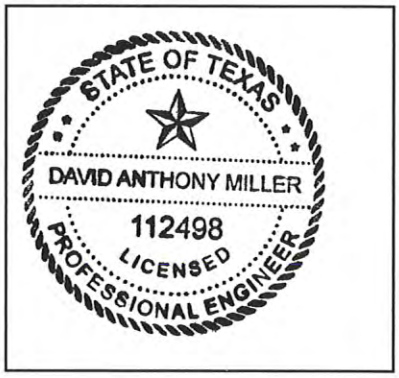
Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey Flue Gas Desulfurization (FGD) Stackout Area CCR management area and that the requirements of 40 CFR 257.93(f) have been met.



DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

112498	TEXAS	01.03.20
License Number	Licensing State	Date

ATTACHMENT B
Statistical Analysis Output

GROUNDWATER STATS CONSULTING

December 10, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey Stackout
Statistical Analysis & Background Update – 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the background update of groundwater data for American Electric Power Inc.'s Pirkey Stackout. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-12 and AD-13; and
- **Downgradient wells:** AD-22, AD-33, and AD-7.

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis report was reviewed by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to Groundwater Stats Consulting. The analysis was prepared according to the background screening conducted in December 2017 that was approved by Dr. Cameron.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS;
- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots and box plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B). Values previously flagged during the screening as outliers may be seen in a lighter font and disconnected symbol on the time series graphs, and a summary of those values follows this letter.

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for calcium and pH, and TDS;
2) Interwell prediction limits combined with a 1-of-2 resample plan for boron, chloride, fluoride, and sulfate.

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, the reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory. There is no replacement of historical reporting limits with the most recent reporting limit. It was noted that the most recent RL are significantly lower than those reported historically.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.

- Nonparametric prediction limits are used on data containing greater than 50% nondetects.

Historical Summary - Evaluation of Appendix III Parameters – December 2017

Outlier Evaluation

Time series plots were used to identify suspected outliers, or extreme values that would result in limits that are not conservative from a regulatory perspective, in proposed background data. Suspected outliers at all wells for Appendix III parameters were formally tested using Tukey's box plot method and, when identified, flagged in the computer database with "o" and deselected prior to construction of statistical limits.

During the previous background screening, a high value was flagged as an outlier for TDS in downgradient well AD-33. The current assumption is that changes in concentrations are reflective of natural variation upgradient of the facility; however, a separate study and hydrogeological investigation would be required to fully understand the geochemical conditions and expected groundwater quality for the region. That study and assessment is beyond the scope of services provided by Groundwater Stats Consulting.

Statistical Limits

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, chloride, fluoride, and sulfate; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for calcium, pH and TDS. The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data were screened for any newly suspected outliers or obvious trending patterns using time series plots. Intrawell prediction limits utilized the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the set background data will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. Prediction limit exceedances were noted for boron in wells AD-33 and AD-7; calcium in well AD-13; chloride, fluoride and sulfate in well AD-22; and pH in wells AD-22 and AD-7. The results of those findings were included in the previous screening and may be found in the Prediction Limit Summary tables.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable. Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site which is an indication of natural variability in groundwater unrelated to practices at the site.

No statistically significant increasing or decreasing trends were found for any of the downgradient well/parameter pairs with prediction limit exceedances.

Appendix III Background Update – November 2019

Prior to updating background data, samples are re-evaluated for all wells for intrawell parameters and all upgradient wells for interwell parameters using Tukey's outlier test and visual screening with the May and August 2019 samples. Additionally, samples during August and December 2017 that were previously absent were incorporated into this analysis. No values were flagged for Appendix III parameters except for fluoride in downgradient well AD-7, and the previously flagged outlier for TDS in well AD-33 was also flagged for this background screening. As mentioned above, any flagged data are displayed in a lighter font and as a disconnected symbol on the time series reports, as well as in a lighter font on the accompanying data pages. An updated summary of Tukey's test results and flagged outliers follows this letter (Figure C).

For constituents requiring intrawell prediction limits, the Mann-Whitney (Wilcoxon Rank Sum) test was used to compare the medians of historical data through April 2017 to the new compliance samples at each well through February 2019 to evaluate whether the groups are statistically different at the 99% confidence level, in which case background data may be updated with compliance data.

No statistically significant differences were found between the two groups for any well/parameter pairs. Typically, when the test concludes that the medians of the two groups are significantly different, particularly in the downgradient wells, the background are not updated to include the newer data but will be reconsidered in the future. A summary of these results follows this letter and the test results are included with the Mann Whitney test section at the end of this report (Figure D).

Intrawell prediction limits using all historical data through February 2019 combined with a 1-of-2 resample plan, were constructed for a majority of the well/constituent pairs and a summary of the updated limits follows this letter (Figure E). Seasonal trends appeared to be present for calcium and TDS in wells AD-22 and AD-7 and, therefore, prediction limits were constructed using de-seasonalized values (Figure F).

For parameters tested using interwell analyses, the Sen's Slope/Mann-Kendall trend test was used on upgradient wells to determine whether concentrations are statistically increasing, decreasing or stable (Figure G). No statistically significant increasing or decreasing trends were noted with the exception of fluoride in upgradient well AD-12. The magnitude of this trend, however, is low relative to the average concentrations in these wells. Therefore, no adjustments were required at this time. A summary of these results is included with the trend tests.

Interwell prediction limits, combined with a 1-of-2 resample plan, were updated using all available data from upgradient wells through February 2019 for boron, chloride, fluoride, and sulfate (Figure H). Interwell prediction limits pool upgradient well data to establish a background limit for an individual constituent. A summary table of the updated limits may be found following this letter in the Prediction Limit Summary Tables.

Evaluation of Appendix IV Parameters – November 2019

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure I). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Tukey's test did identify several outliers that were flagged in the database.

Note that the reporting limit during the February 2019 event for molybdenum at wells AD-12, AD-13, AD-22 and AD-33 was 0.04 mg/L compared to a historical reporting limit of 0.002 mg/L. Well AD-7, however, had a reporting limit of 0.002 mg/L during this

event. The resulting nondetects reported at 0.04 mg/L are censored at much higher levels than the rest of the data and, therefore, are flagged as outliers.

The reporting limit (or practical quantitation limit) for the February 2019 event for thallium also increased from the historical reporting limit of 0.002 mg/L to 0.01 mg/L for all wells. However, since no detections were present above the method detection limit of 0.002 mg/L for this event, the historical reporting limit of 0.002 mg/L was used for historic nondetects and the nondetects with a reporting limit of 0.01 mg/L were flagged as outliers.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure J).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of the MCL, CCR-Rule specified levels, or ACL as discussed above (Figure K). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No confidence interval exceedances were noted; however, seasonal patterns were noted in some wells and additional confidence intervals were constructed using deseasonalized data as discussed below. A summary of the confidence interval results follows this letter.

Seasonal patterns were observed on the time series plots for beryllium and cobalt in wells AD-22 and AD-7, and combined radium 226 + 228 in well AD-7. When seasonal patterns are observed, data are deseasonalized so that the resulting limits will correctly account for the seasonality as a predictable pattern rather than random variation or a release. It was noted that cadmium in well AD-22 may also be exhibiting some seasonal influence; however, all reported measurements are well below the GWPS and, therefore, this record did not require additional adjustments. Confidence intervals were constructed with deseasonalized values for those wells and constituents mentioned above and the results follow this letter (Figure L). The GWPS was exceeded by wells AD-22 and AD-7 for beryllium, and by well AD-22 for cobalt.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for Pirkey Stackout. If you have any questions or comments, please feel free to contact us.

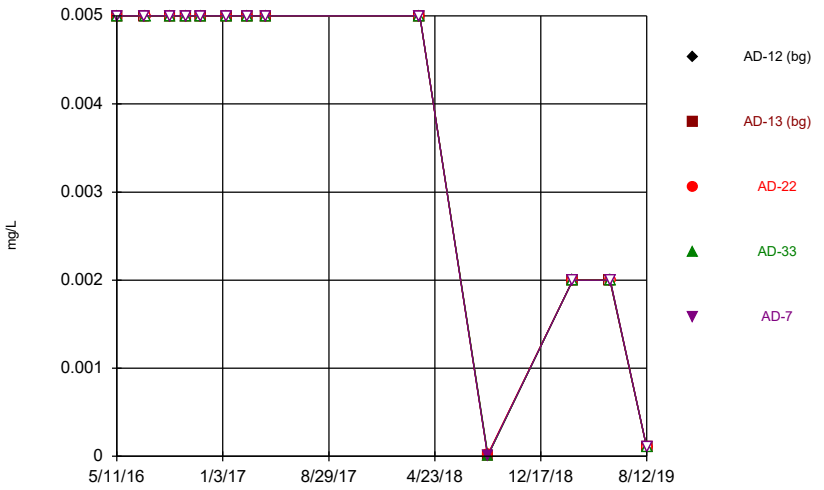
For Groundwater Stats Consulting,

Andrew T. Collins
Groundwater Analyst

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

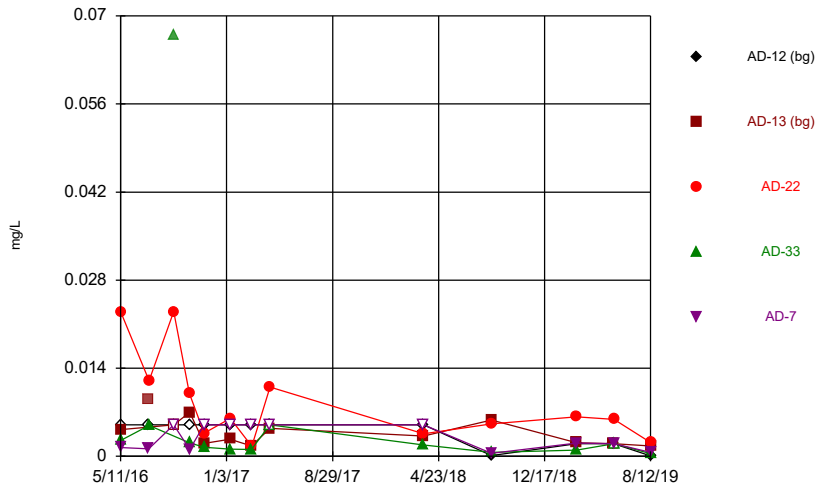
Time Series



Constituent: Antimony, total Analysis Run 12/10/2019 12:28 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

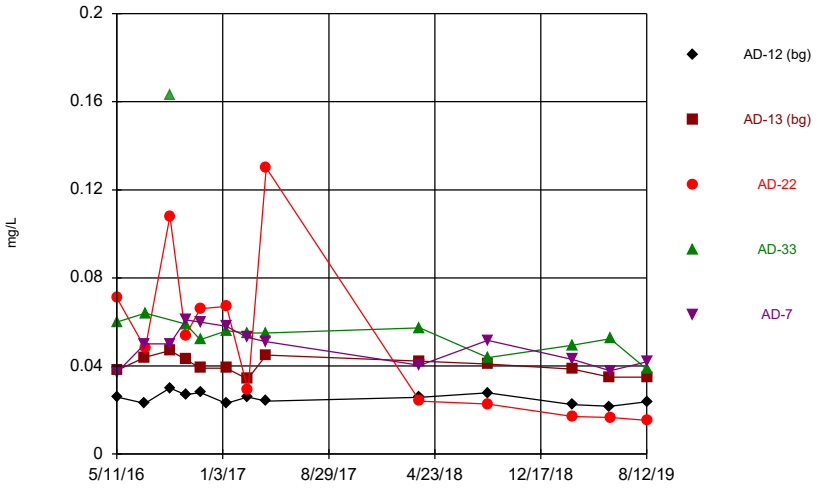
Time Series



Constituent: Arsenic, total Analysis Run 12/10/2019 12:28 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

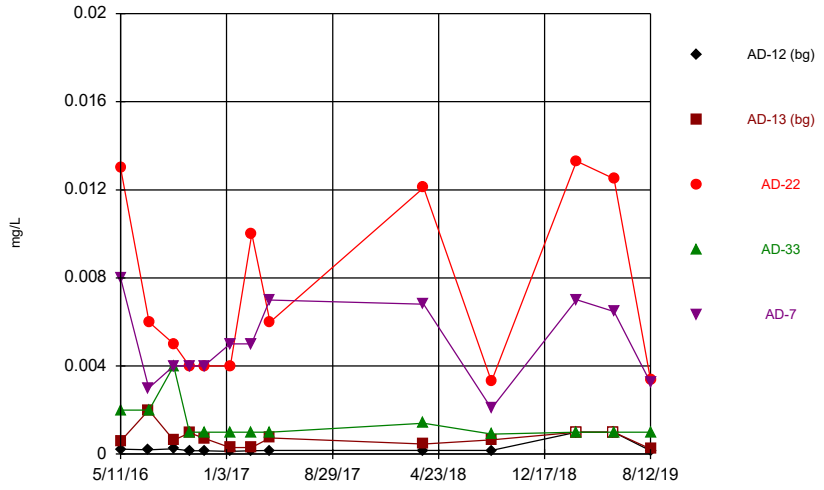
Time Series



Constituent: Barium, total Analysis Run 12/10/2019 12:28 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

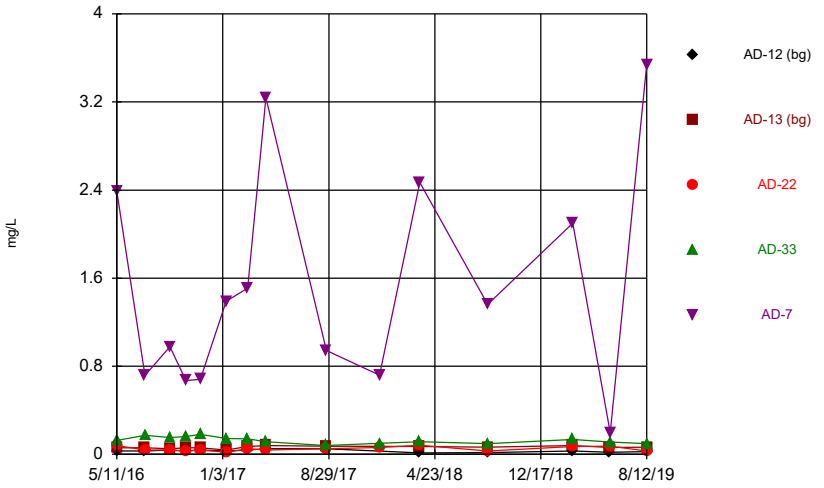
Time Series



Constituent: Beryllium, total Analysis Run 12/10/2019 12:28 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

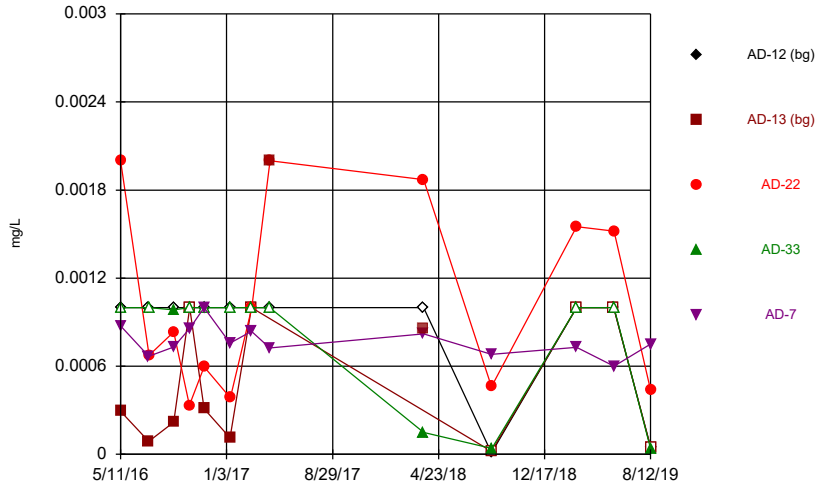
Time Series



Constituent: Boron, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

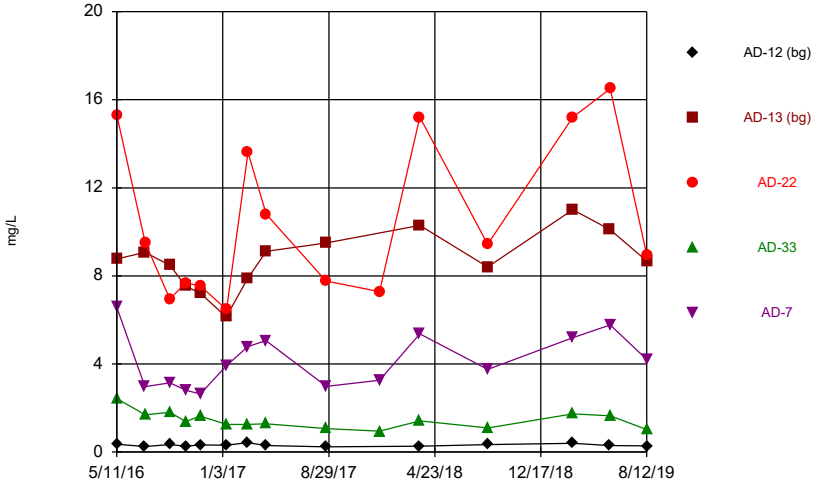
Time Series



Constituent: Cadmium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

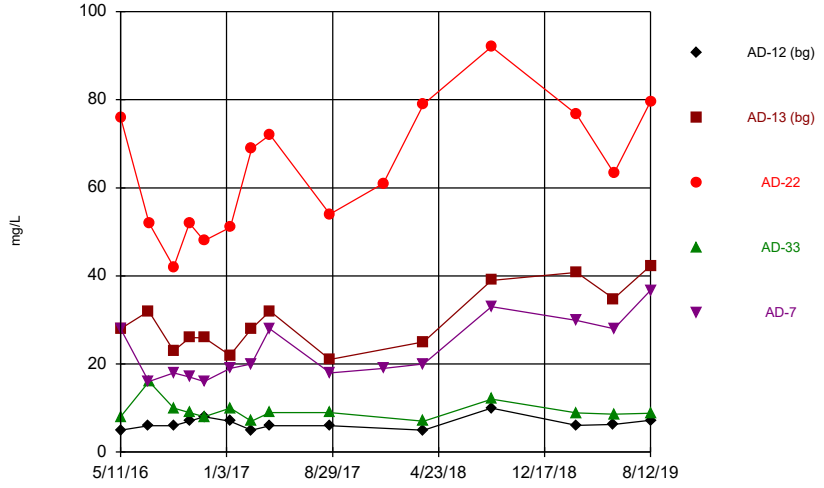
Time Series



Constituent: Calcium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

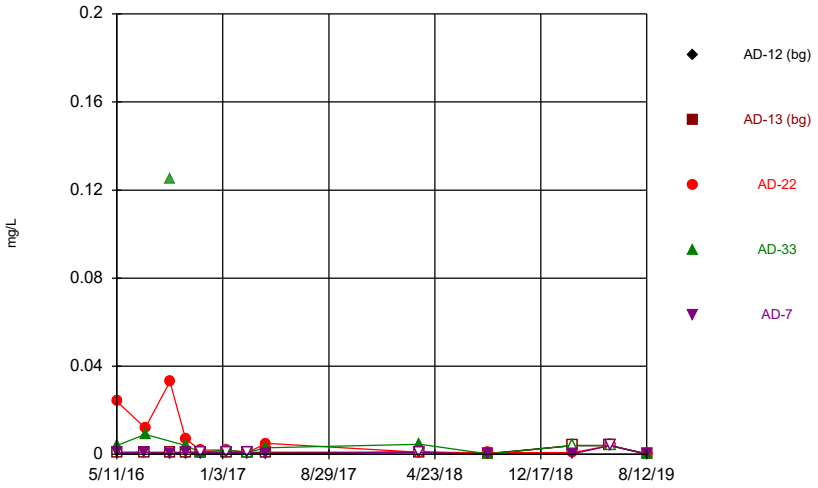
Time Series



Constituent: Chloride, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

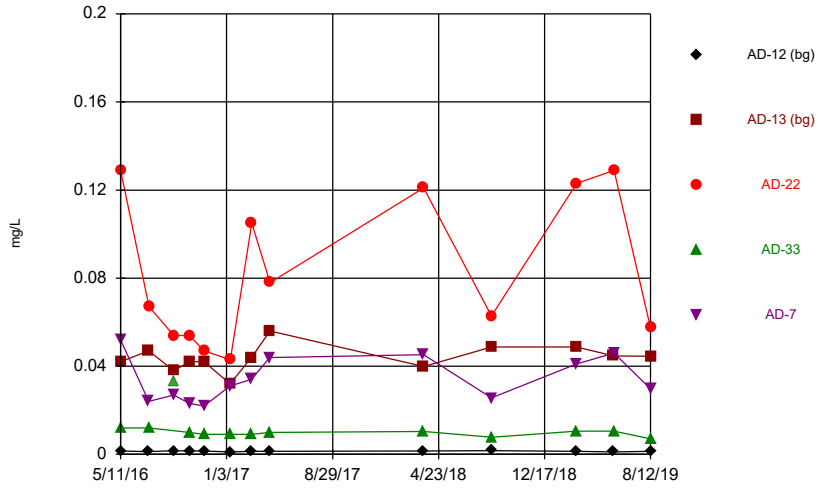
Time Series



Constituent: Chromium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

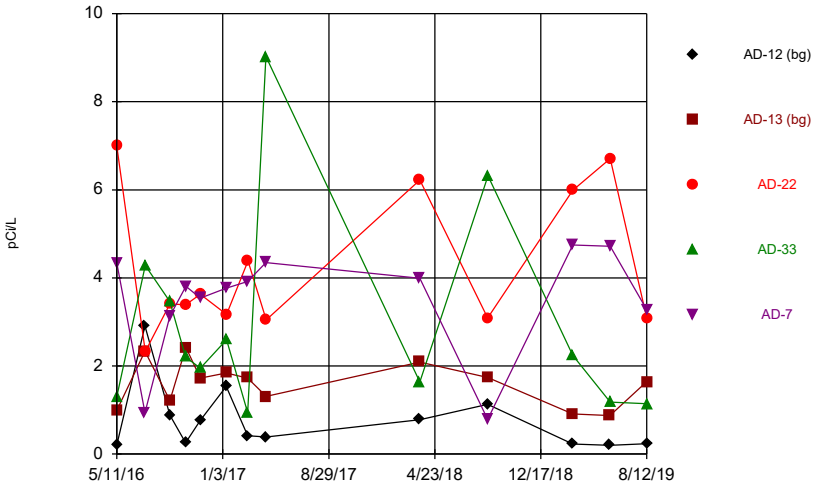
Time Series



Constituent: Cobalt, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

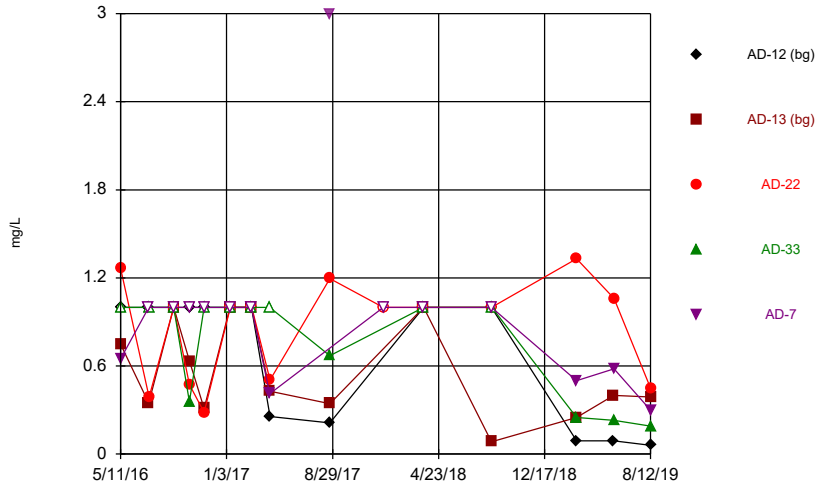
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

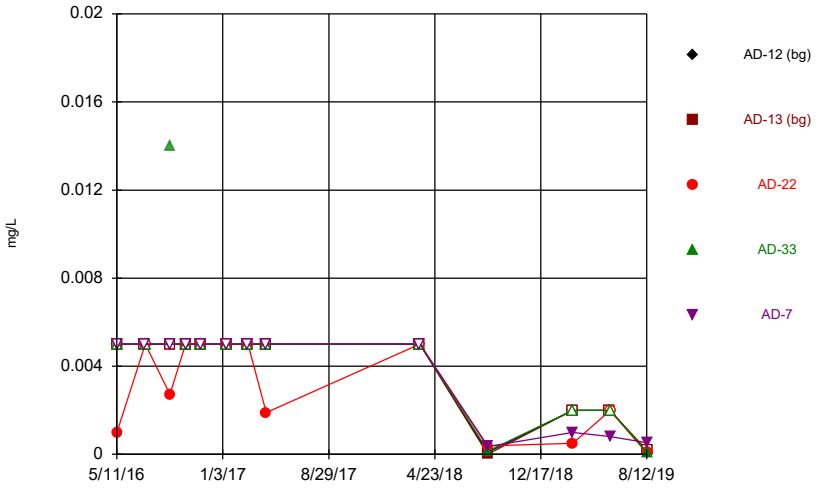
Time Series



Constituent: Fluoride, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

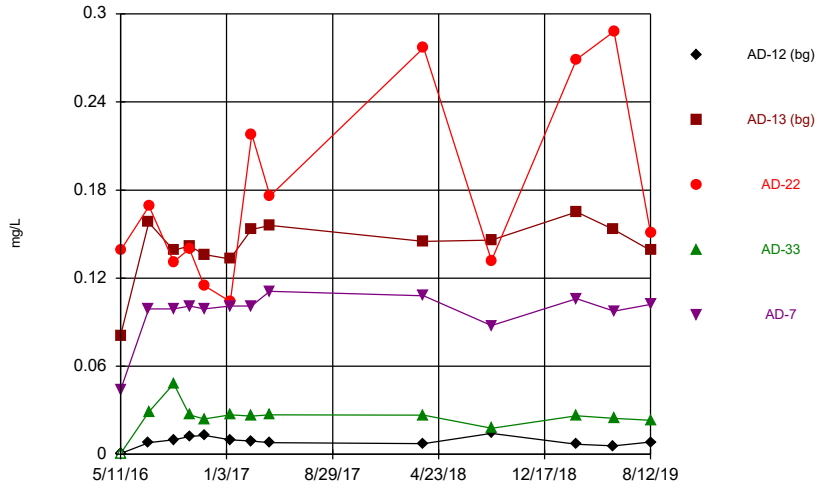
Time Series



Constituent: Lead, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

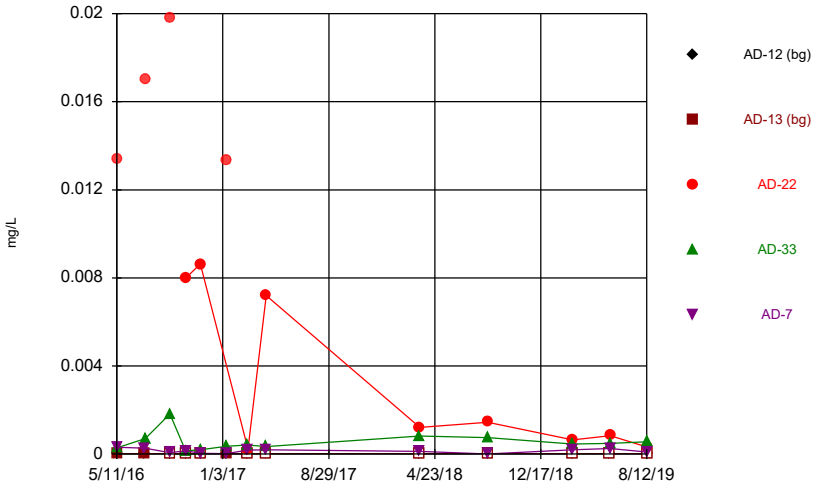
Time Series



Constituent: Lithium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

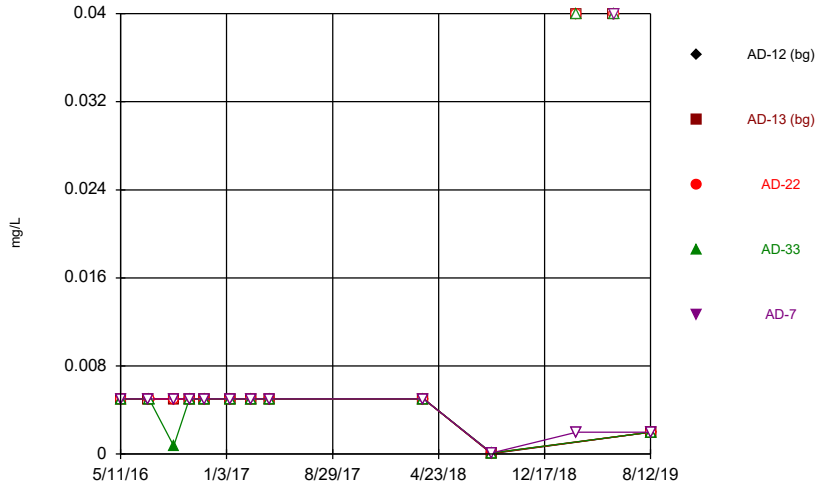
Time Series



Constituent: Mercury, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

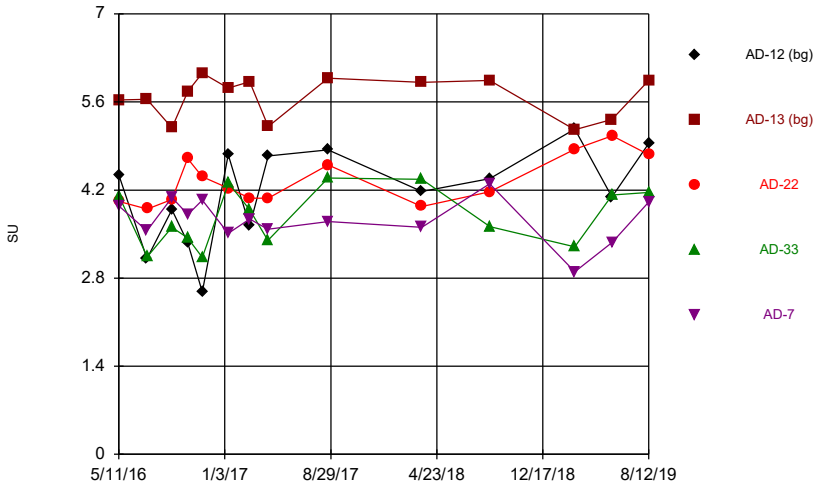
Time Series



Constituent: Molybdenum, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



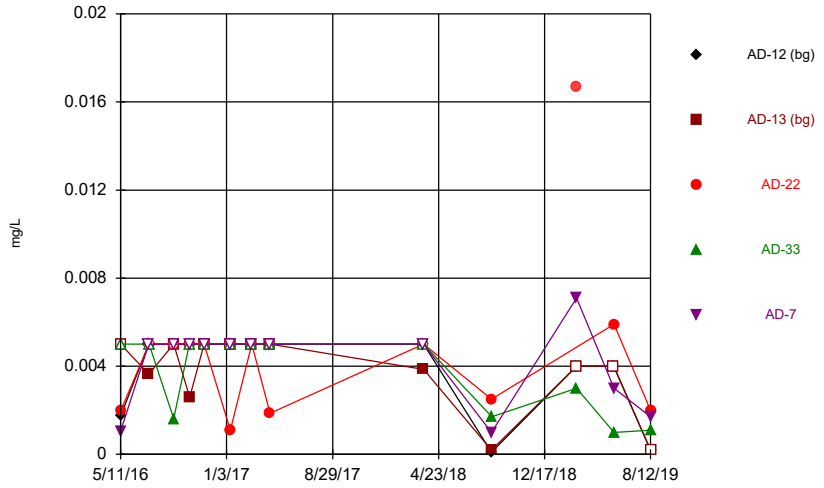
Constituent: pH, field Analysis Run 12/10/2019 12:29 PM View: Time Series

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Time Series

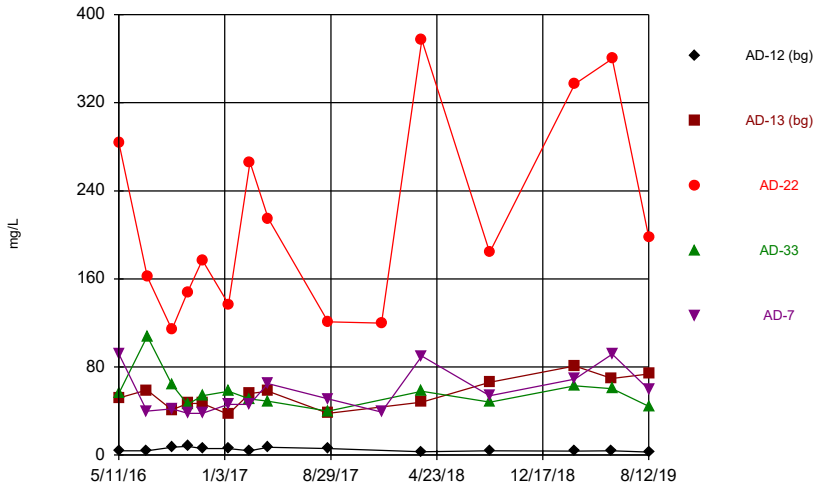


Constituent: Selenium, total Analysis Run 12/10/2019 12:29 PM View: Time Series

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



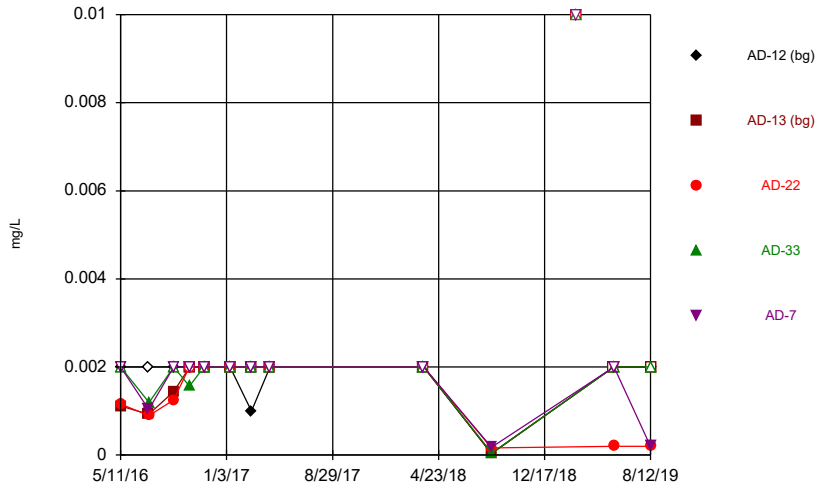
Constituent: Sulfate, total Analysis Run 12/10/2019 12:29 PM View: Time Series

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Time Series

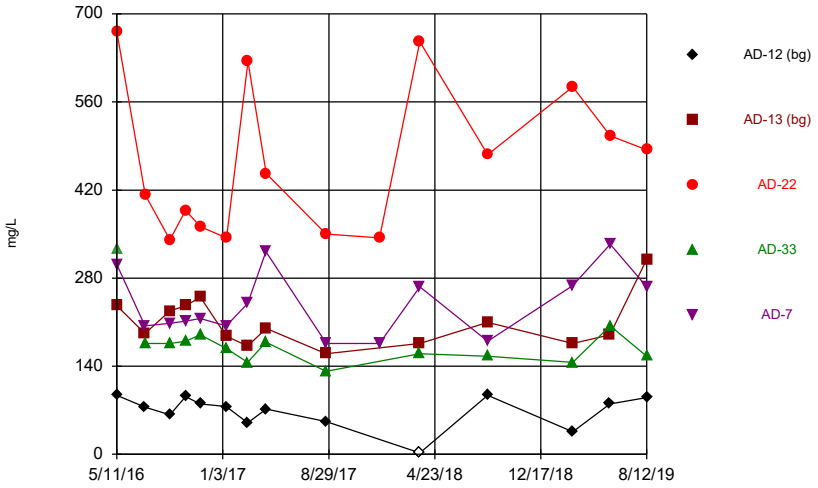


Constituent: Thallium, total Analysis Run 12/10/2019 12:29 PM View: Time Series

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

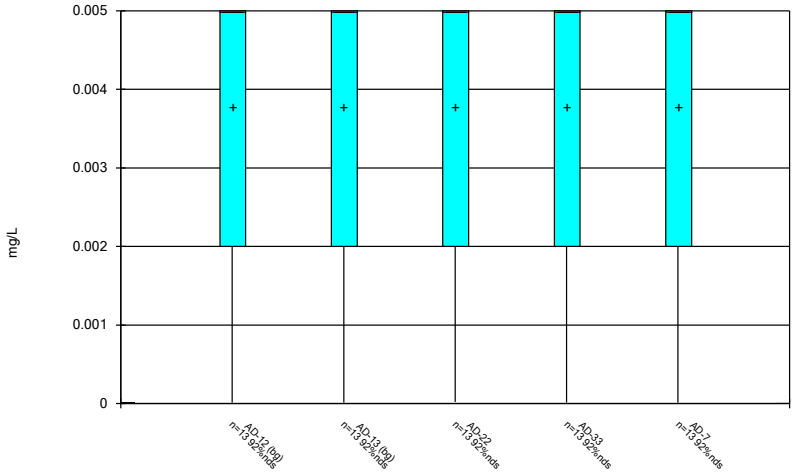
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



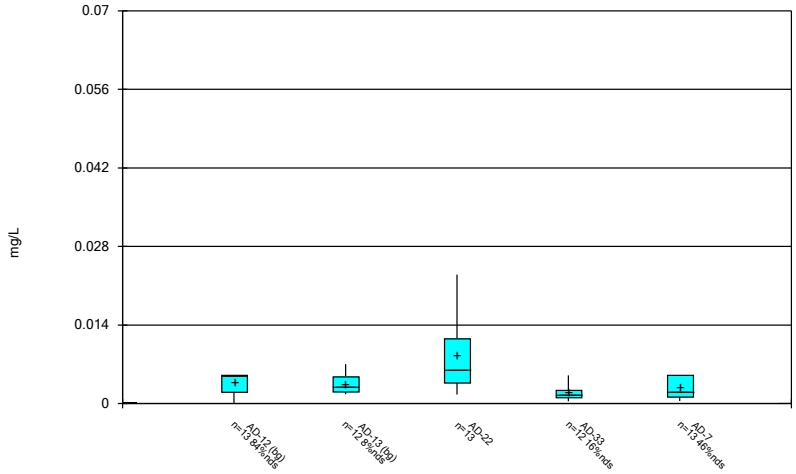
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



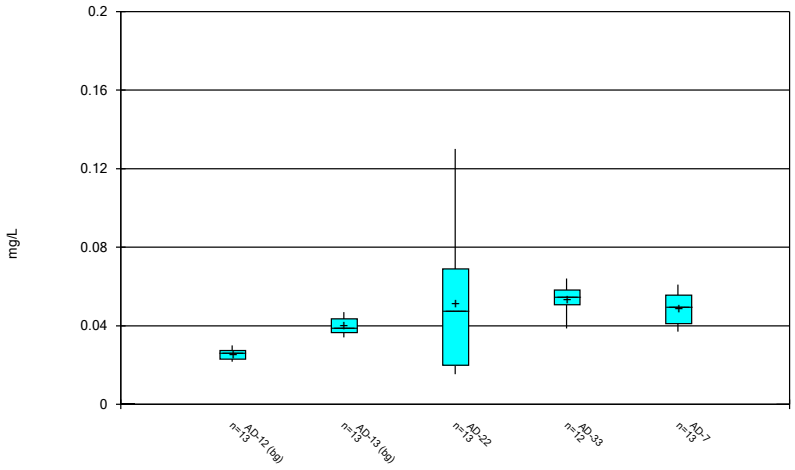
Constituent: Antimony, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



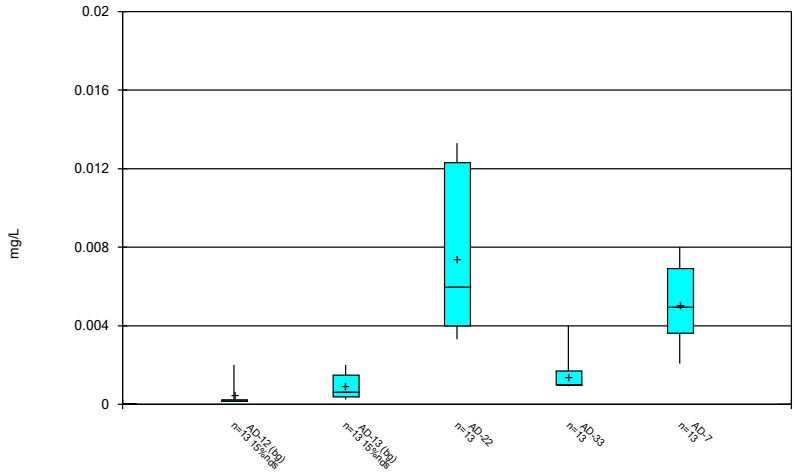
Constituent: Arsenic, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



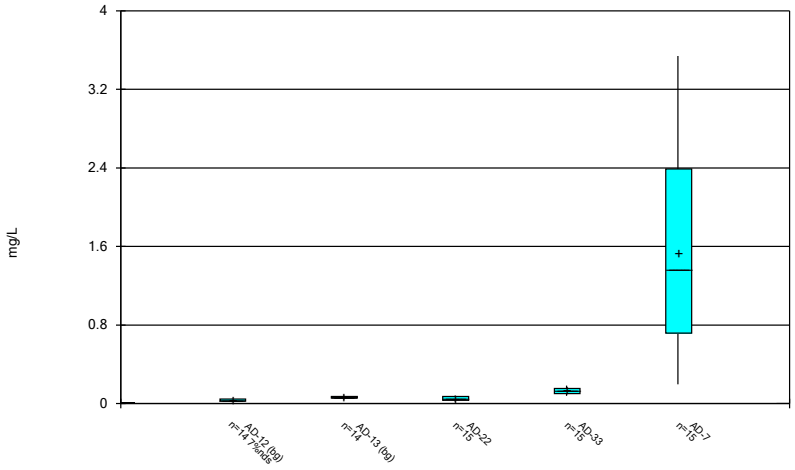
Constituent: Barium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



Constituent: Beryllium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

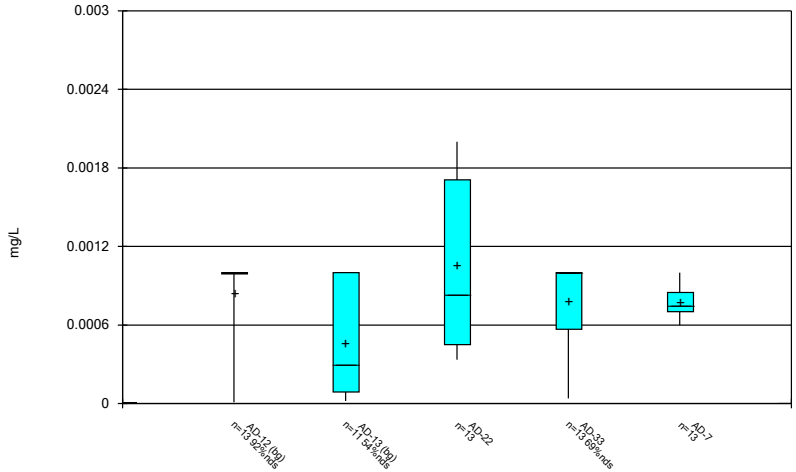
Box & Whiskers Plot



Constituent: Boron, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

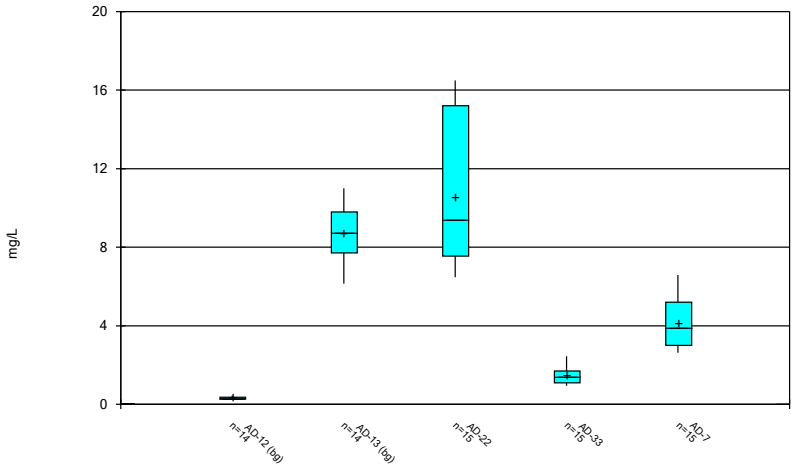
Box & Whiskers Plot



Constituent: Cadmium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

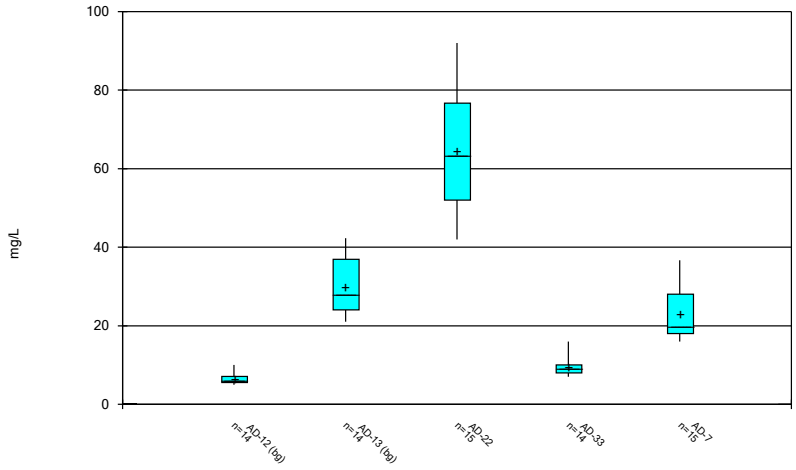
Box & Whiskers Plot



Constituent: Calcium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

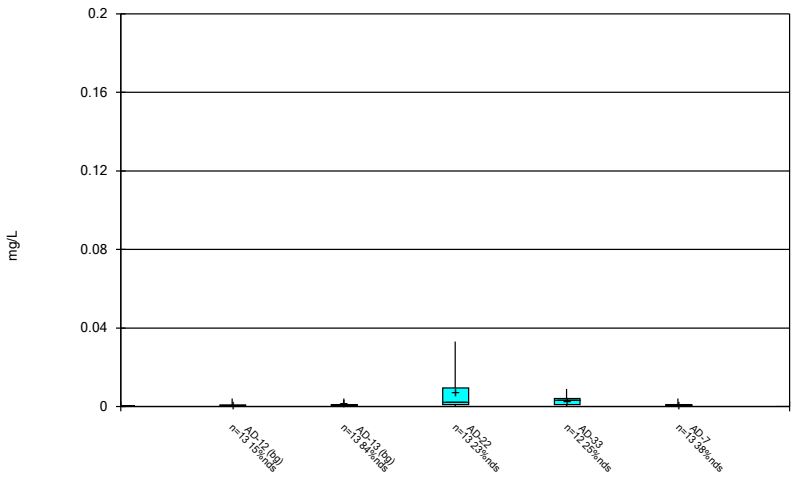
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Chloride, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

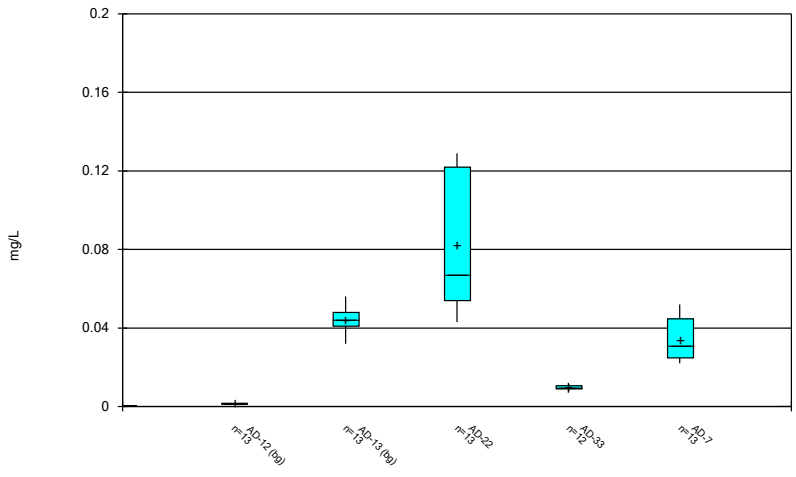
Box & Whiskers Plot



Constituent: Chromium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

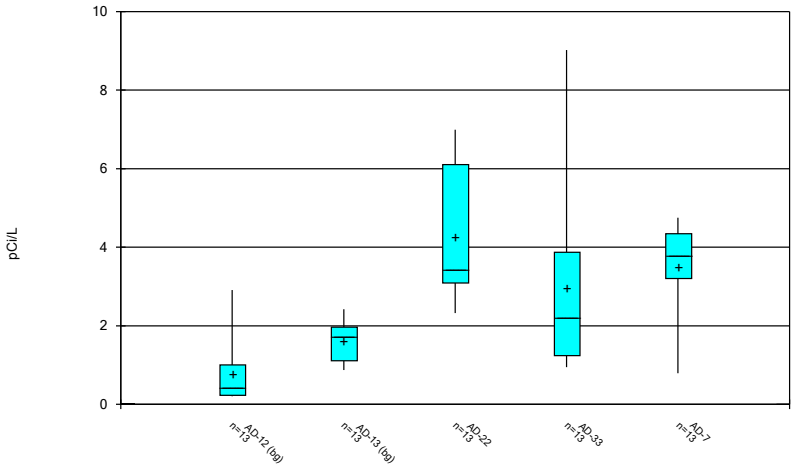
Box & Whiskers Plot



Constituent: Cobalt, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

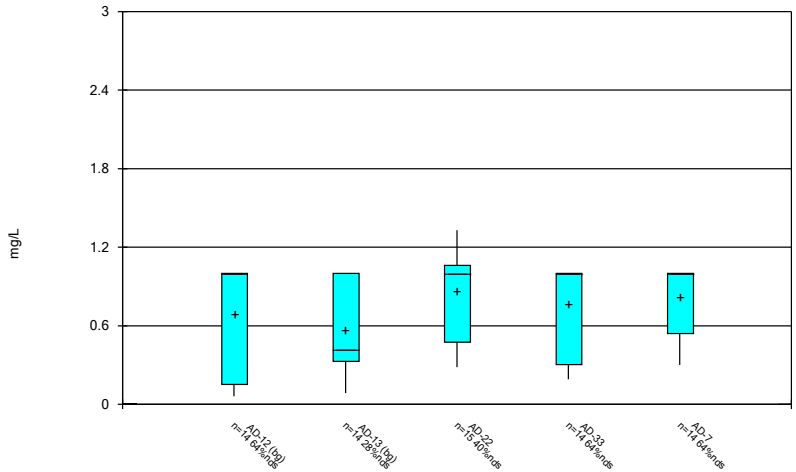
Box & Whiskers Plot



Constituent: Combined Radium 226 + 228 Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

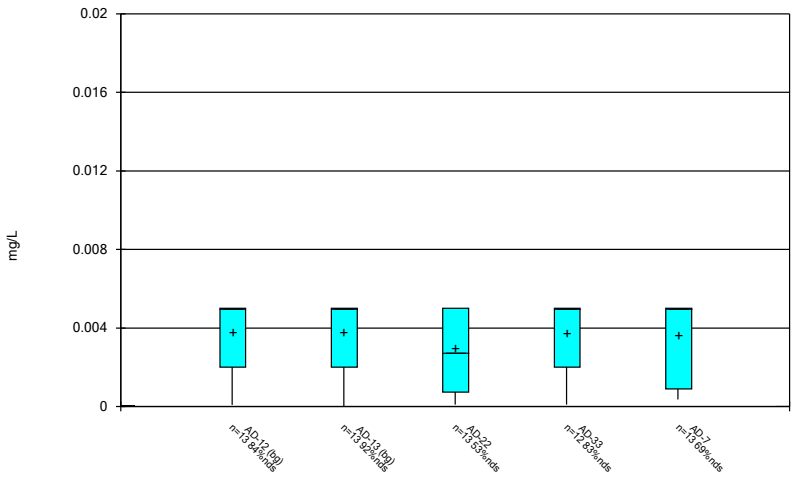
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot



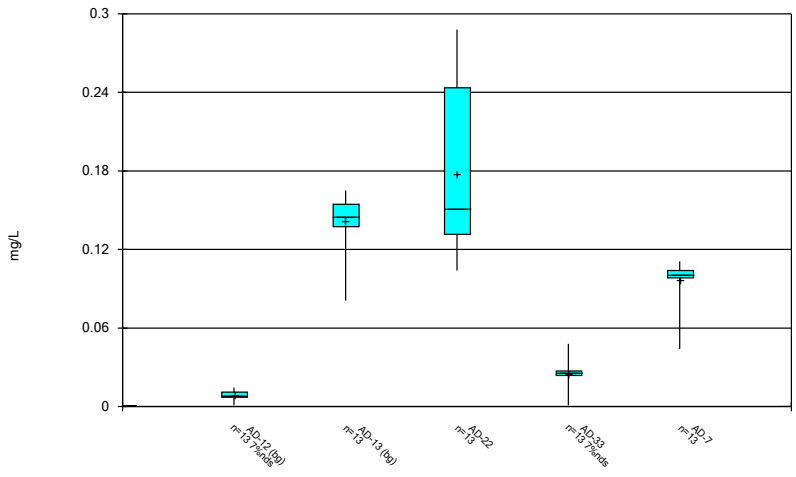
Constituent: Fluoride, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



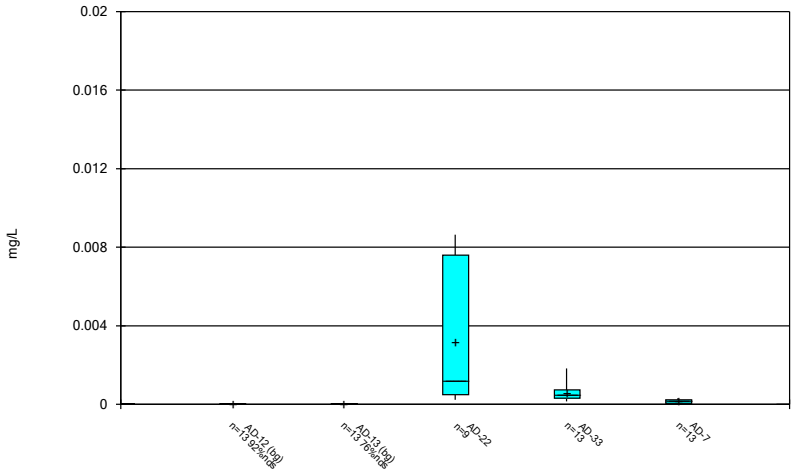
Constituent: Lead, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



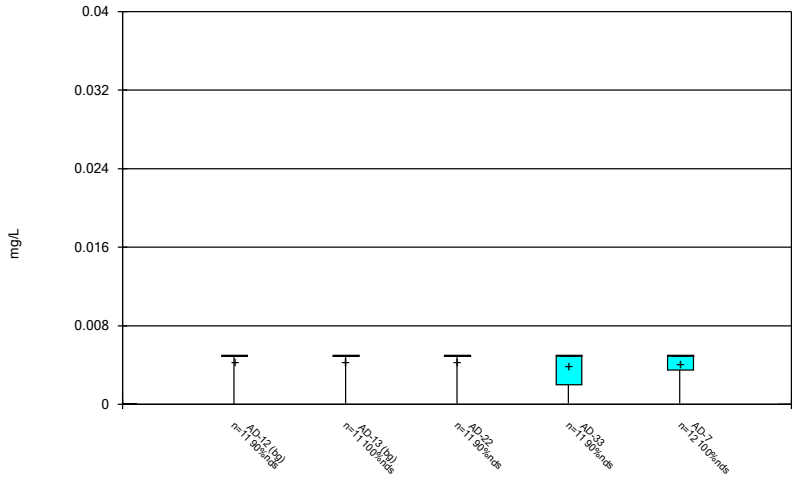
Constituent: Lithium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



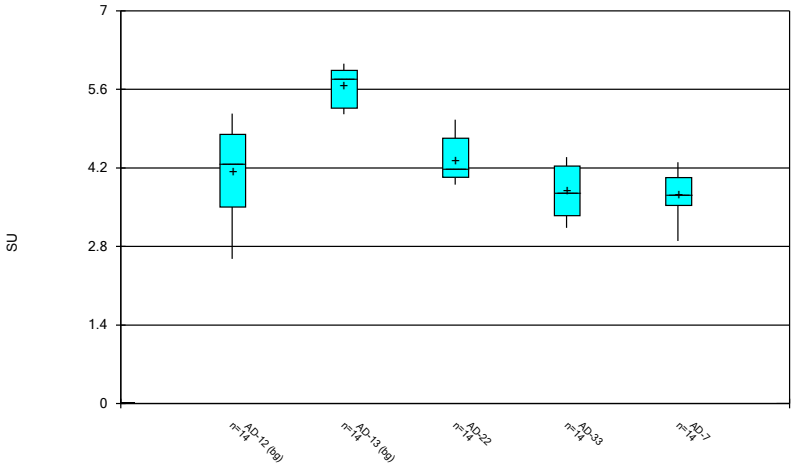
Constituent: Mercury, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



Constituent: Molybdenum, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

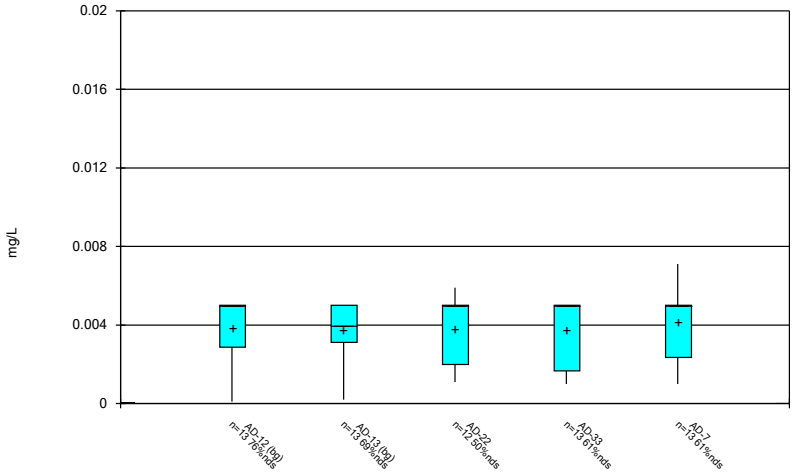
Box & Whiskers Plot



Constituent: pH, field Analysis Run 12/6/2019 11:14 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

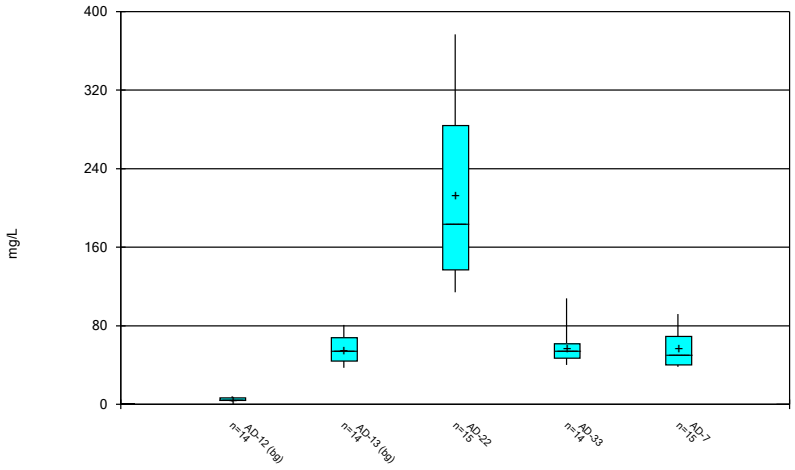
Box & Whiskers Plot



Constituent: Selenium, total Analysis Run 12/6/2019 11:14 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

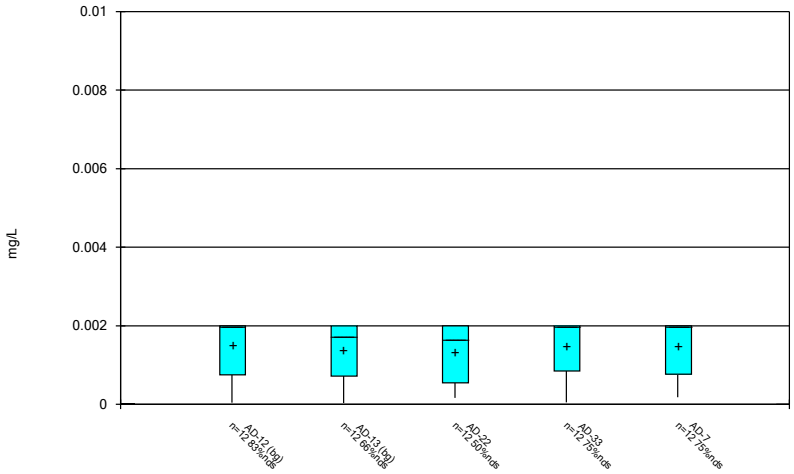
Box & Whiskers Plot



Constituent: Sulfate, total Analysis Run 12/6/2019 11:14 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

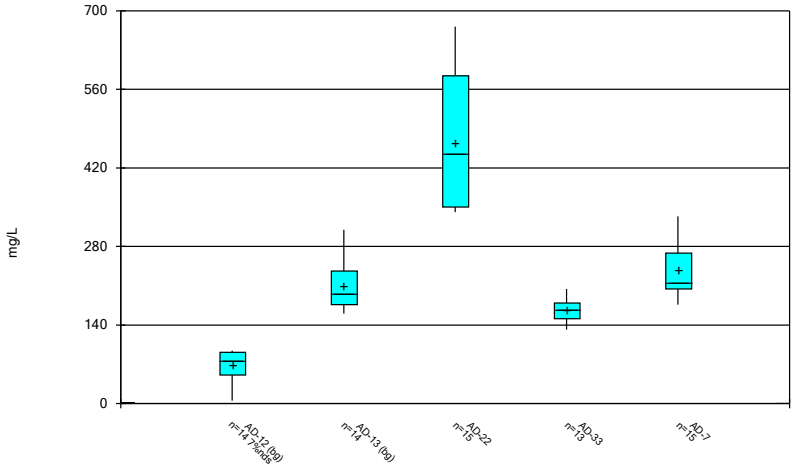
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Thallium, total Analysis Run 12/6/2019 11:14 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/6/2019 11:14 AM

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Outlier Summary

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/10/2019, 12:26 PM

	AD-13 Arsenic, total (mg/L)	AD-33 Arsenic, total (mg/L)	AD-33 Barium, total (mg/L)	AD-13 Cadmium, total (mg/L)	AD-33 Chromium, total (mg/L)	AD-33 Cobalt, total (mg/L)	AD-7 Fluoride, total (mg/L)	AD-33 Lead, total (mg/L)	AD-22 Mercury, total (mg/L)	AD-12 Molybdenum, total (mg/L)
5/11/2016									0.01341 (o)	
7/13/2016	0.009 (o)									
7/14/2016									0.017 (o)	
9/7/2016		0.067 (o)	0.163 (o)		0.125 (o)	0.033 (o)		0.014 (o)	0.019829 (o)	
1/12/2017									0.01332 (o)	
4/11/2017				0.002 (o)						
8/24/2017							2.994 (o)			
3/21/2018				0.00086 (Jo)						
2/27/2019										<0.04 (o)
5/21/2019										<0.04 (o)
5/22/2019										

	AD-13 Molybdenum, total (mg/L)	AD-22 Molybdenum, total (mg/L)	AD-33 Molybdenum, total (mg/L)	AD-7 Molybdenum, total (mg/L)	AD-22 Selenium, total (mg/L)	AD-12 Thallium, total (mg/L)	AD-13 Thallium, total (mg/L)	AD-22 Thallium, total (mg/L)	AD-33 Thallium, total (mg/L)	AD-7 Thallium, total (mg/L)
5/11/2016										
7/13/2016										
7/14/2016										
9/7/2016										
1/12/2017										
4/11/2017										
8/24/2017										
3/21/2018										
2/27/2019	<0.04 (o)	<0.04 (o)	<0.04 (o)		0.0167 (o)	<0.002 (o)	<0.002 (o)	<0.002 (o)	<0.002 (o)	<0.002 (o)
5/21/2019	<0.04 (o)									
5/22/2019		<0.04 (o)	<0.04 (o)	<0.04 (o)						

	AD-33 Total Dissolved Solids [TDS] (mg/L)
5/11/2016	326 (o)
7/13/2016	
7/14/2016	
9/7/2016	
1/12/2017	
4/11/2017	
8/24/2017	
3/21/2018	
2/27/2019	
5/21/2019	
5/22/2019	

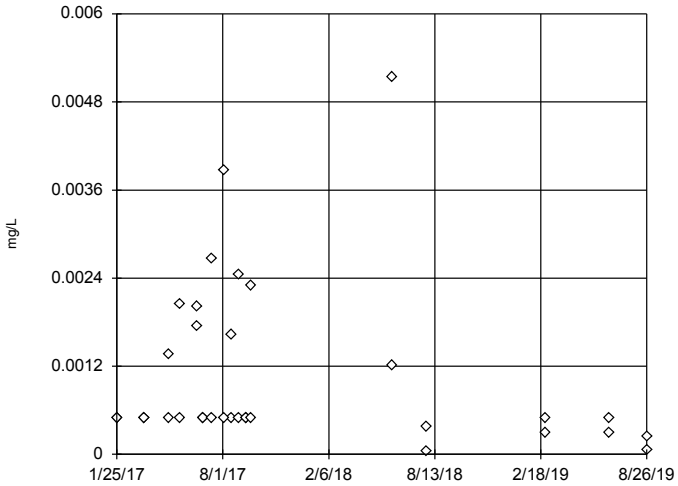
Upgradient Outlier Analysis - All Results

Northeastern BAP Client: Geosyntec Data: Northeastern BAP Printed 12/5/2019, 7:06 PM

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.001066	0.001141	ln(x)	ShapiroWilk
Arsenic (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.0167	0.01515	x^(1/3)	ShapiroWilk
Barium (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	1.517	0.909	sqrt(x)	ShapiroWilk
Beryllium (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.0006003	0.0009429	ln(x)	ShapiroWilk
Boron (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.3369	0.09923	x^(1/3)	ShapiroWilk
Cadmium (mg/L)	SP-4,SP-5	n/a	n/a	NP	NaN	34	0.0006194	0.001226	unknown	ShapiroWilk
Chloride (mg/L)	**SP-4,SP-5**	**Yes**	**52,62,1834**	**NP**	**NaN**	**34**	**562.2**	**280.7**	**sqrt(x)**	**ShapiroWilk**
Chromium (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.008442	0.01735	ln(x)	ShapiroWilk
Cobalt (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.004423	0.008256	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	SP-4,SP-5	No	n/a	NP	NaN	33	8.197	3.807	normal	ShapiroWilk
Fluoride (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	36	3.171	0.7808	x^2	ShapiroWilk
Lead (mg/L)	**SP-4,SP-5**	**Yes**	**0.03663**	**NP**	**NaN**	**34**	**0.003275**	**0.006578**	**ln(x)**	**ShapiroWilk**
Lithium (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.09636	0.02338	sqrt(x)	ShapiroWilk
Mercury (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.00002218	0.000009233	x^(1/3)	ShapiroWilk
Molybdenum (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.006372	0.003953	x^(1/3)	ShapiroWilk
pH, field (SU)	SP-4,SP-5	No	n/a	NP	NaN	32	7.796	0.449	ln(x)	ShapiroWilk
Selenium (mg/L)	SP-4,SP-5	n/a	n/a	NP	NaN	34	0.001084	0.0007727	unknown	ShapiroWilk
Sulfate (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	31.97	29.27	ln(x)	ShapiroWilk
Thallium (mg/L)	SP-4,SP-5	n/a	n/a	NP	NaN	34	0.0005265	0.0002563	unknown	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	**SP-4,SP-5**	**Yes**	**3008**	**NP**	**NaN**	**34**	**1328**	**333.4**	**ln(x)**	**ShapiroWilk**

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.06435, low cutoff = 0.00001309, based on IQR multiplier of 3.

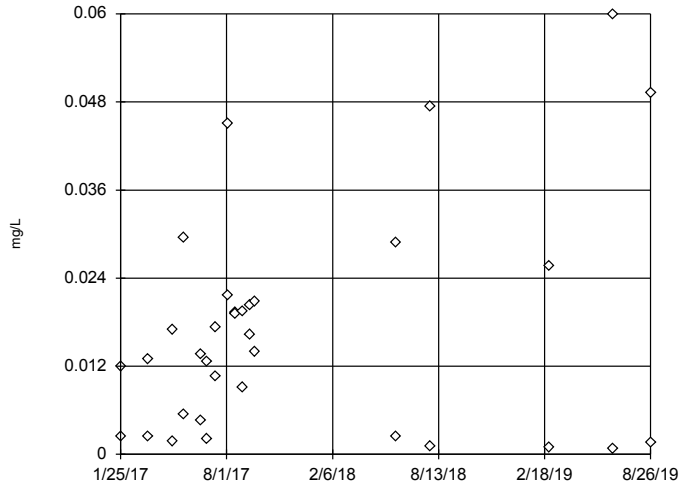
Constituent: Antimony Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.3424, low cutoff = -0.02368, based on IQR multiplier of 3.

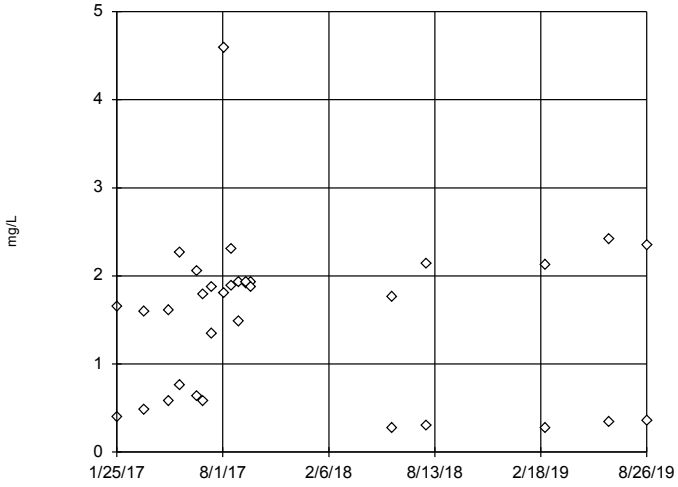
Constituent: Arsenic Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 11.31, low cutoff = -1.424, based on IQR multiplier of 3.

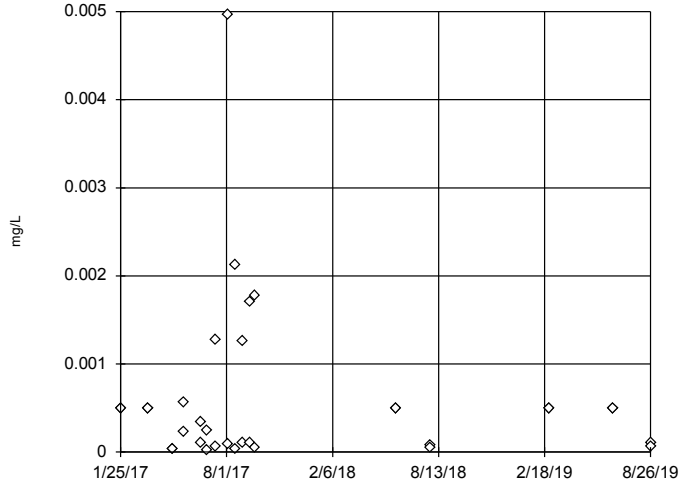
Constituent: Barium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

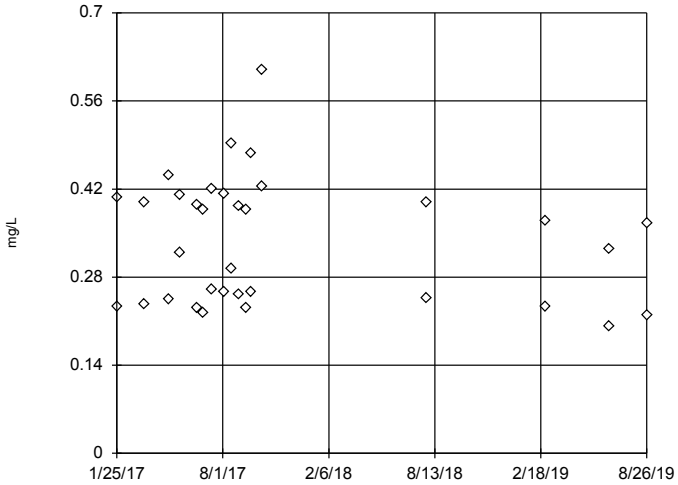
High cutoff = 0.1952, low cutoff = 1.8e-7, based on IQR multiplier of 3.

Constituent: Beryllium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1.34, low cutoff = 0.01787, based on IQR multiplier of 3.

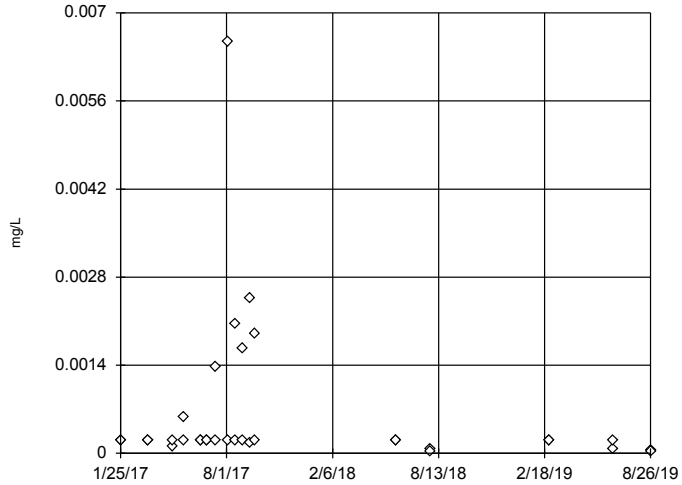
Constituent: Boron Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

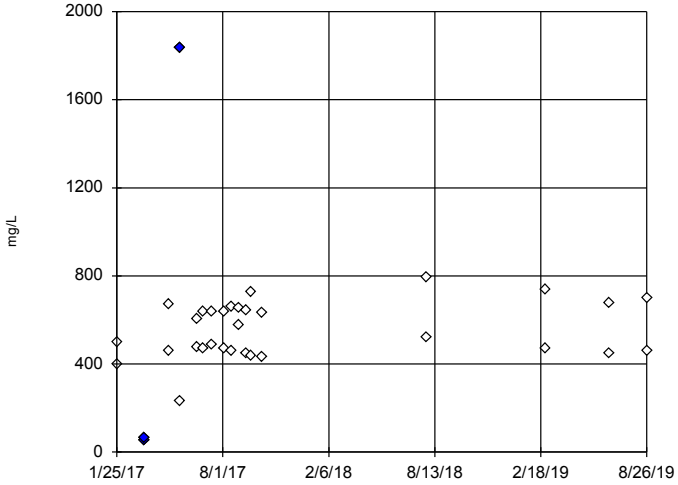
Constituent: Cadmium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

Outliers are drawn as solid.
Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1487, low cutoff = 69.92, based on IQR multiplier of 3.

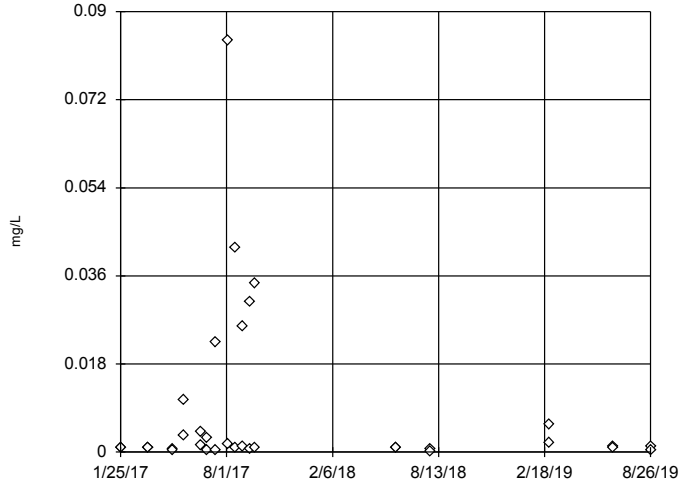
Constituent: Chloride Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

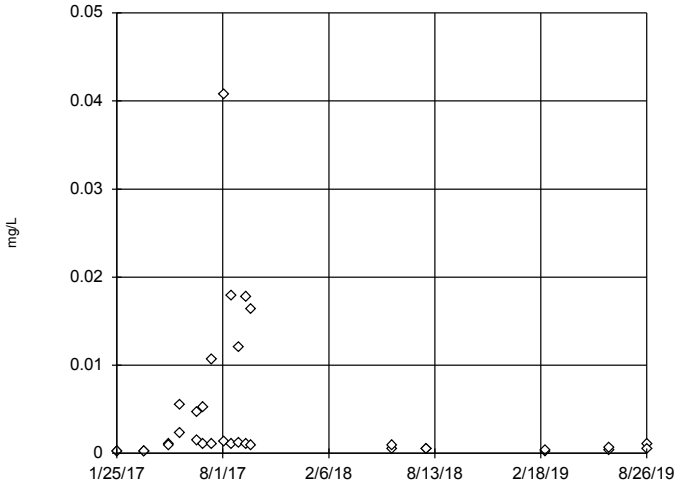
High cutoff = 1.453, low cutoff = 0.000002366, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 5.308, low cutoff = 4.5e-7, based on IQR multiplier of 3.

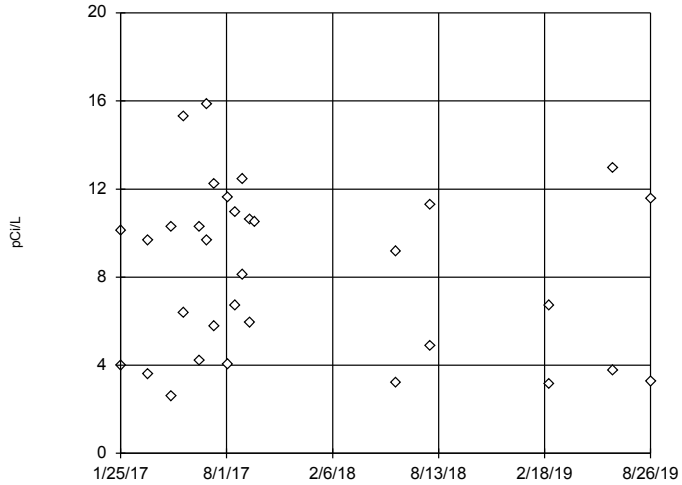
Constituent: Cobalt Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 33

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 32.17, low cutoff = -16.94, based on IQR multiplier of 3.

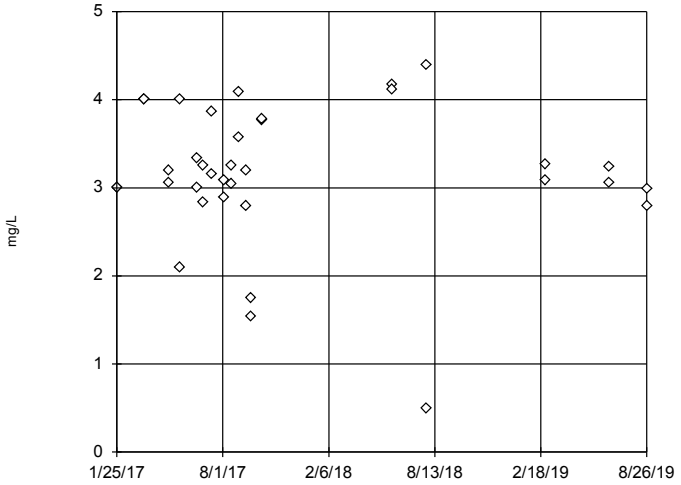
Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 36

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 5.492, low cutoff = -2.631, based on IQR multiplier of 3.

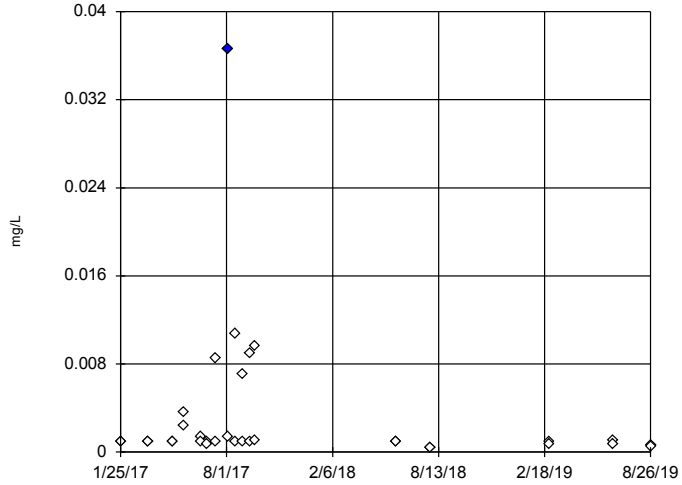
Constituent: Fluoride Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

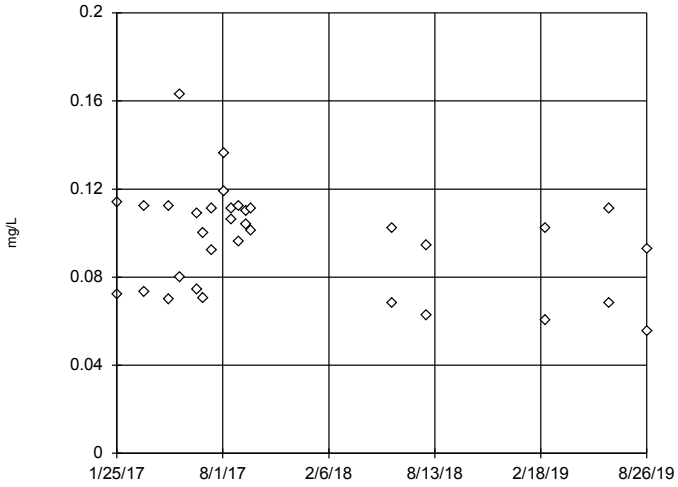
High cutoff = 0.01438, low cutoff = 0.0001192, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.2755, low cutoff = 0.00601, based on IQR multiplier of 3.

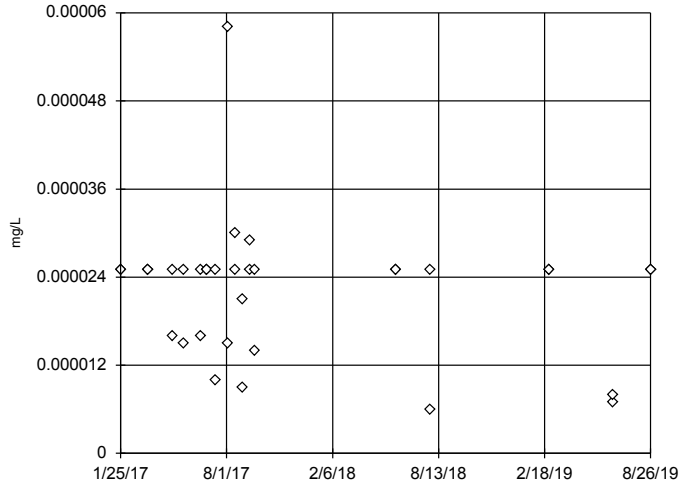
Constituent: Lithium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.00007499, low cutoff = 0.000001728, based on IQR multiplier of 3.

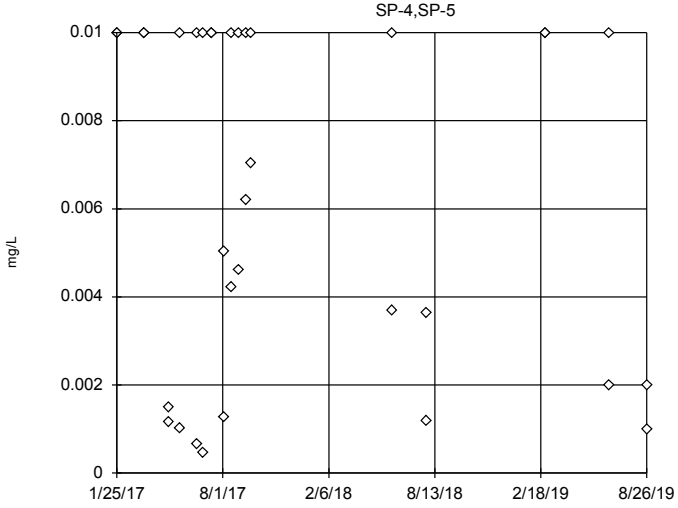
Constituent: Mercury Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1258, low cutoff = -0.004525, based on IQR multiplier of 3.

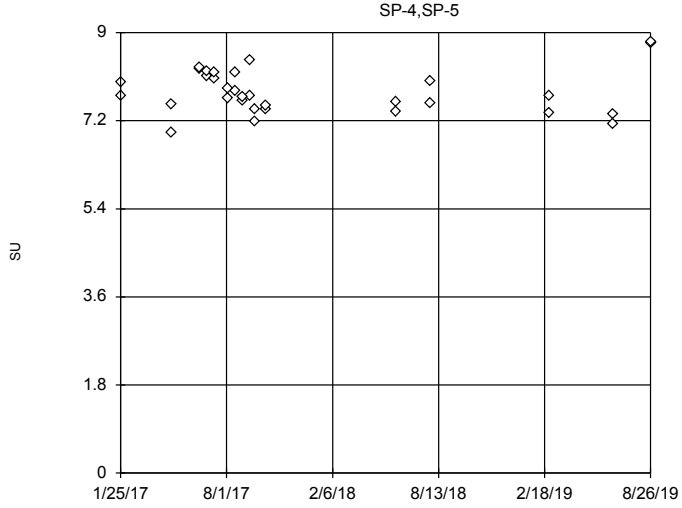
Constituent: Molybdenum Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 32

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

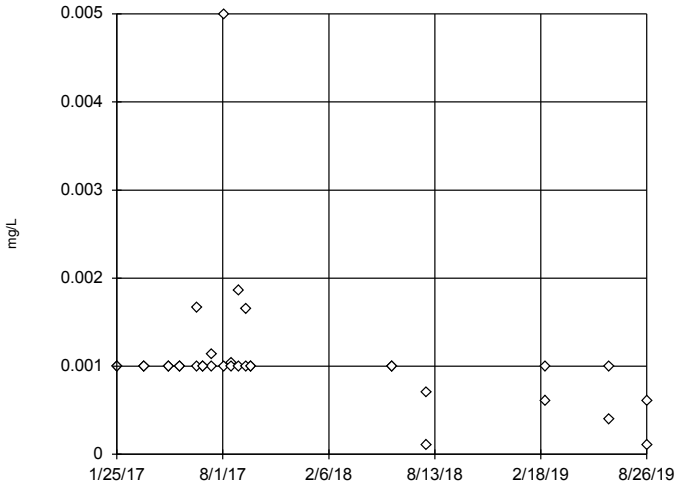
High cutoff = 10.49, low cutoff = 5.804, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

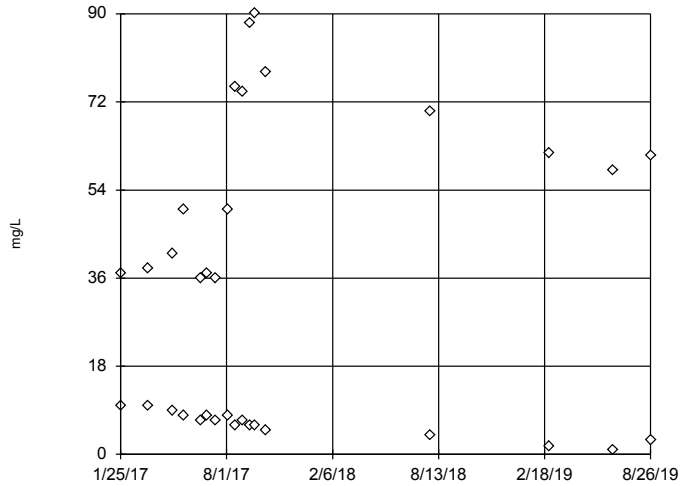
Constituent: Selenium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 45988, low cutoff = 0.008382, based on IQR multiplier of 3.

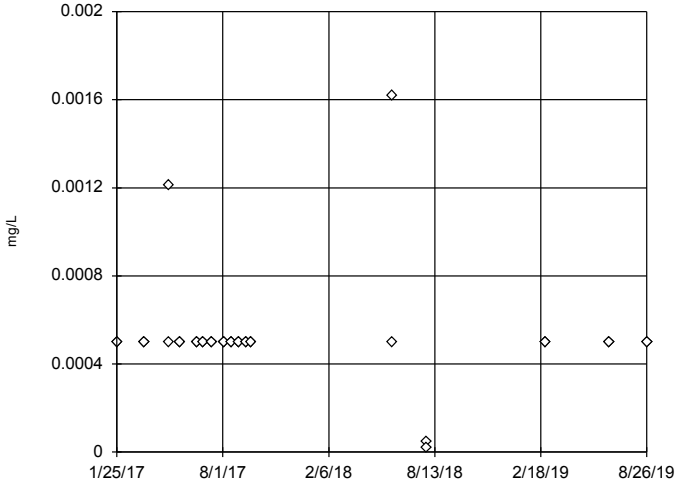
Constituent: Sulfate Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

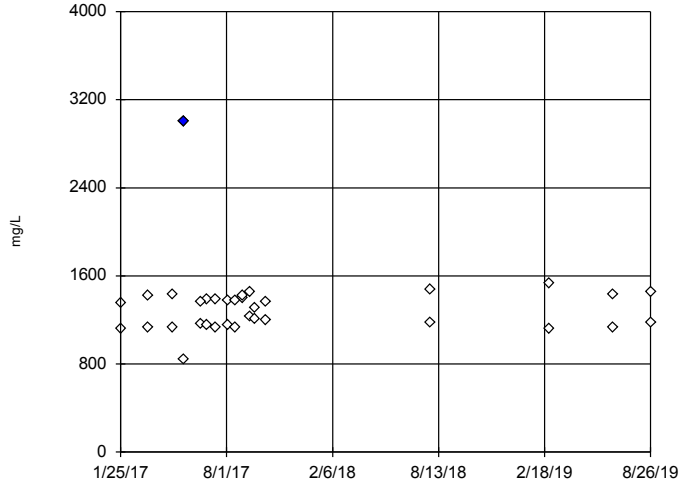
Constituent: Thallium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2753, low cutoff = 589.4, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Outlier Analysis - Significant Results

Northeastern BAP Client: Geosyntec Data: Northeastern BAP Printed 12/5/2019, 7:09 PM

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Combined Radium 226 + 228 (pCi/L)	**SP-1**	**Yes**	**14.29**	**NP**	**NaN**	**16**	**4.103**	**2.814**	**ln(x)**	**ShapiroWilk**

Outlier Analysis - All Results

Northeastern BAP Client: Geosyntec Data: Northeastern BAP Printed 12/5/2019, 7:09 PM

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony (mg/L)	SP-1	No	n/a	NP	NaN	16	0.003233	0.002181	x^(1/3)	ShapiroWilk
Antimony (mg/L)	SP-10	No	n/a	NP	NaN	13	0.002672	0.001941	ln(x)	ShapiroWilk
Antimony (mg/L)	SP-11	No	n/a	NP	NaN	13	0.003377	0.003125	x^(1/3)	ShapiroWilk
Antimony (mg/L)	SP-2	No	n/a	NP	NaN	16	0.003766	0.002879	ln(x)	ShapiroWilk
Arsenic (mg/L)	SP-1	No	n/a	NP	NaN	16	0.003415	0.001954	ln(x)	ShapiroWilk
Arsenic (mg/L)	SP-10	No	n/a	NP	NaN	13	0.006745	0.004118	ln(x)	ShapiroWilk
Arsenic (mg/L)	SP-11	No	n/a	NP	NaN	13	0.005585	0.003026	sqrt(x)	ShapiroWilk
Arsenic (mg/L)	SP-2	No	n/a	NP	NaN	16	0.003491	0.002932	ln(x)	ShapiroWilk
Barium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.2006	0.03818	ln(x)	ShapiroWilk
Barium (mg/L)	SP-10	No	n/a	NP	NaN	13	1.744	1.731	x^(1/3)	ShapiroWilk
Barium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.2556	0.169	ln(x)	ShapiroWilk
Barium (mg/L)	SP-2	No	n/a	NP	NaN	16	1.251	0.5881	ln(x)	ShapiroWilk
Beryllium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.0003881	0.0004295	ln(x)	ShapiroWilk
Beryllium (mg/L)	SP-10	No	n/a	NP	NaN	13	0.0002218	0.0002294	ln(x)	ShapiroWilk
Beryllium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.0002799	0.000199	sqrt(x)	ShapiroWilk
Beryllium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.0003344	0.0004011	ln(x)	ShapiroWilk
Cadmium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.000355	0.0001958	ln(x)	ShapiroWilk
Cadmium (mg/L)	SP-10	n/a	n/a	NP	NaN	13	0.0001731	0.00006575	unknown	ShapiroWilk
Cadmium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.0009385	0.001086	ln(x)	ShapiroWilk
Cadmium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.0003475	0.000205	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-1	No	n/a	NP	NaN	17	122.3	10.05	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-10	No	n/a	NP	NaN	13	93.32	58.74	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-11	No	n/a	NP	NaN	13	453.3	447.6	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-2	No	n/a	NP	NaN	16	107.1	35.8	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-4 (bg)	No	n/a	NP	NaN	17	400.9	478.9	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-5 (bg)	No	n/a	NP	NaN	17	67.18	24.87	ln(x)	ShapiroWilk
Chromium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.001149	0.0006792	ln(x)	ShapiroWilk
Chromium (mg/L)	SP-10	No	n/a	NP	NaN	13	0.01004	0.03012	ln(x)	ShapiroWilk
Chromium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.01025	0.01287	ln(x)	ShapiroWilk
Chromium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.001531	0.001234	x^(1/3)	ShapiroWilk
Cobalt (mg/L)	SP-1	No	n/a	NP	NaN	16	0.001367	0.001295	ln(x)	ShapiroWilk
Cobalt (mg/L)	SP-10	No	n/a	NP	NaN	13	0.002623	0.001741	x^(1/3)	ShapiroWilk
Cobalt (mg/L)	SP-11	No	n/a	NP	NaN	13	0.006188	0.004931	x^(1/3)	ShapiroWilk
Cobalt (mg/L)	SP-2	No	n/a	NP	NaN	16	0.001122	0.0008247	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	**SP-1**	**Yes**	**14.29**	**NP**	**NaN**	**16**	**4.103**	**2.814**	**ln(x)**	**ShapiroWilk**
Combined Radium 226 + 228 (pCi/L)	SP-10	No	n/a	NP	NaN	13	6.984	8.061	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	SP-11	No	n/a	NP	NaN	13	3.502	6.649	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	SP-2	No	n/a	NP	NaN	13	12.31	6.281	ln(x)	ShapiroWilk
Fluoride (mg/L)	SP-1	No	n/a	NP	NaN	17	0.9669	0.8403	ln(x)	ShapiroWilk
Fluoride (mg/L)	SP-10	No	n/a	NP	NaN	15	5.447	2.95	x^2	ShapiroWilk
Fluoride (mg/L)	SP-11	No	n/a	NP	NaN	15	3.185	0.8592	normal	ShapiroWilk
Fluoride (mg/L)	SP-2	No	n/a	NP	NaN	17	2.871	0.7089	x^2	ShapiroWilk
Lead (mg/L)	SP-1	No	n/a	NP	NaN	16	0.002924	0.002167	ln(x)	ShapiroWilk
Lead (mg/L)	SP-10	No	n/a	NP	NaN	13	0.001517	0.0007715	x^(1/3)	ShapiroWilk
Lead (mg/L)	SP-11	No	n/a	NP	NaN	13	0.003791	0.00305	sqrt(x)	ShapiroWilk
Lead (mg/L)	SP-2	No	n/a	NP	NaN	16	0.003164	0.002194	ln(x)	ShapiroWilk
Lithium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.007072	0.006362	ln(x)	ShapiroWilk
Lithium (mg/L)	SP-10	No	n/a	NP	NaN	13	0.2841	0.02877	x^3	ShapiroWilk
Lithium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.08066	0.03839	x^(1/3)	ShapiroWilk
Lithium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.07643	0.02586	x^3	ShapiroWilk
Mercury (mg/L)	SP-1	n/a	n/a	NP	NaN	16	0.00002194	0.000006277	unknown	ShapiroWilk
Mercury (mg/L)	SP-10	No	n/a	NP	NaN	13	0.00001762	0.000007974	normal	ShapiroWilk
Mercury (mg/L)	SP-11	No	n/a	NP	NaN	13	0.00002062	0.00001449	ln(x)	ShapiroWilk
Mercury (mg/L)	SP-2	No	n/a	NP	NaN	16	0.00002069	0.000007939	normal	ShapiroWilk
Molybdenum (mg/L)	SP-1	No	n/a	NP	NaN	16	0.01242	0.004984	normal	ShapiroWilk

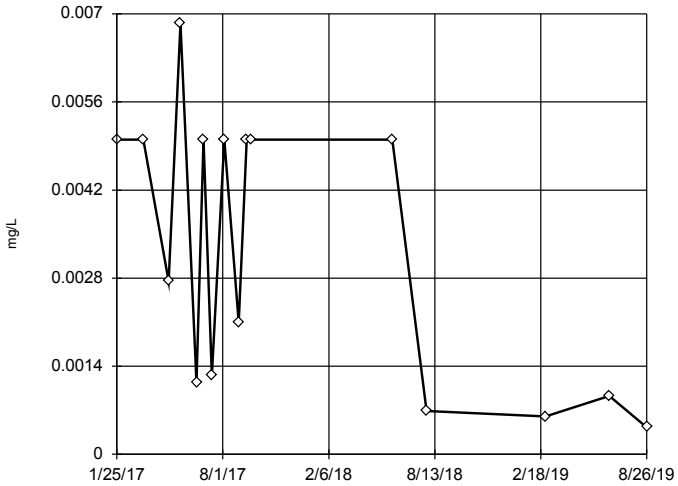
Outlier Analysis - All Results

Northeastern BAP Client: Geosyntec Data: Northeastern BAP Printed 12/5/2019, 7:09 PM

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Molybdenum (mg/L)	SP-10	No	n/a	NP	NaN	13	0.09942	0.2528	ln(x)	ShapiroWilk
Molybdenum (mg/L)	SP-11	No	n/a	NP	NaN	13	0.03278	0.02353	x^2	ShapiroWilk
Molybdenum (mg/L)	SP-2	No	n/a	NP	NaN	16	0.02792	0.007558	normal	ShapiroWilk
Selenium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.005163	0.002543	ln(x)	ShapiroWilk
Selenium (mg/L)	SP-10	No	n/a	NP	NaN	13	0.002548	0.00244	x^(1/3)	ShapiroWilk
Selenium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.003052	0.002409	x^(1/3)	ShapiroWilk
Selenium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.01075	0.01048	ln(x)	ShapiroWilk
Thallium (mg/L)	SP-1	n/a	n/a	NP	NaN	16	0.001693	0.000682	unknown	ShapiroWilk
Thallium (mg/L)	SP-10	n/a	n/a	NP	NaN	13	0.0004646	0.0001276	unknown	ShapiroWilk
Thallium (mg/L)	SP-11	n/a	n/a	NP	NaN	13	0.0004638	0.0001304	unknown	ShapiroWilk
Thallium (mg/L)	SP-2	n/a	n/a	NP	NaN	16	0.00176	0.0006558	unknown	ShapiroWilk

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.05525, low cutoff = -0.001289, based on IQR multiplier of 3.

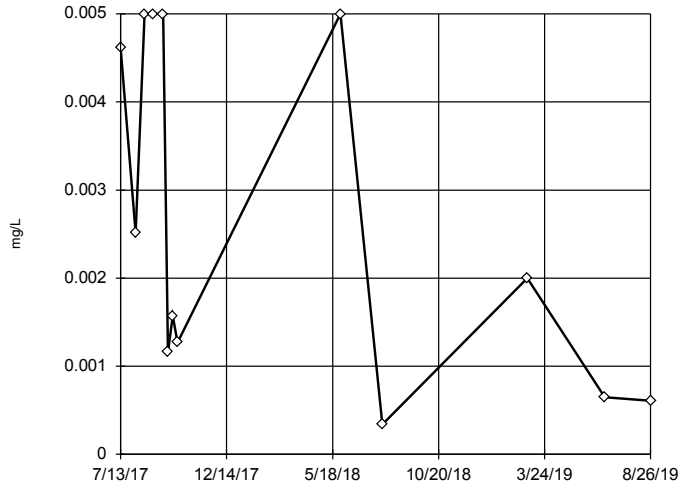
Constituent: Antimony Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.9546, low cutoff = 0.000004548, based on IQR multiplier of 3.

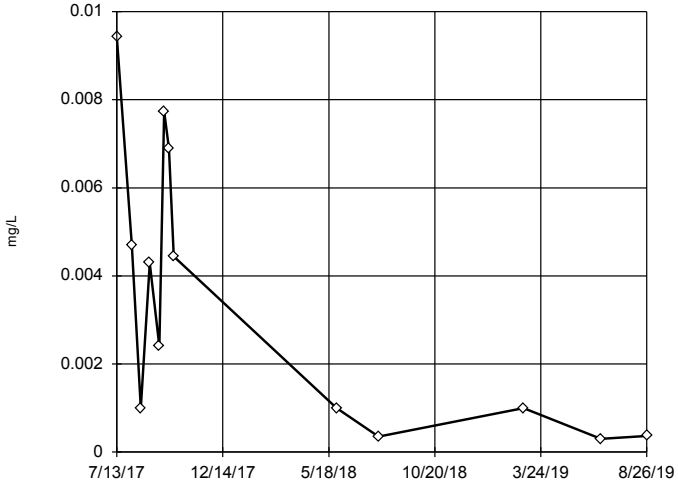
Constituent: Antimony Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.09601, low cutoff = -0.007201, based on IQR multiplier of 3.

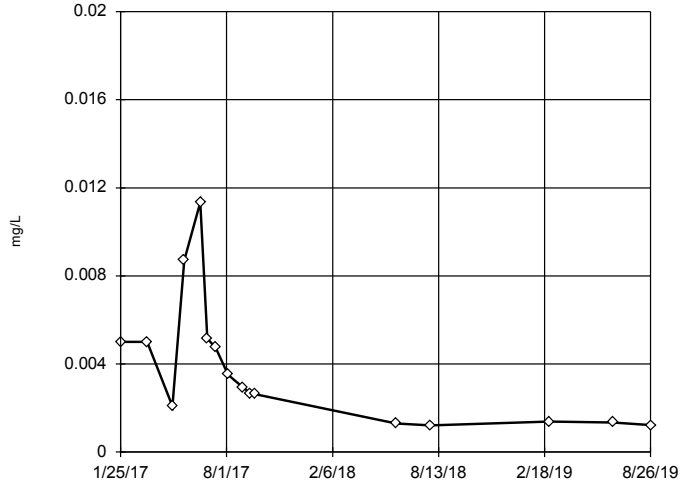
Constituent: Antimony Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

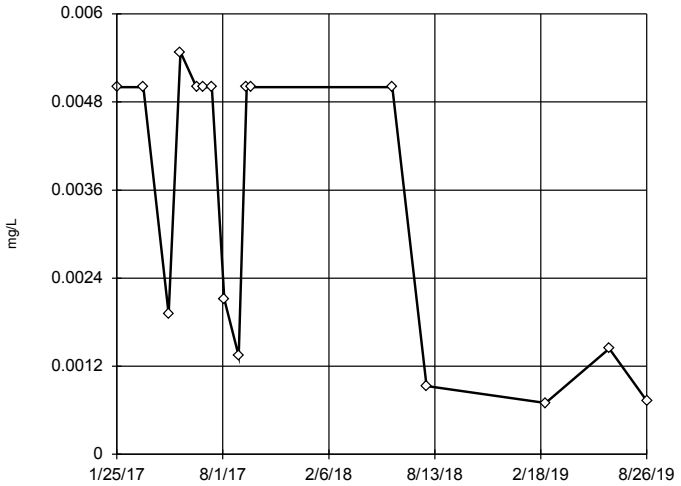
High cutoff = 0.2459, low cutoff = 0.00002775, based on IQR multiplier of 3.

Constituent: Antimony Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.2332, low cutoff = 0.00002979, based on IQR multiplier of 3.

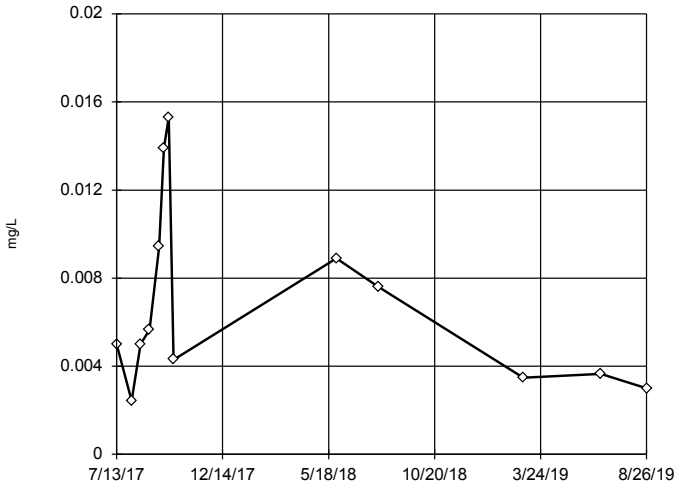
Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1546, low cutoff = 0.0002113, based on IQR multiplier of 3.

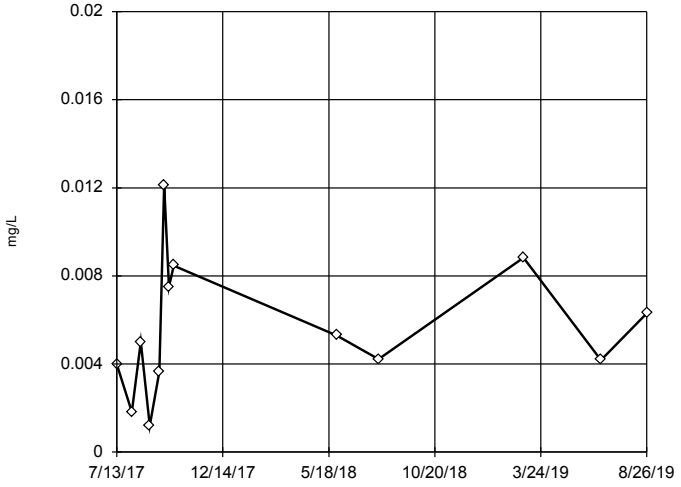
Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.02951, low cutoff = -0.0004253, based on IQR multiplier of 3.

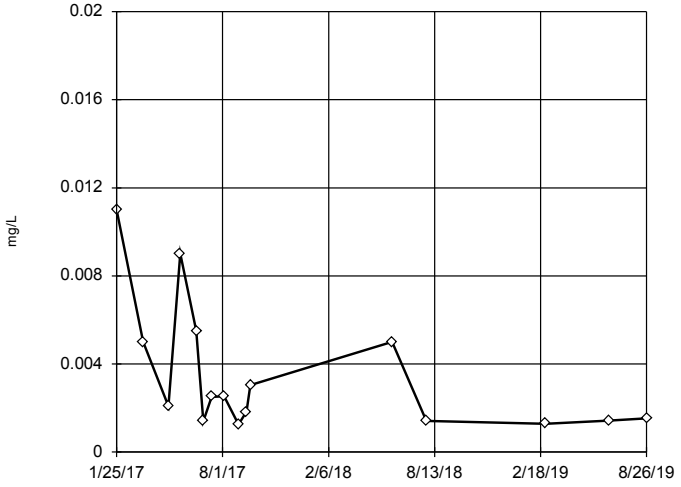
Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

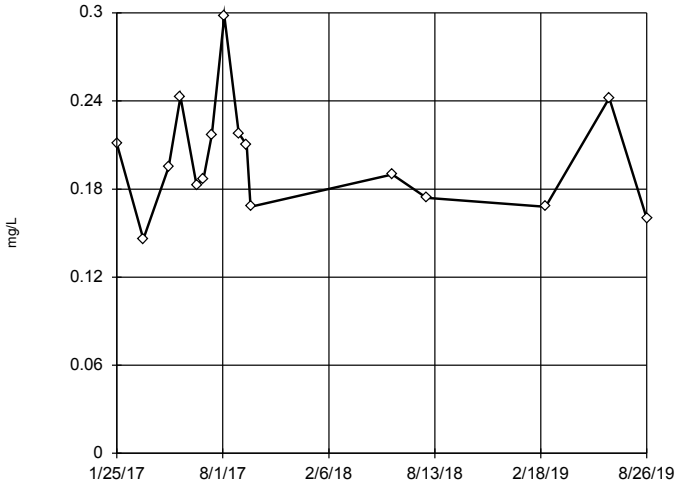
High cutoff = 0.216, low cutoff = 0.00003299, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.4478, low cutoff = 0.08305, based on IQR multiplier of 3.

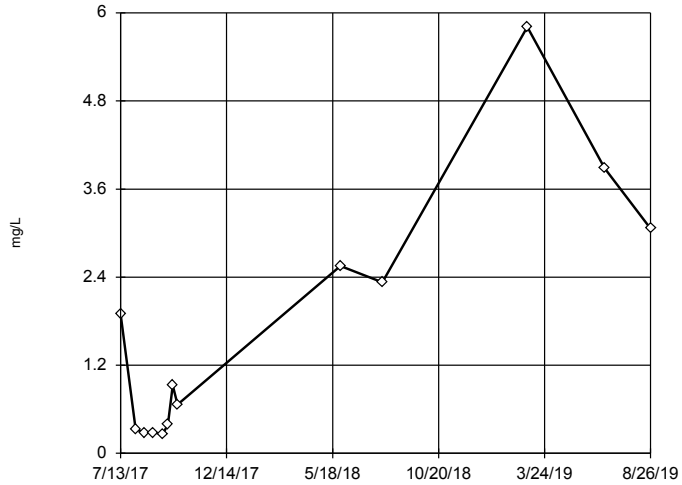
Constituent: Barium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 47.27, low cutoff = -3.605, based on IQR multiplier of 3.

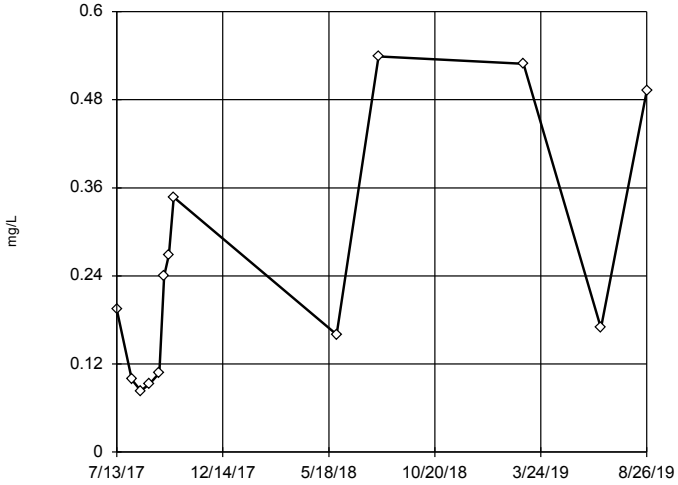
Constituent: Barium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 26.47, low cutoff = 0.001612, based on IQR multiplier of 3.

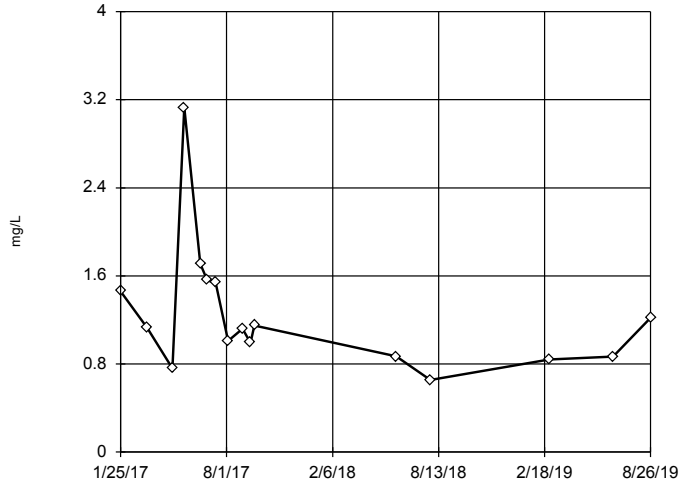
Constituent: Barium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

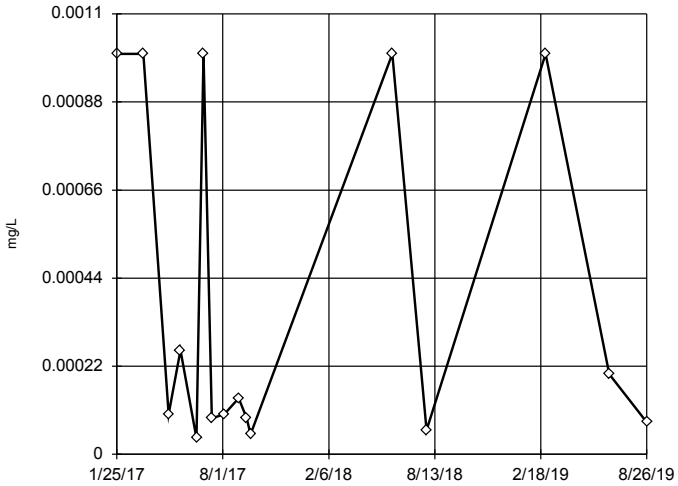
High cutoff = 7.717, low cutoff = 0.1688, based on IQR multiplier of 3.

Constituent: Barium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1.637, low cutoff = 5.2e-8, based on IQR multiplier of 3.

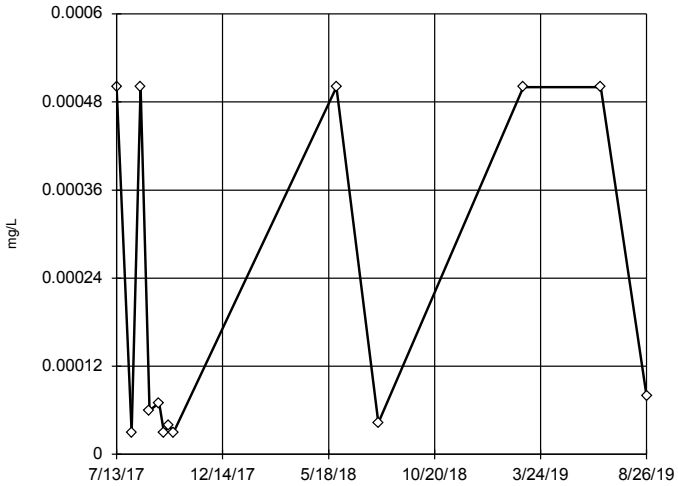
Constituent: Beryllium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1.504, low cutoff = 1.2e-8, based on IQR multiplier of 3.

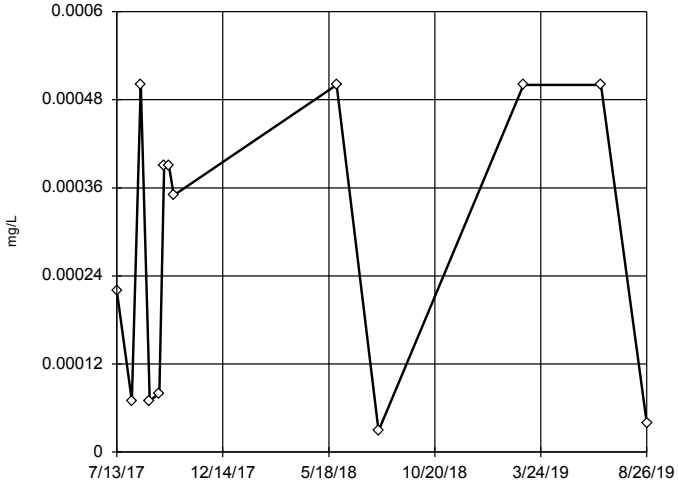
Constituent: Beryllium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.00414, low cutoff = -0.00113, based on IQR multiplier of 3.

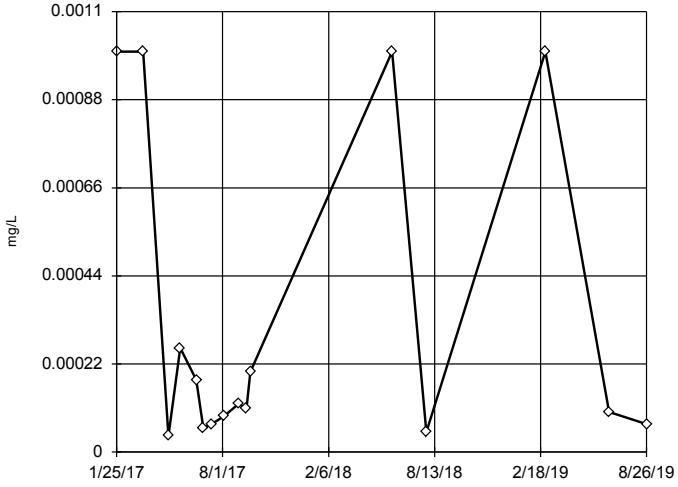
Constituent: Beryllium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

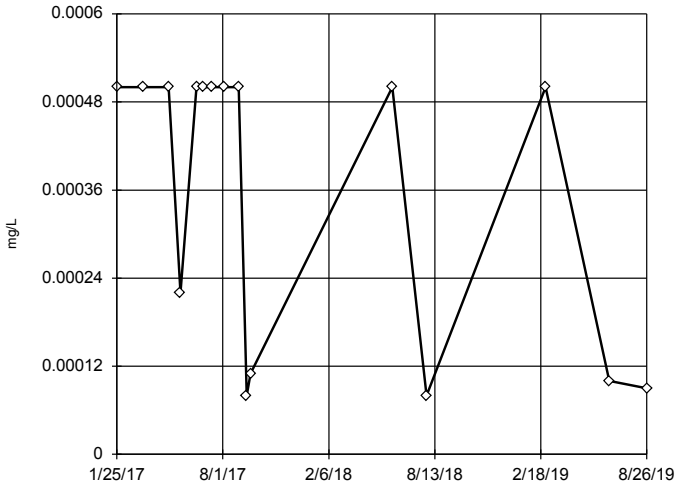
High cutoff = 0.1971, low cutoff = 1.8e-7, based on IQR multiplier of 3.

Constituent: Beryllium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.05417, low cutoff = 9.7e-7, based on IQR multiplier of 3.

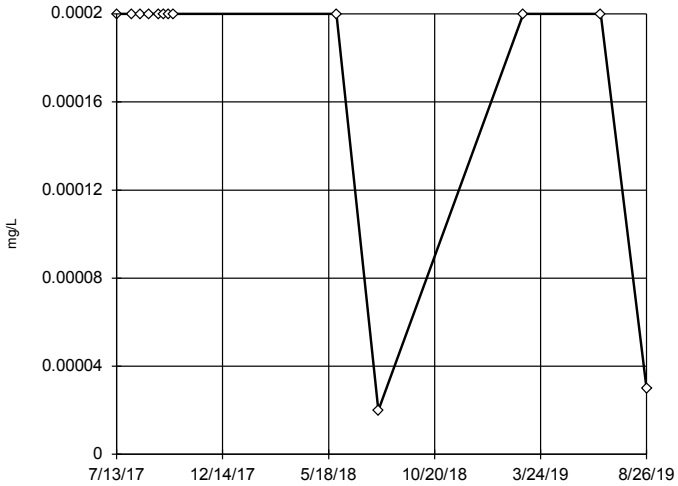
Constituent: Cadmium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

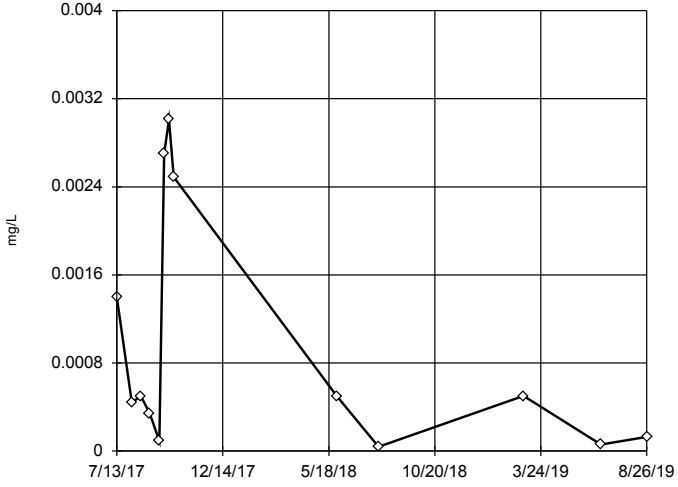
Constituent: Cadmium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 9.602, low cutoff = 2.1e-8, based on IQR multiplier of 3.

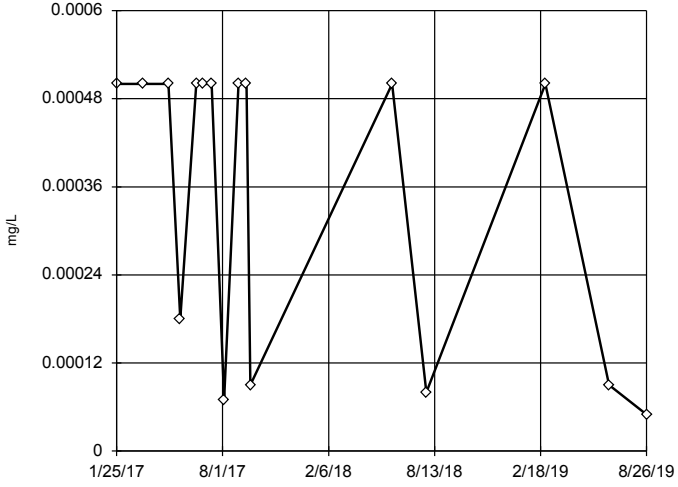
Constituent: Cadmium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

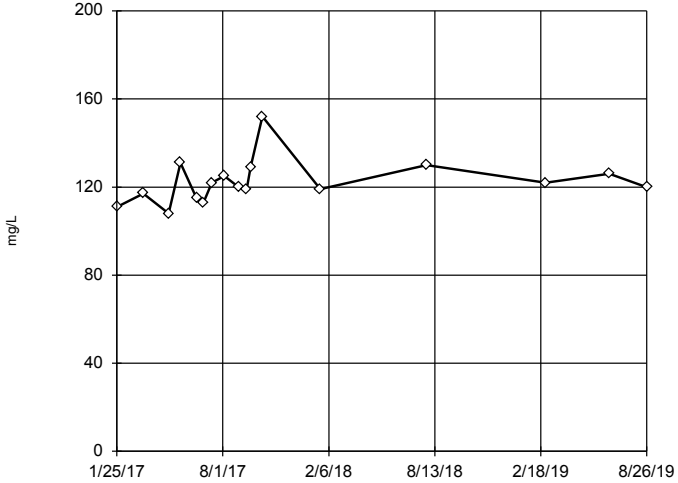
High cutoff = 0.08573, low cutoff = 5.2e-7, based on IQR multiplier of 3.

Constituent: Cadmium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



n = 17

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 169.3, low cutoff = 87.36, based on IQR multiplier of 3.

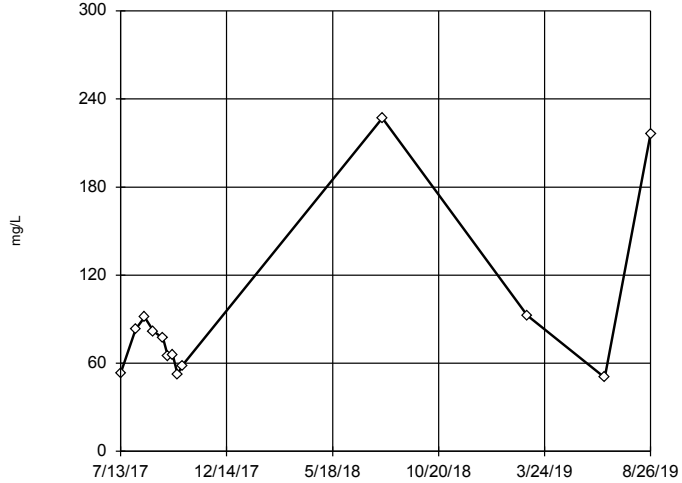
Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 416, low cutoff = 12.3, based on IQR multiplier of 3.

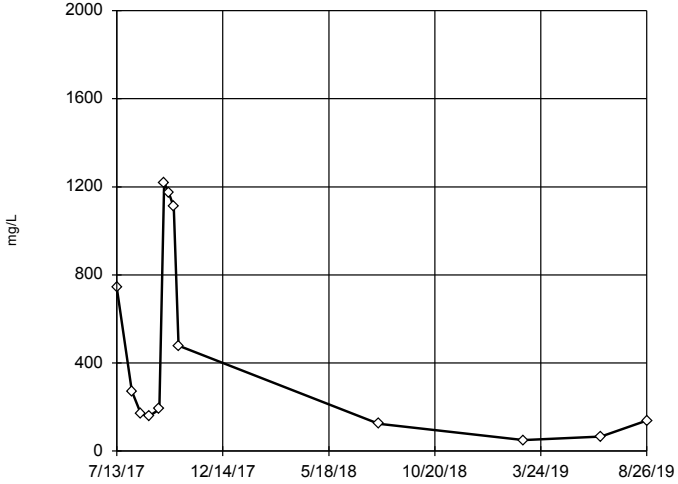
Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 299778, low cutoff = 0.3975, based on IQR multiplier of 3.

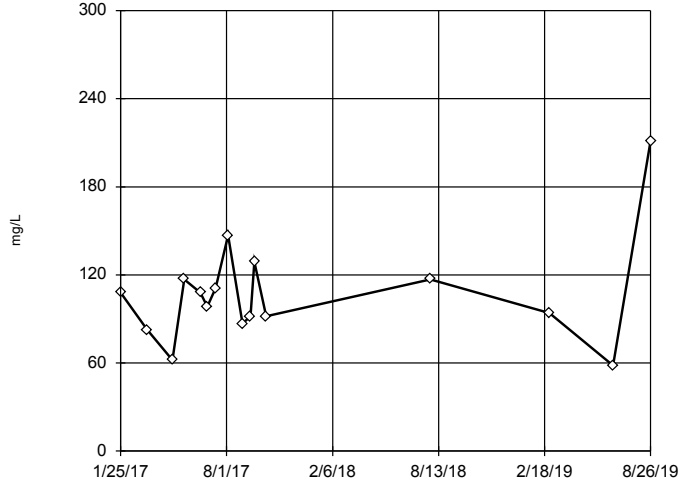
Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

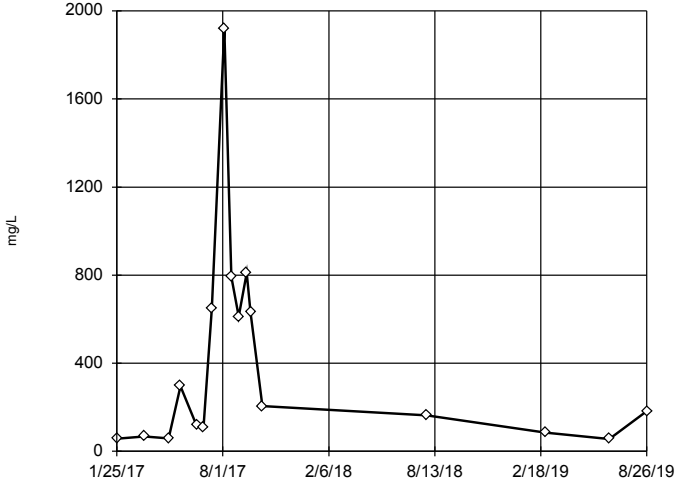
High cutoff = 263.5, low cutoff = 39.64, based on IQR multiplier of 3.

Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-4 (bg)



n = 17

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 383715, low cutoff = 0.1261, based on IQR multiplier of 3.

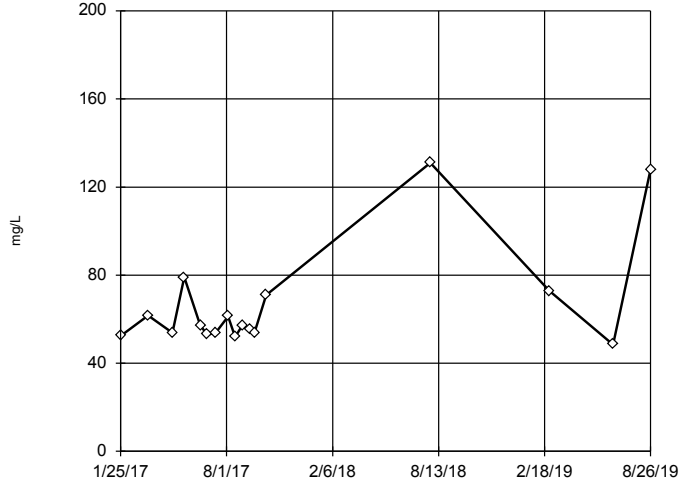
Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-5 (bg)



n = 17

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 176, low cutoff = 21.8, based on IQR multiplier of 3.

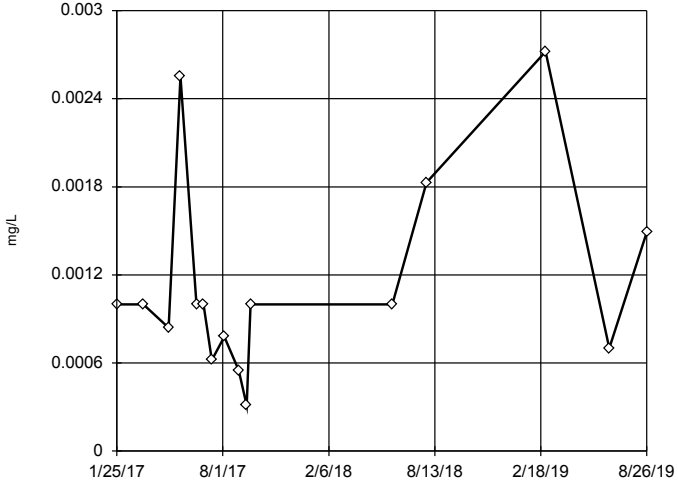
Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.005503, low cutoff = 0.0001639, based on IQR multiplier of 3.

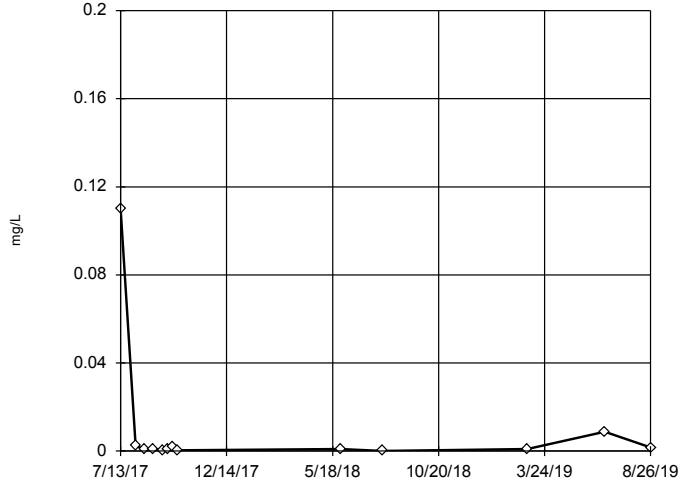
Constituent: Chromium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

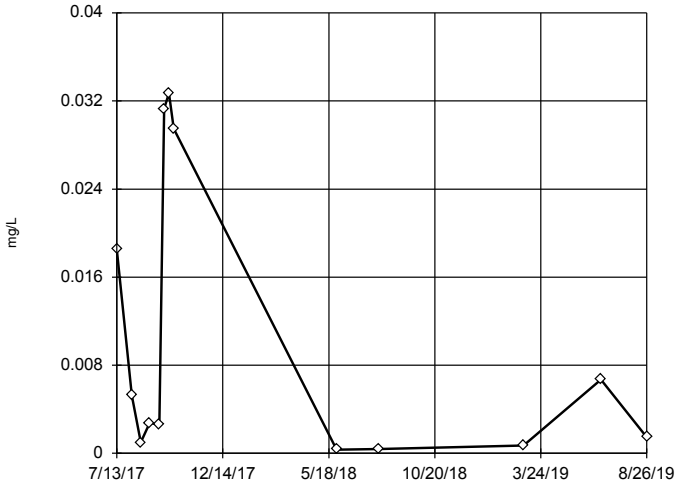
High cutoff = 0.1338, low cutoff = 0.000009664, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 509.3, low cutoff = 3.8e-8, based on IQR multiplier of 3.

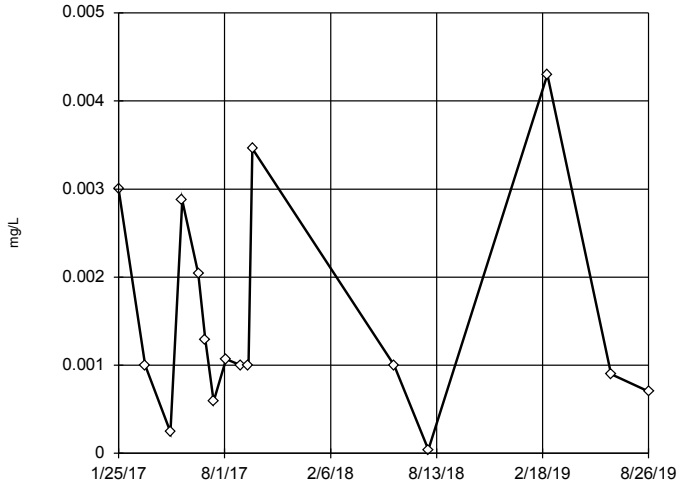
Constituent: Chromium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.01754, low cutoff = -0.00003478, based on IQR multiplier of 3.

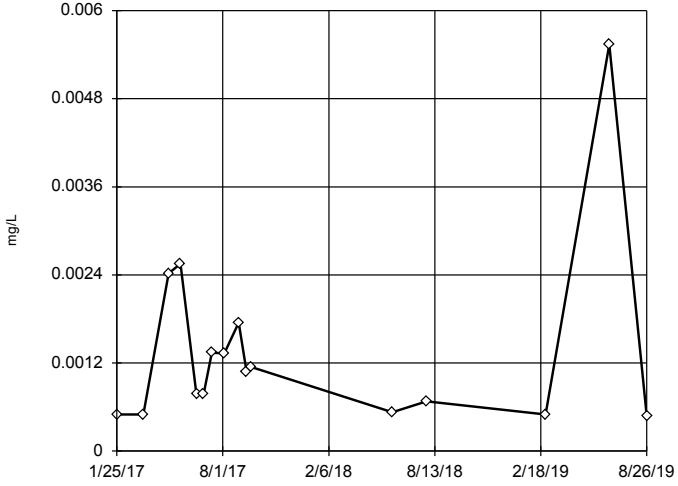
Constituent: Chromium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.04031, low cutoff = 0.00001956, based on IQR multiplier of 3.

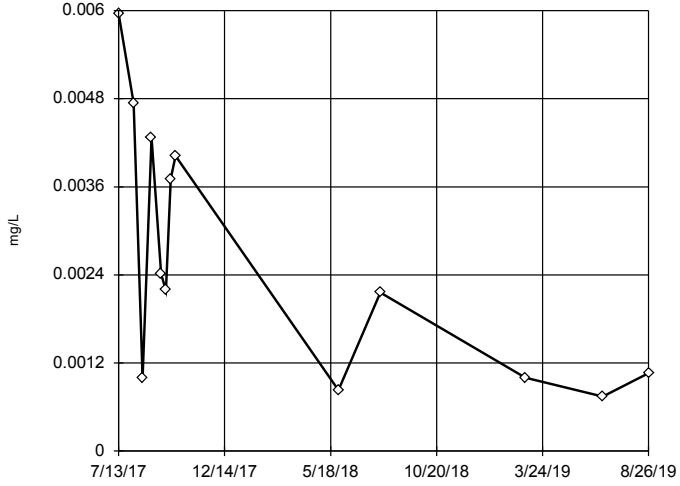
Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

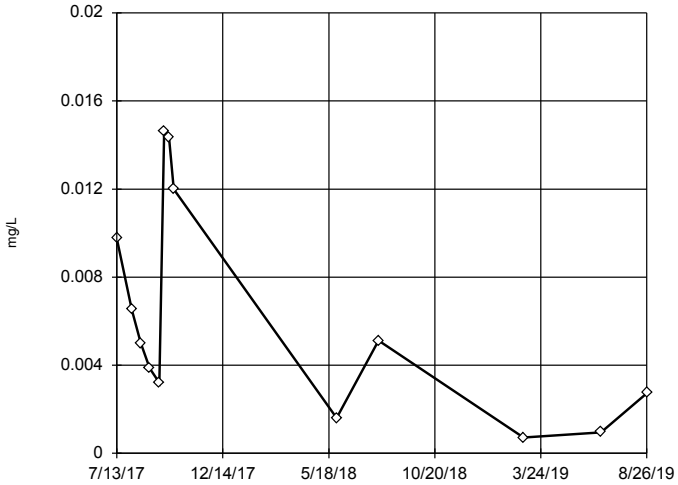
High cutoff = 0.04017, low cutoff = -0.0005485, based on IQR multiplier of 3.

Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1248, low cutoff = -0.003371, based on IQR multiplier of 3.

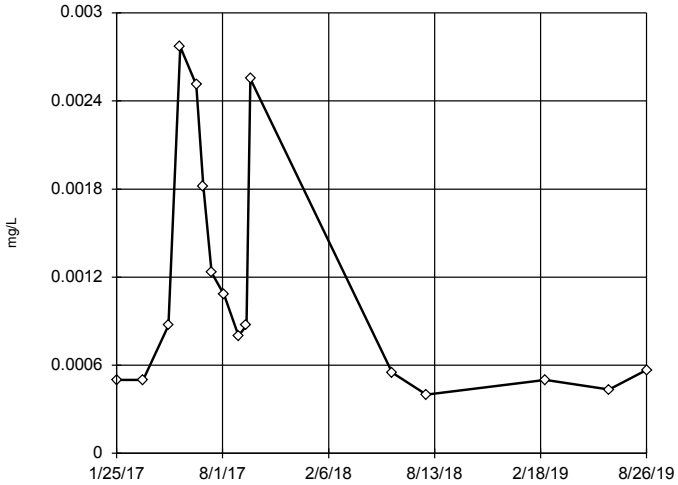
Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.04009, low cutoff = 0.00001866, based on IQR multiplier of 3.

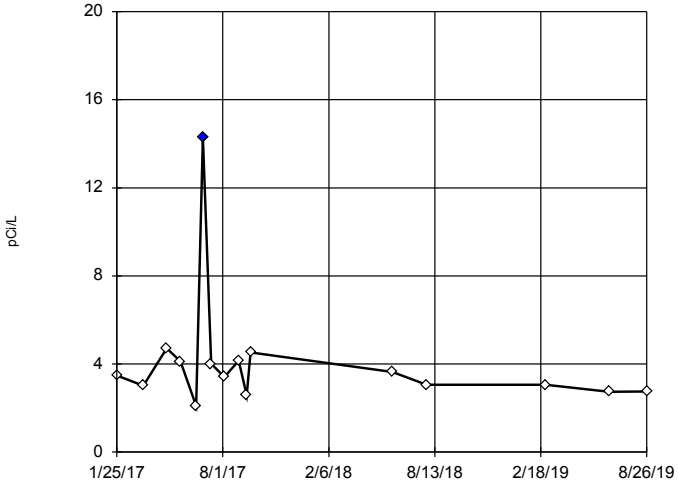
Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 12.25, low cutoff = 0.9717, based on IQR multiplier of 3.

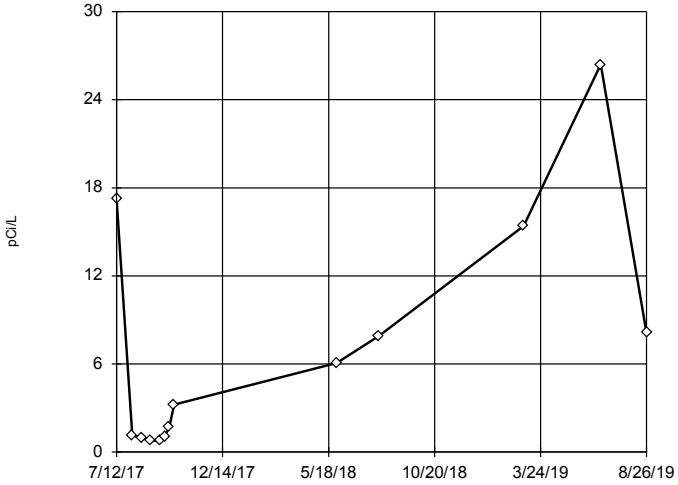
Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

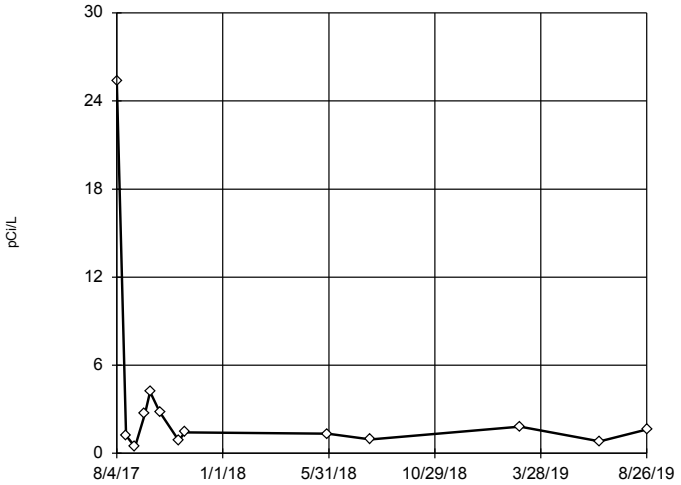
High cutoff = 14360, low cutoff = 0.0008, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 77.88, low cutoff = 0.03186, based on IQR multiplier of 3.

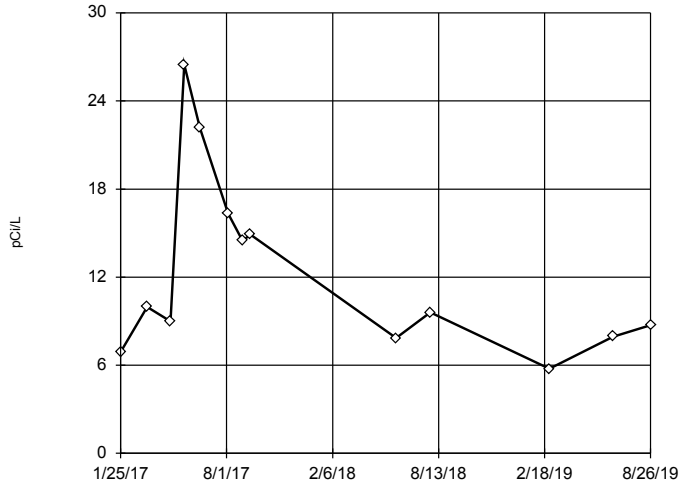
Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 120.3, low cutoff = 1.024, based on IQR multiplier of 3.

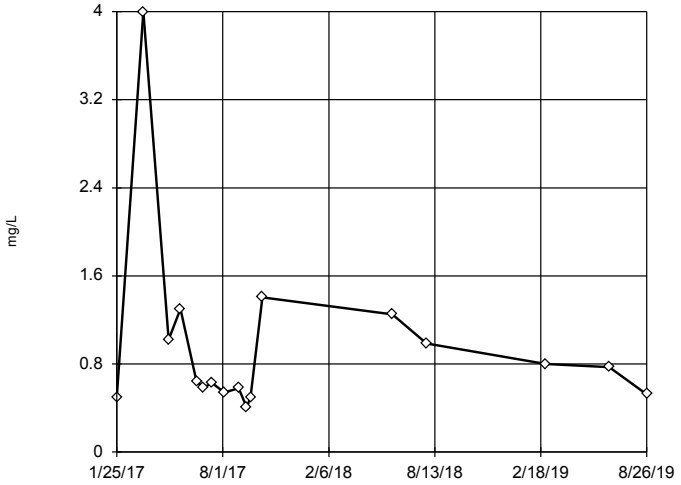
Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 17

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 10.71, low cutoff = 0.05624, based on IQR multiplier of 3.

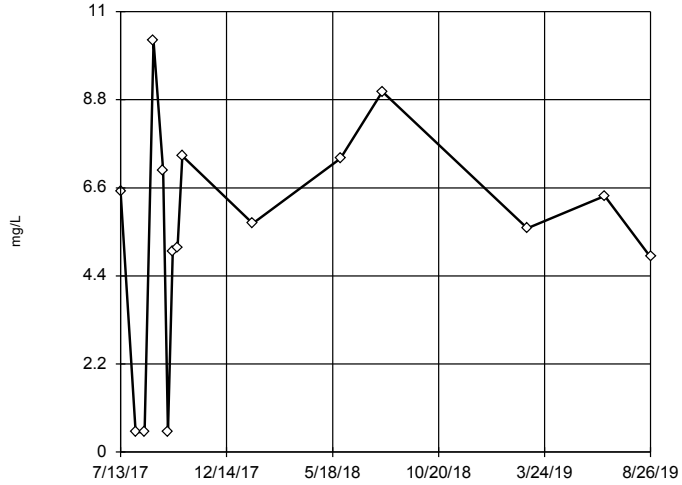
Constituent: Fluoride Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 15

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

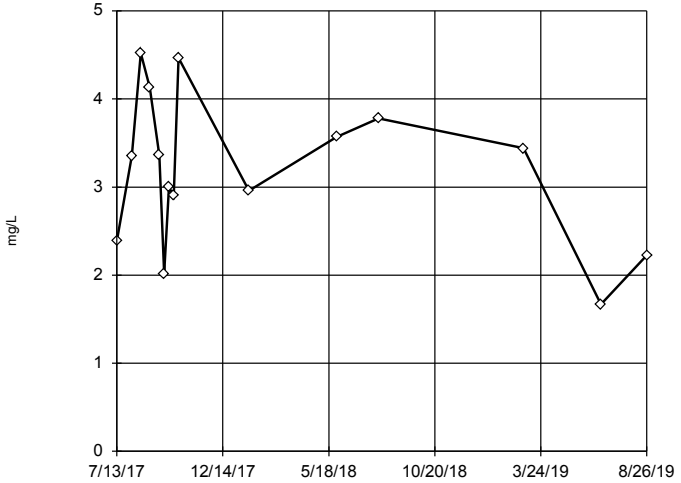
High cutoff = 11.99, low cutoff = -8.134, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 15

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 7.962, low cutoff = -1.796, based on IQR multiplier of 3.

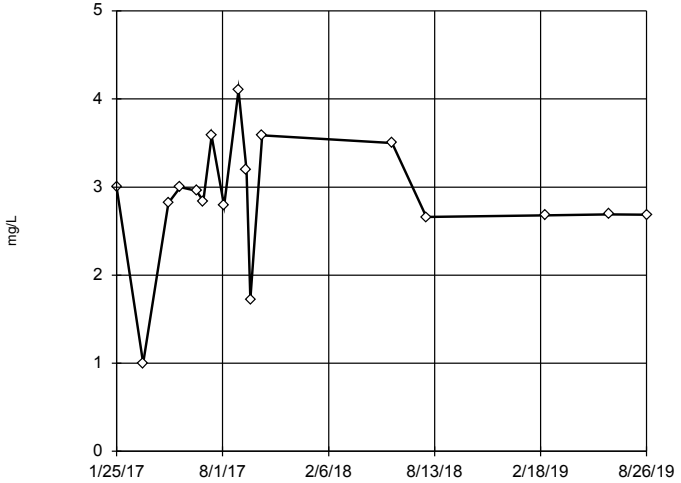
Constituent: Fluoride Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 17

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 4.831, low cutoff = -2.217, based on IQR multiplier of 3.

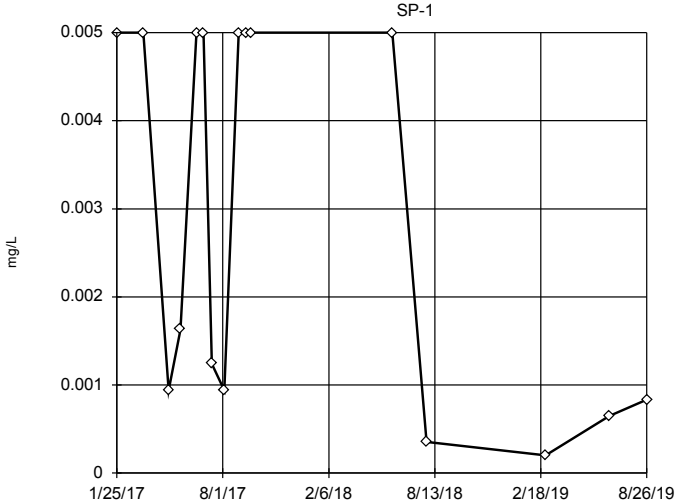
Constituent: Fluoride Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.8988, low cutoff = 0.000004929, based on IQR multiplier of 3.

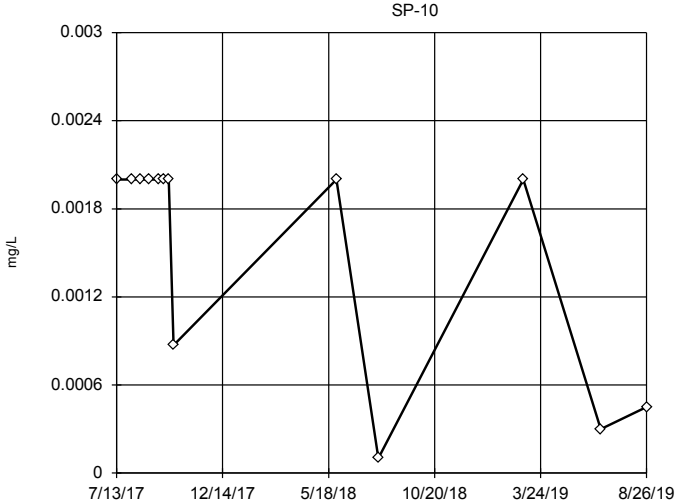
Constituent: Lead Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

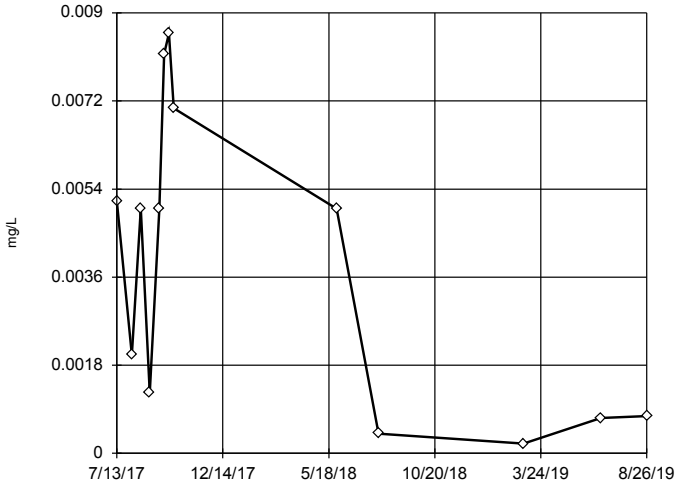
High cutoff = 0.01487, low cutoff = -0.00003896, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.05286, low cutoff = -0.01557, based on IQR multiplier of 3.

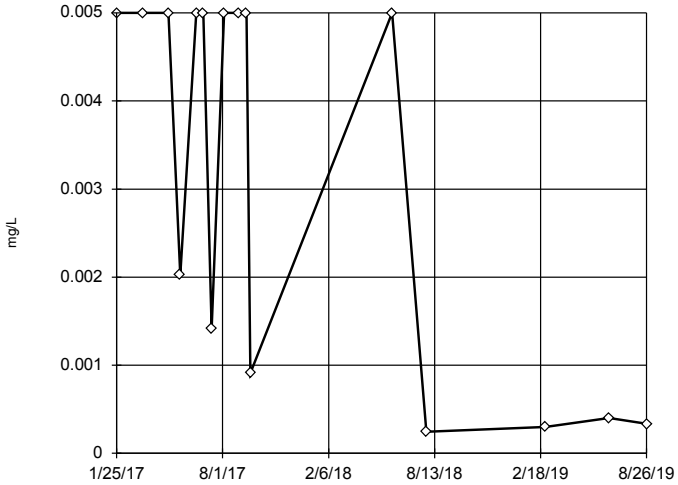
Constituent: Lead Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2.846, low cutoff = 0.00000106, based on IQR multiplier of 3.

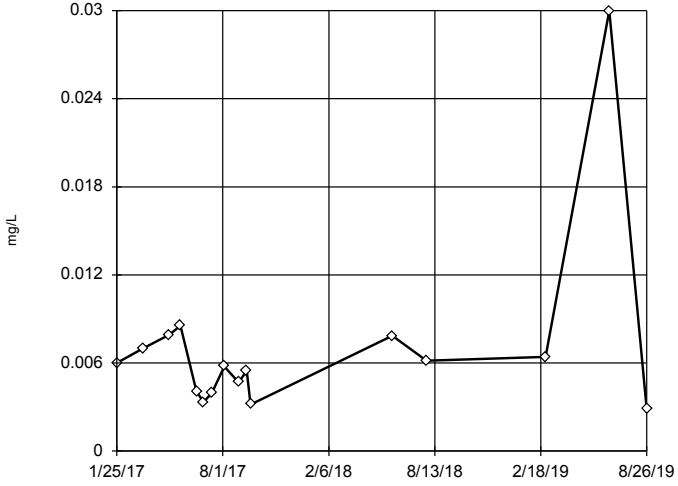
Constituent: Lead Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.04684, low cutoff = 0.0006345, based on IQR multiplier of 3.

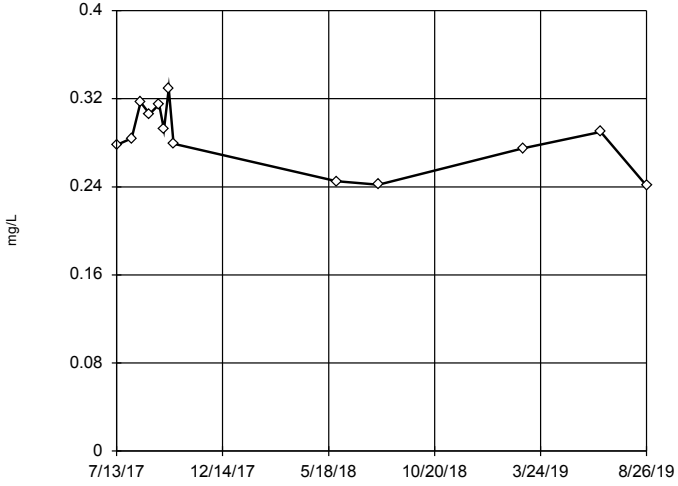
Constituent: Lithium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

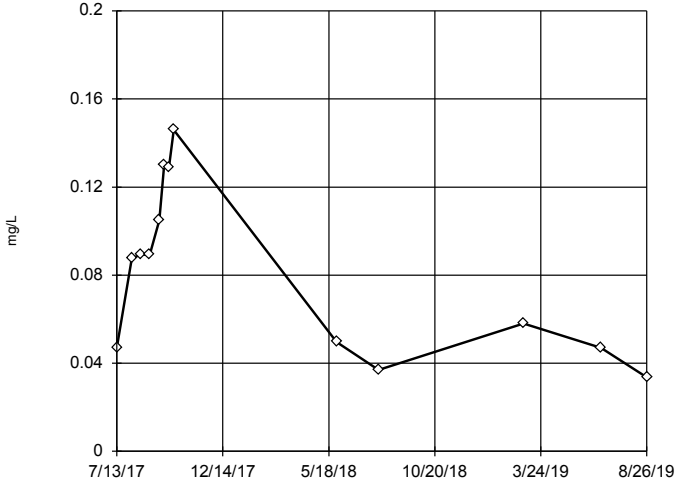
High cutoff = 0.4053, low cutoff = -0.2662, based on IQR multiplier of 3.

Constituent: Lithium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.662, low cutoff = -0.00001086, based on IQR multiplier of 3.

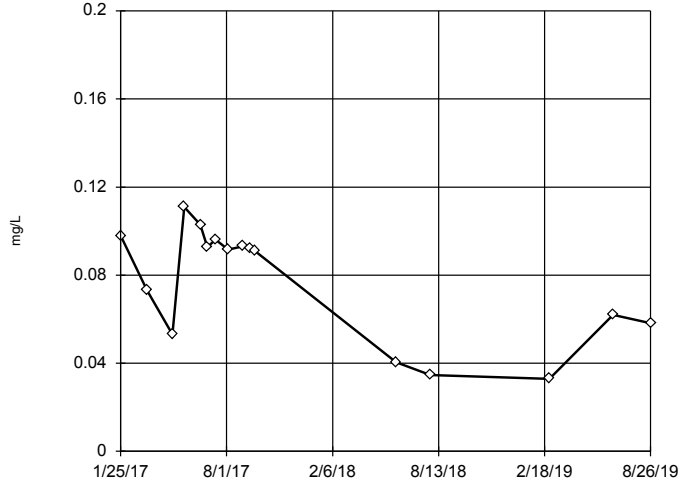
Constituent: Lithium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1421, low cutoff = -0.1227, based on IQR multiplier of 3.

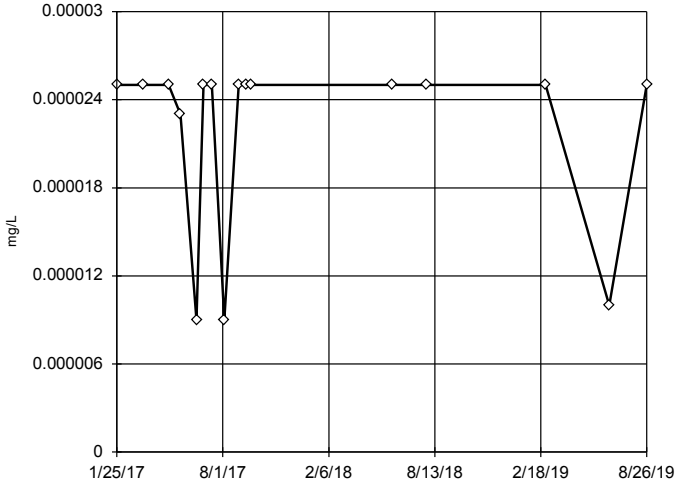
Constituent: Lithium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because both the lower and upper quartiles represent reporting limits.

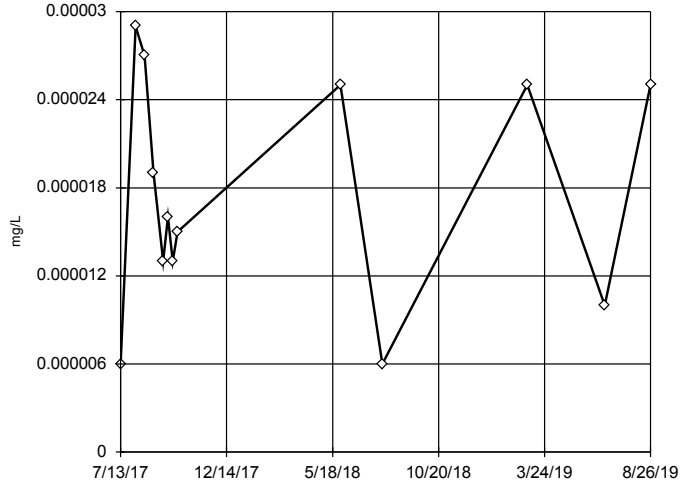
Constituent: Mercury Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

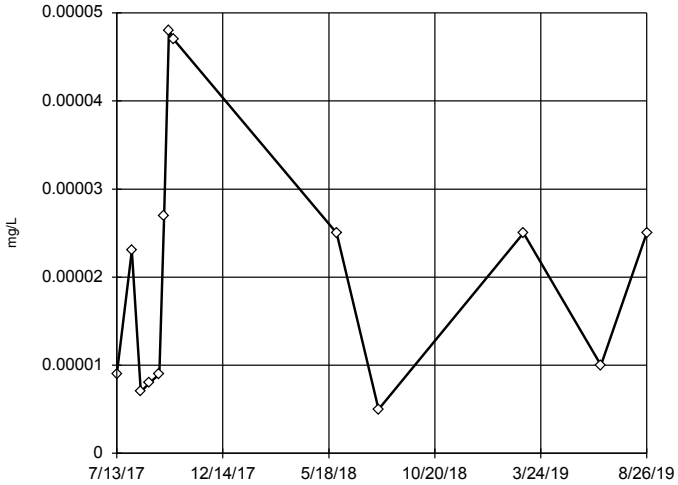
High cutoff = 0.0000655, low cutoff = -0.000029, based on IQR multiplier of 3.

Constituent: Mercury Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.0007458, low cutoff = 3.0e-7, based on IQR multiplier of 3.

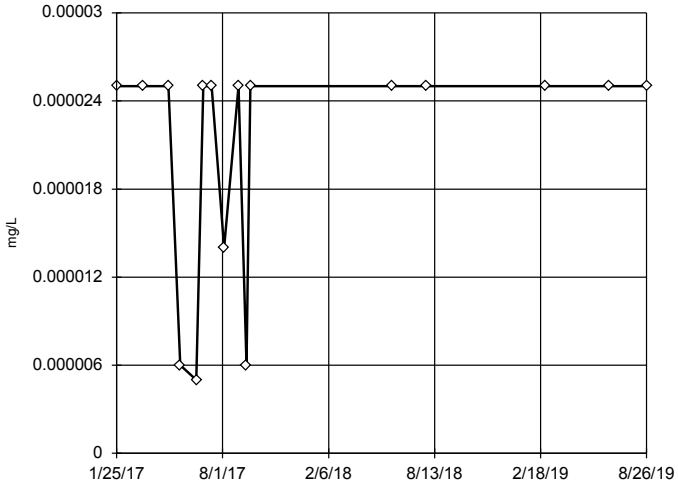
Constituent: Mercury Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.0000415, low cutoff = 0.000003, based on IQR multiplier of 3.

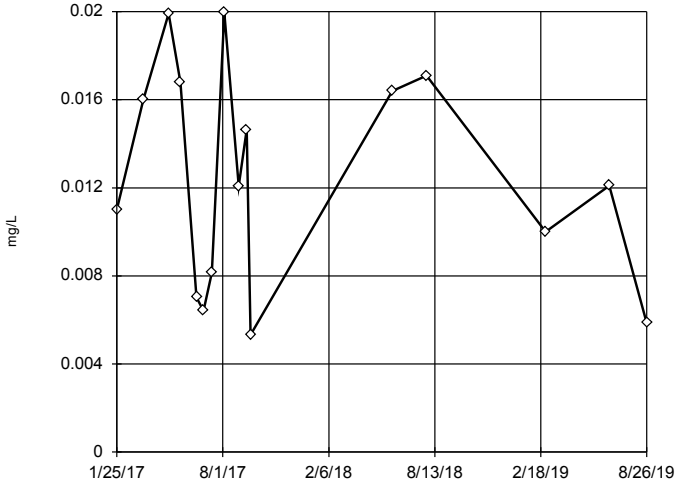
Constituent: Mercury Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.0436, low cutoff = -0.01944, based on IQR multiplier of 3.

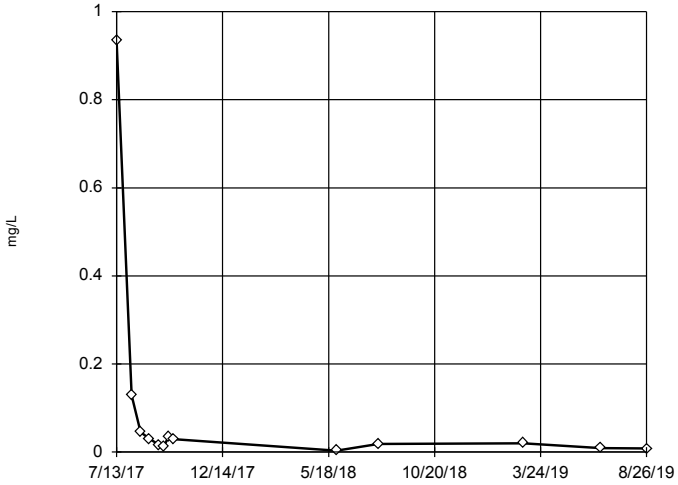
Constituent: Molybdenum Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1.972, low cutoff = 0.0002265, based on IQR multiplier of 3.

Constituent: Molybdenum Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11

n = 13

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

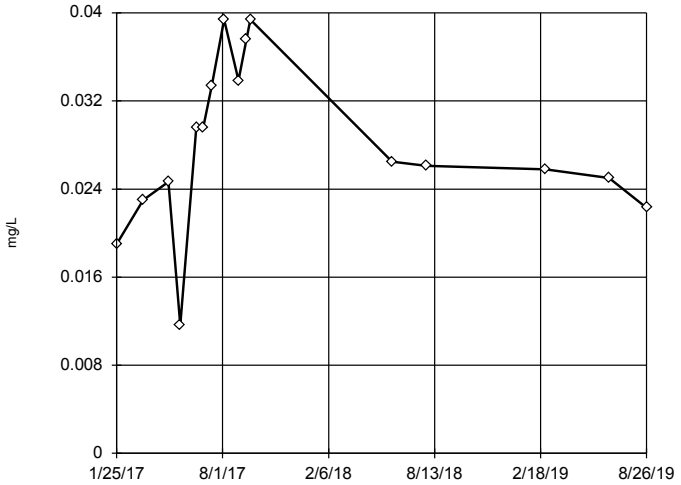
High cutoff = 0.09964, low cutoff = -0.08594, based on IQR multiplier of 3.

Constituent: Molybdenum Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

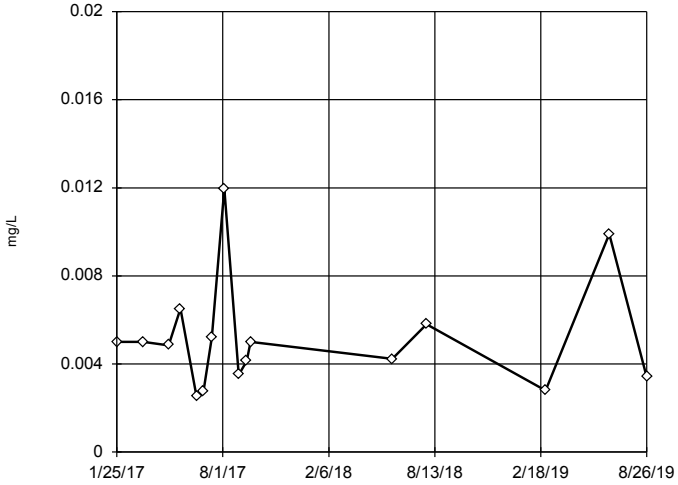
High cutoff = 0.06286, low cutoff = -0.00543, based on IQR multiplier of 3.

Constituent: Molybdenum Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

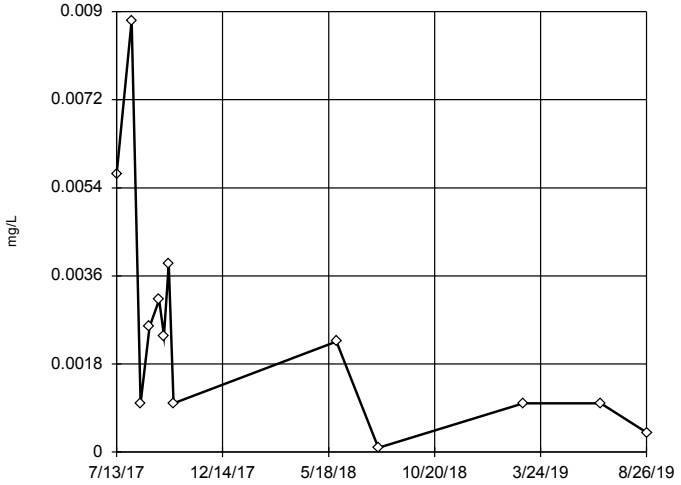
High cutoff = 0.02215, low cutoff = 0.0008574, based on IQR multiplier of 3.

Constituent: Selenium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

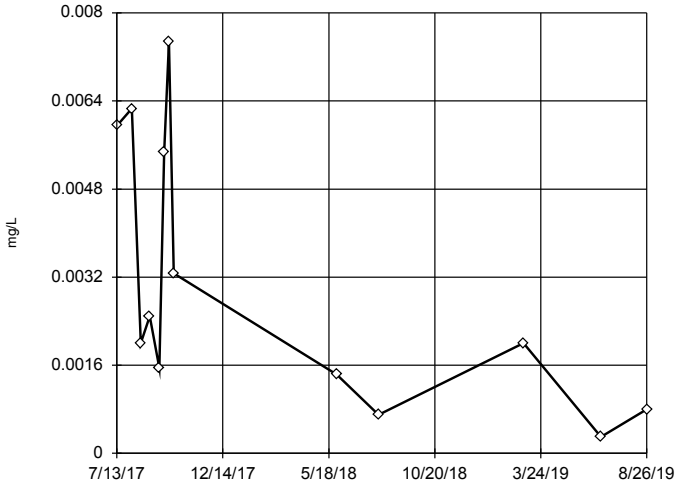
High cutoff = 0.02841, low cutoff = -0.0001561, based on IQR multiplier of 3.

Constituent: Selenium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.0671, low cutoff = -0.001951, based on IQR multiplier of 3.

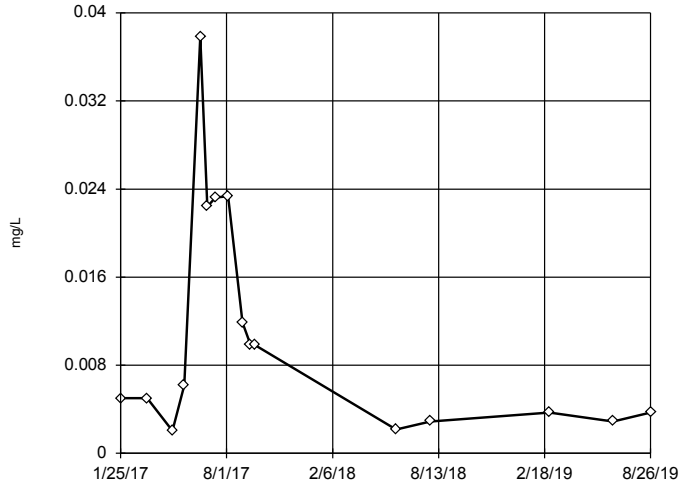
Constituent: Selenium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2.01, low cutoff = 0.00002657, based on IQR multiplier of 3.

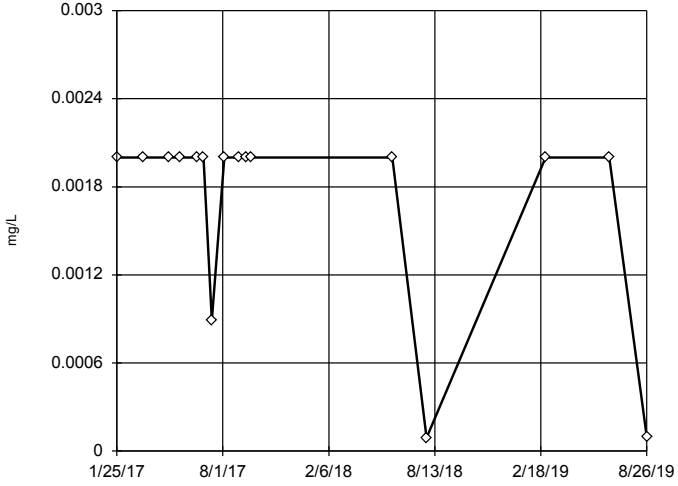
Constituent: Selenium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

The results were invalidated, because both the lower and upper quartiles represent reporting limits.

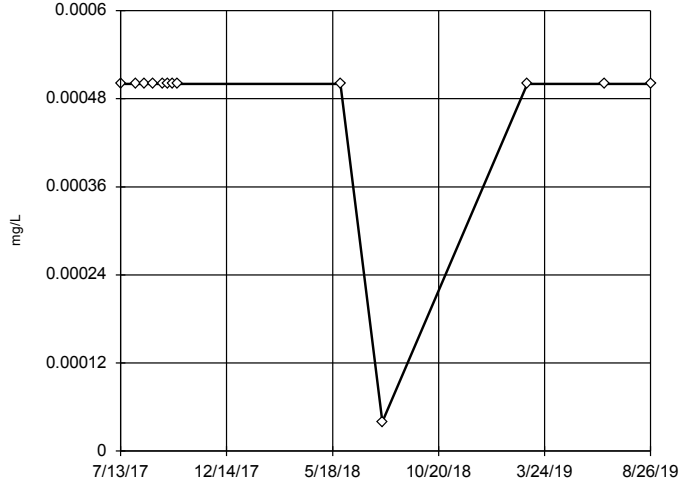
Constituent: Thallium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

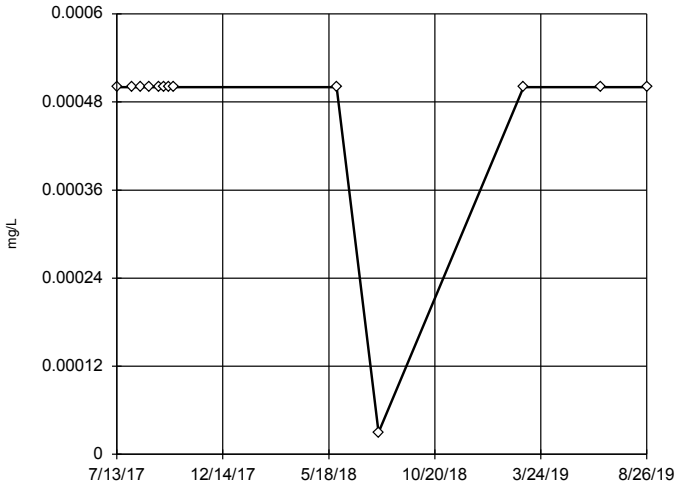
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

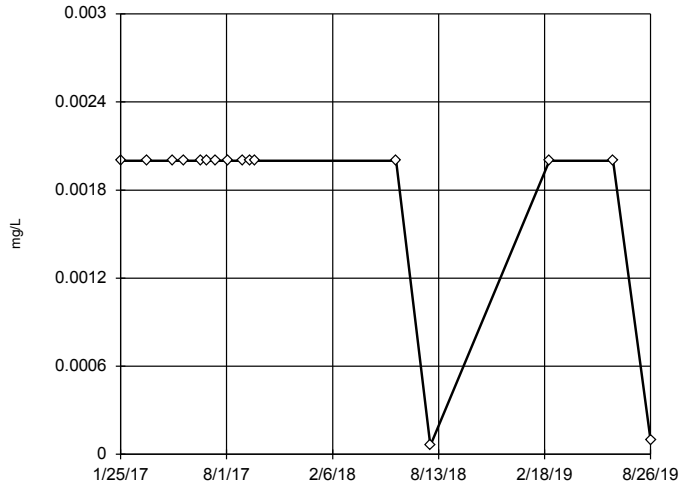
Constituent: Thallium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

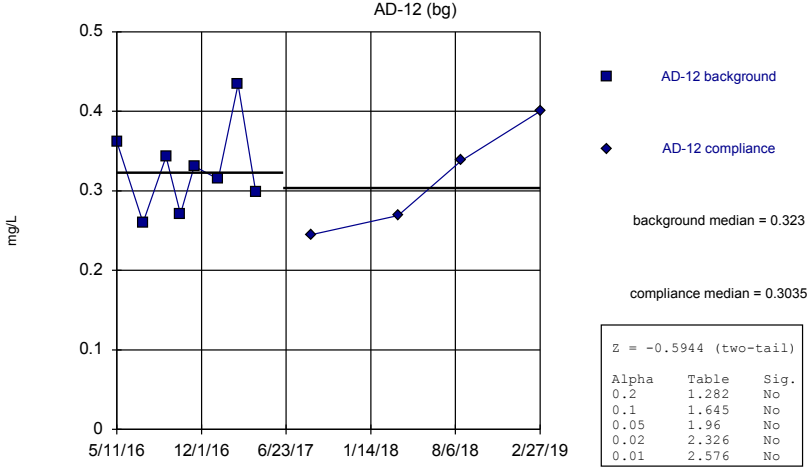
Welch's t-test/Mann-Whitney - All Results (No Significant Results)

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 7:57 AM

Constituent	Well	Calc.	0.01	Method
Calcium, total (mg/L)	AD-12 (bg)	-0.5944	No	Mann-W
Calcium, total (mg/L)	AD-13 (bg)	1.953	No	Mann-W
Calcium, total (mg/L)	AD-22	0.5131	No	Mann-W
Calcium, total (mg/L)	AD-33	-1.537	No	Mann-W
Calcium, total (mg/L)	AD-7	0.6587	No	Mann-W
pH, field (SU)	AD-12 (bg)	1.613	No	Mann-W
pH, field (SU)	AD-13 (bg)	0.5944	No	Mann-W
pH, field (SU)	AD-22	0.7656	No	Mann-W
pH, field (SU)	AD-33	1.104	No	Mann-W
pH, field (SU)	AD-7	-0.4246	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-1.361	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-13 (bg)	-1.79	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-22	0.2932	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-33	-2.278	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-7	-1.248	No	Mann-W

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



Z = -0.5944 (two-tail)

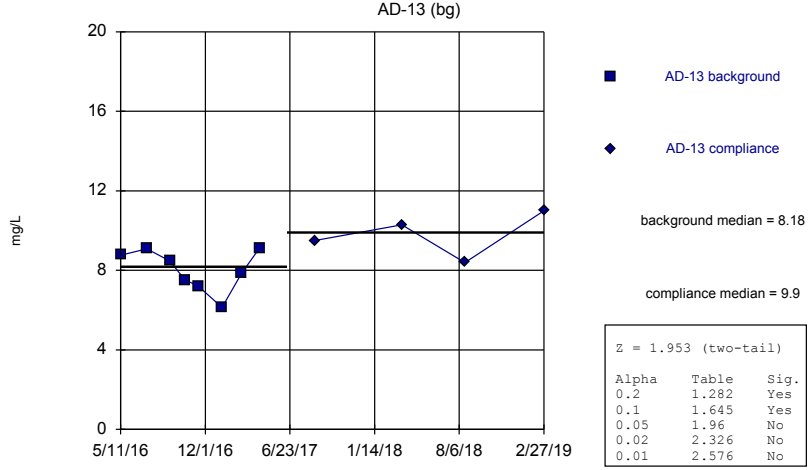
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-13 (bg)



Z = 1.953 (two-tail)

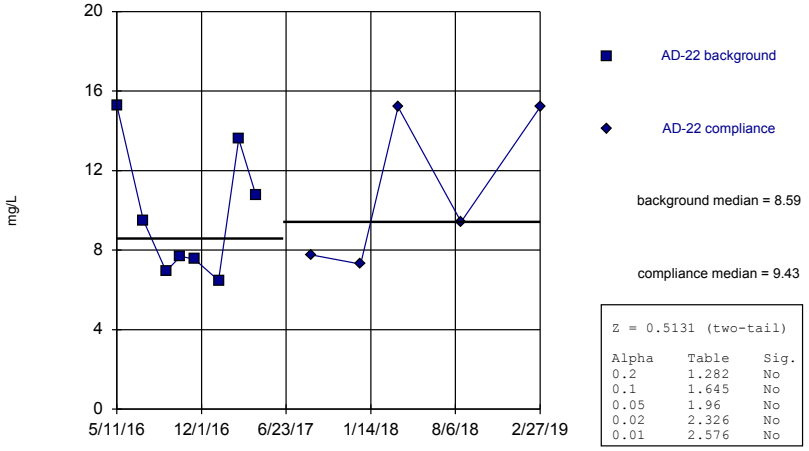
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-22



Z = 0.5131 (two-tail)

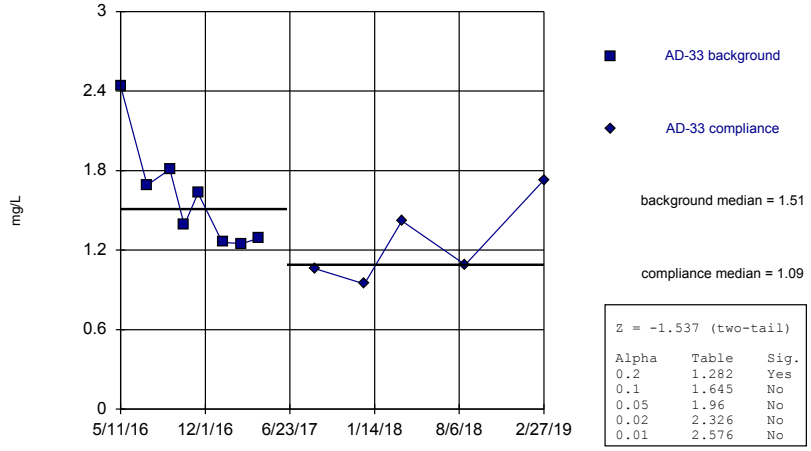
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-33



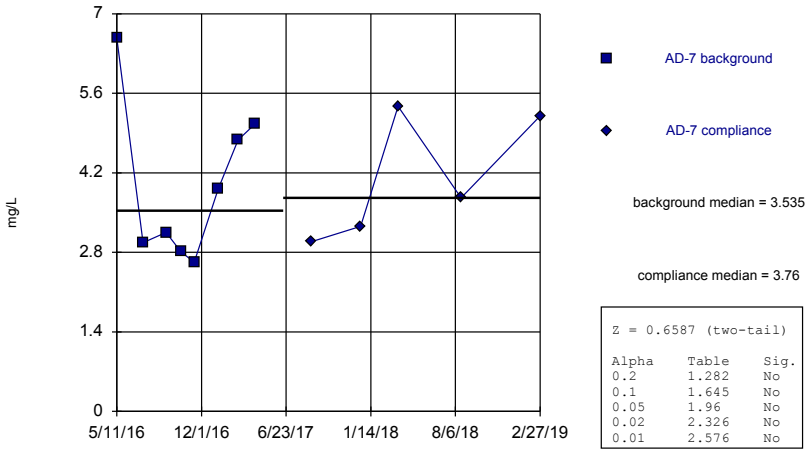
Z = -1.537 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

AD-7



Z = 0.6587 (two-tail)

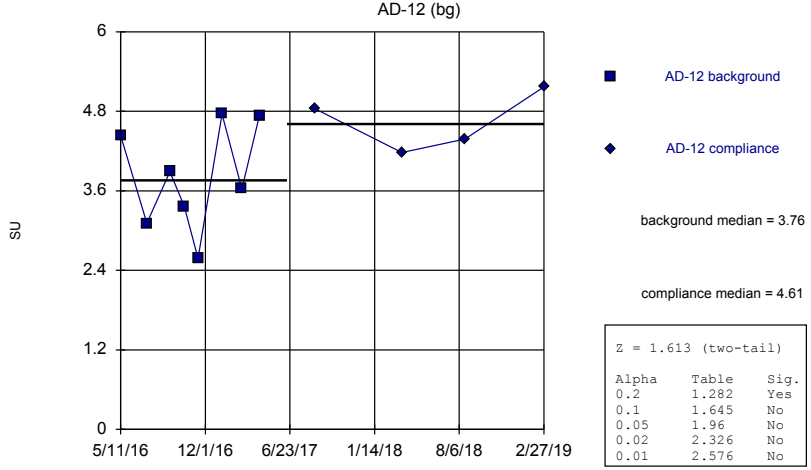
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



Z = 1.613 (two-tail)

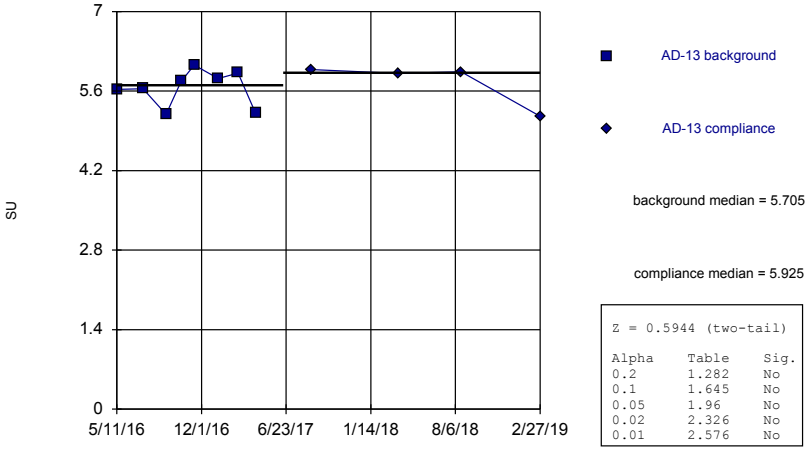
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-13 (bg)



Z = 0.5944 (two-tail)

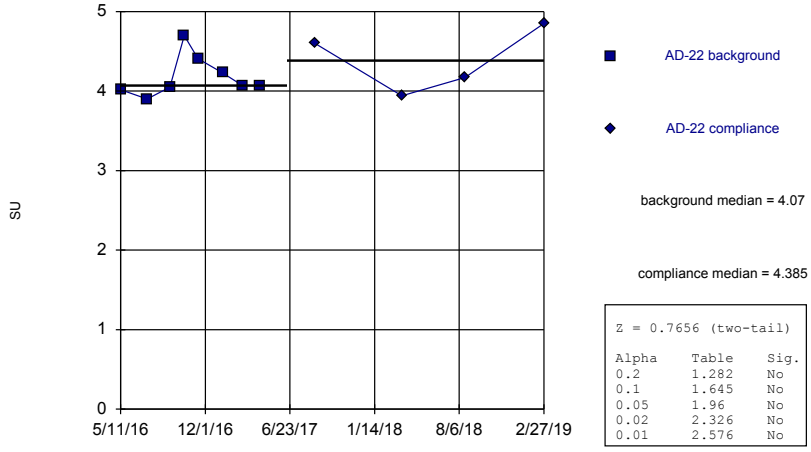
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-22



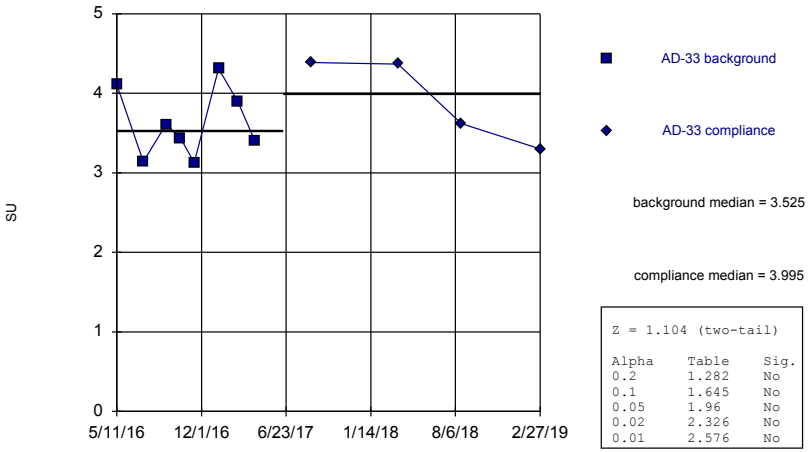
Z = 0.7656 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

AD-33

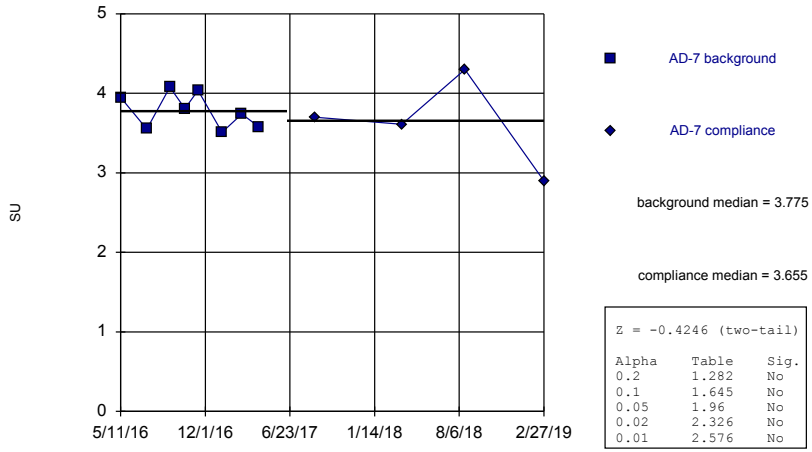


Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-7

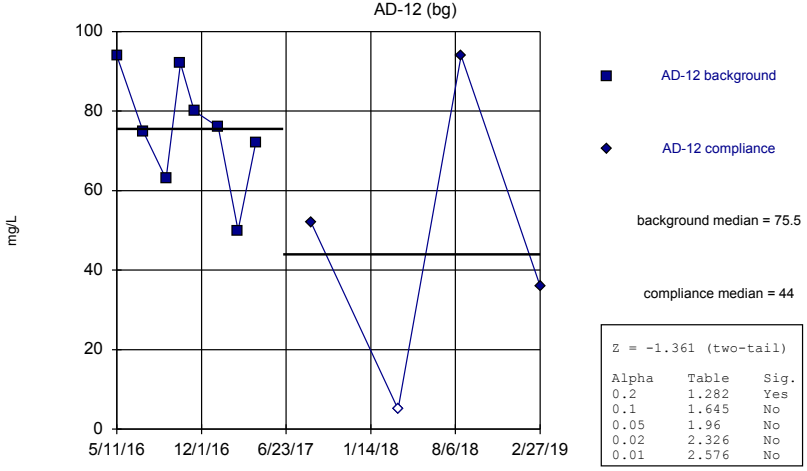


Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)

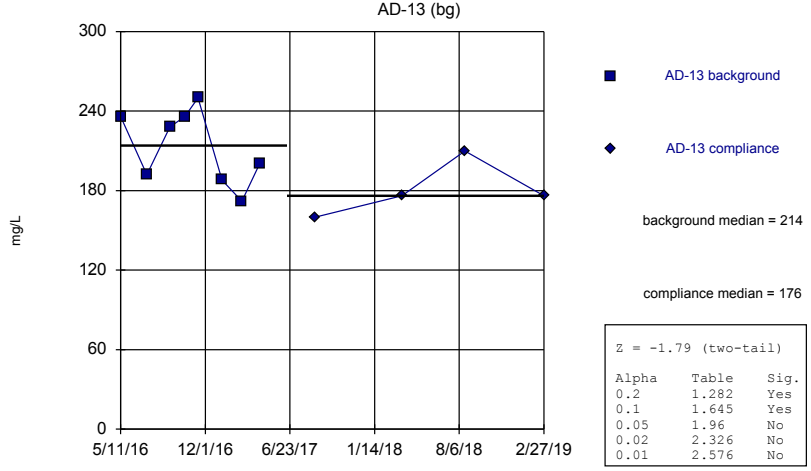


Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

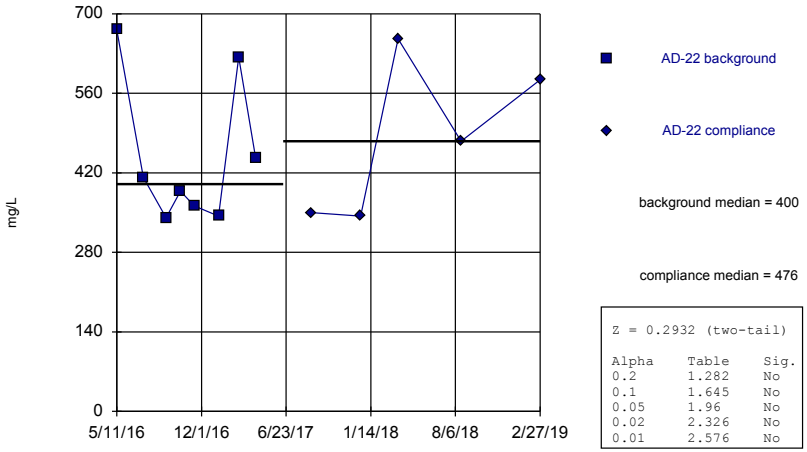
AD-13 (bg)



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

AD-22



Z = 0.2932 (two-tail)

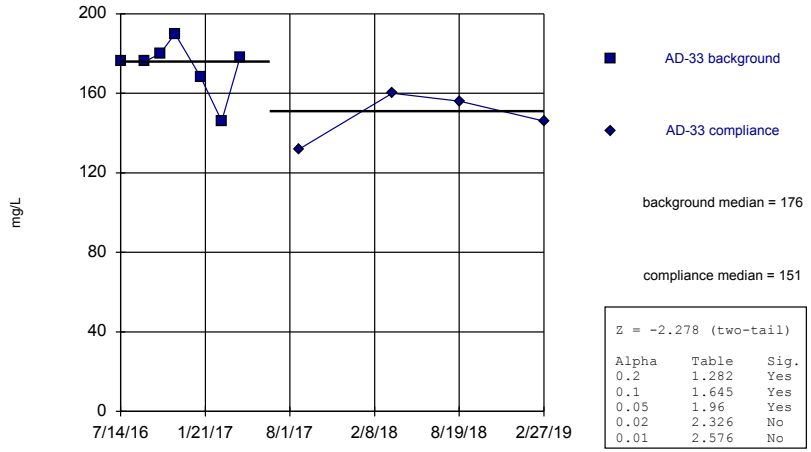
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-33



Z = -2.278 (two-tail)

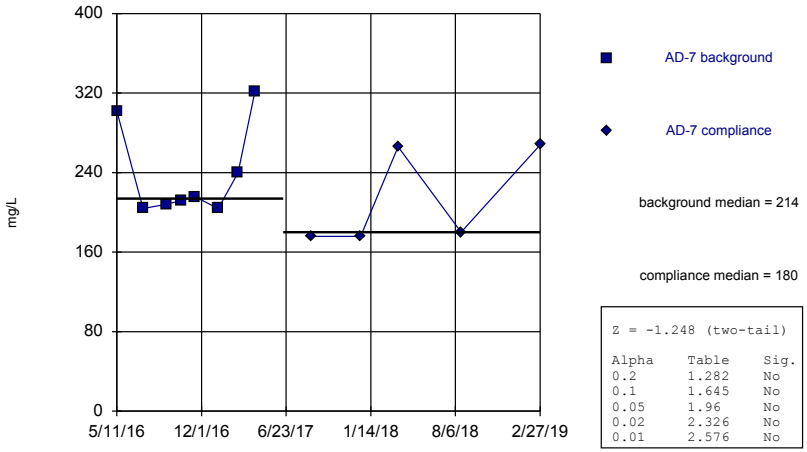
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	No
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-7



Z = -1.248 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

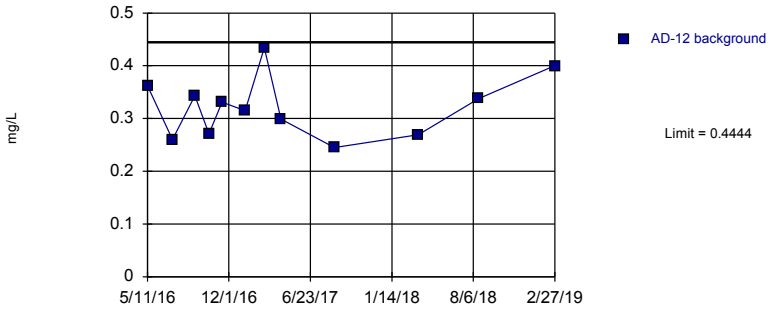
Intrawell Prediction Limit Summary Table - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 8:00 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-12	0.4444	n/a	n/a	1 future	n/a	12	0.3223	0.05781	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-13	11.44	n/a	n/a	1 future	n/a	12	8.617	1.337	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-33	2.292	n/a	n/a	1 future	n/a	13	1.462	0.3998	0	None	No	0.002505	Param Intra 1 of 2
pH, field (SU)	AD-12	5.754	2.427	n/a	1 future	n/a	12	4.091	0.7877	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-13	6.376	4.995	n/a	1 future	n/a	12	5.686	0.3269	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-22	4.917	3.585	n/a	1 future	n/a	12	4.251	0.3153	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-33	4.725	2.726	n/a	1 future	n/a	12	3.726	0.4733	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-7	4.486	2.976	n/a	1 future	n/a	12	3.731	0.3575	0	None	No	0.001253	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	121.8	n/a	n/a	1 future	n/a	12	65.75	26.52	8.333	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-13	264.6	n/a	n/a	1 future	n/a	12	202	29.65	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-33	203.2	n/a	n/a	1 future	n/a	11	164.4	17.84	0	None	No	0.002505	Param Intra 1 of 2

Prediction Limit

Intrawell Parametric, AD-12 (bg)



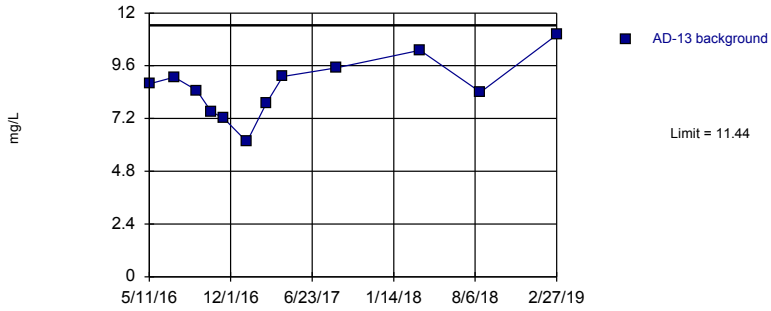
Background Data Summary: Mean=0.3223, Std. Dev.=0.05781, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9547, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-13 (bg)



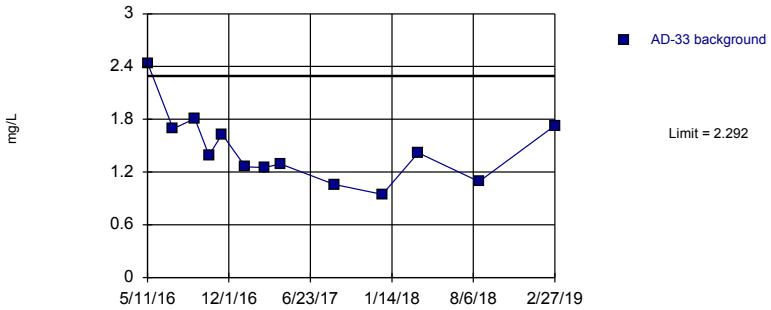
Background Data Summary: Mean=8.617, Std. Dev.=1.337, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9916, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-33



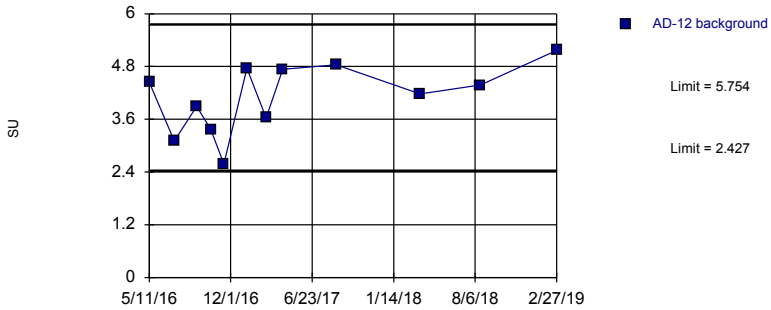
Background Data Summary: Mean=1.462, Std. Dev.=0.3998, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9183, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-12 (bg)

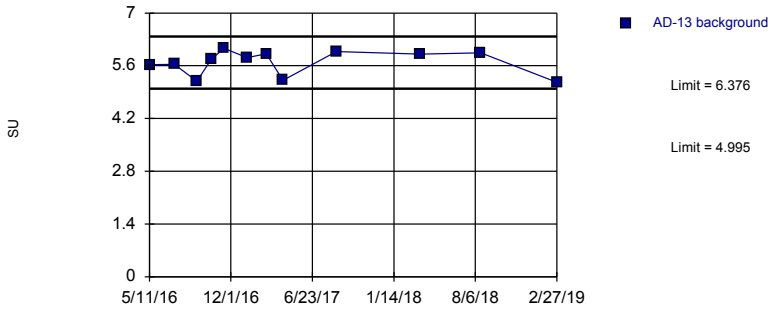


Background Data Summary: Mean=4.091, Std. Dev.=0.7877, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9544, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-13 (bg)



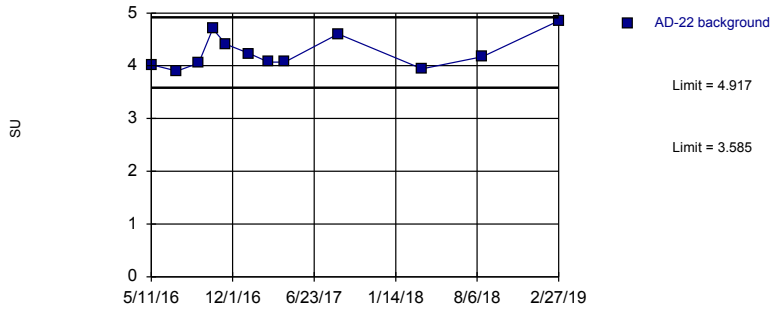
Background Data Summary: Mean=5.686, Std. Dev.=0.3269, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8494, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-22



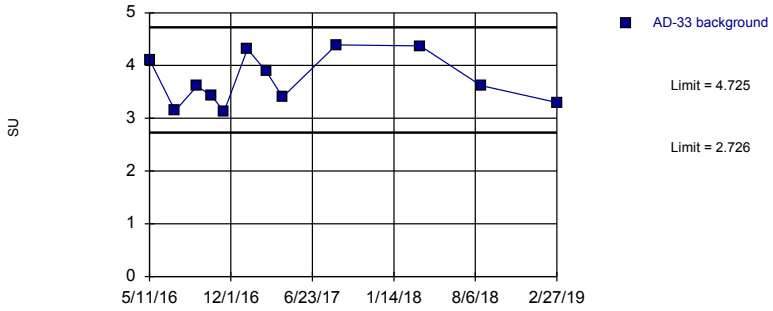
Background Data Summary: Mean=4.251, Std. Dev.=0.3153, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.885, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-33



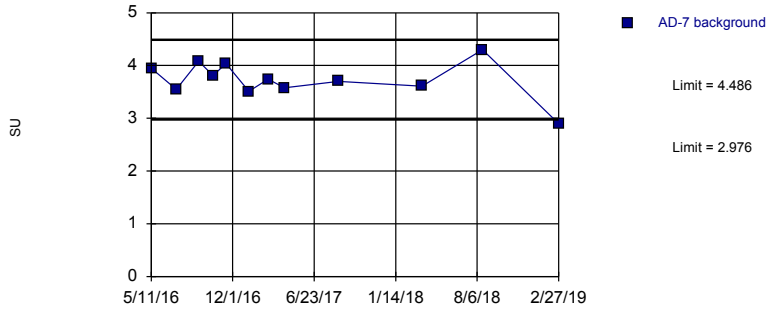
Background Data Summary: Mean=3.726, Std. Dev.=0.4733, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9014, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-7



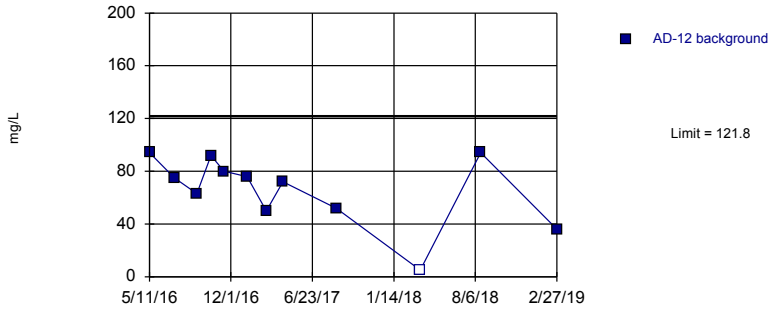
Background Data Summary: Mean=3.731, Std. Dev.=0.3575, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9396, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-12 (bg)

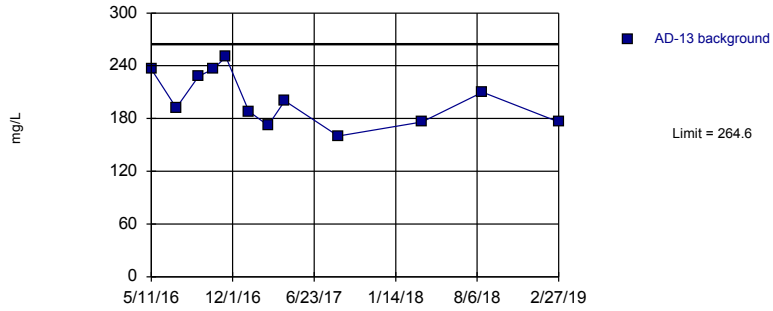


Background Data Summary: Mean=65.75, Std. Dev.=26.52, n=12, 8.333% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9032, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-13 (bg)

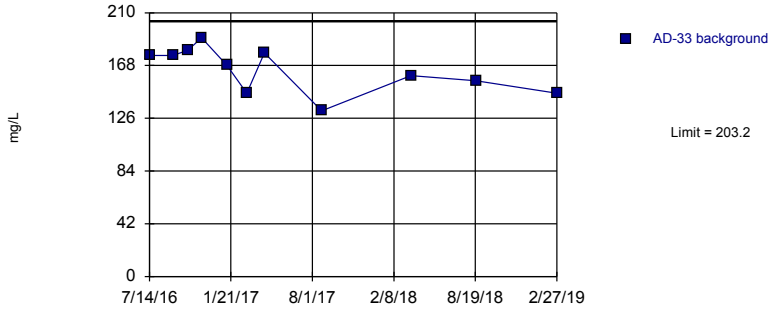


Background Data Summary: Mean=202, Std. Dev.=29.65, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9362, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-33



Background Data Summary: Mean=164.4, Std. Dev.=17.84, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9491, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

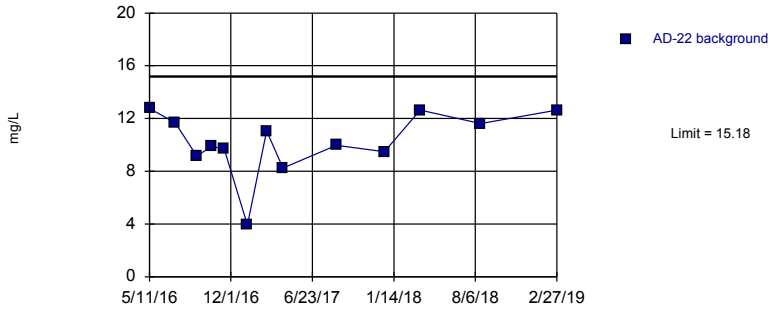
Deseasonalized Intrawell Prediction Limit Summary Table - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 8:06 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-22	15.18	n/a	n/a	1 future	n/a	13	10.21	2.393	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-7	5.315	n/a	n/a	1 future	n/a	13	4.037	0.6157	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-22	651.2	n/a	n/a	1 future	n/a	13	461.5	91.38	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-7	291.3	n/a	n/a	1 future	n/a	13	228.8	30.1	0	None	No	0.002505	Param Intra 1 of 2

Prediction Limit

Intrawell Parametric, AD-22



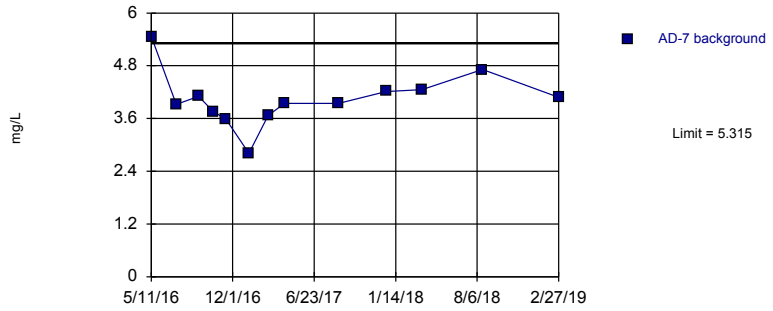
Background Data Summary: Mean=10.21, Std. Dev.=2.393, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8604, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total, Alt. Values Analysis Run 12/9/2019 8:05 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-7



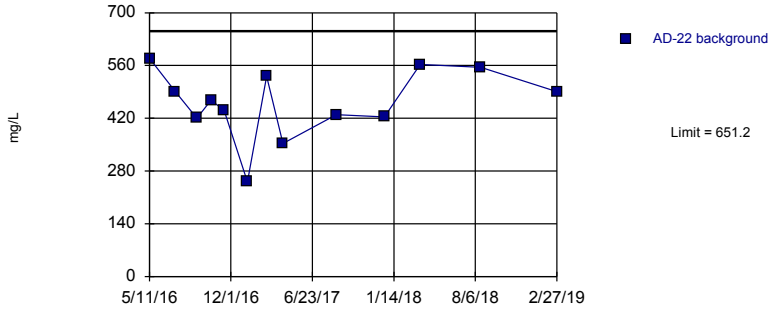
Background Data Summary: Mean=4.037, Std. Dev.=0.6157, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9217, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total, Alt. Values Analysis Run 12/9/2019 8:05 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-22



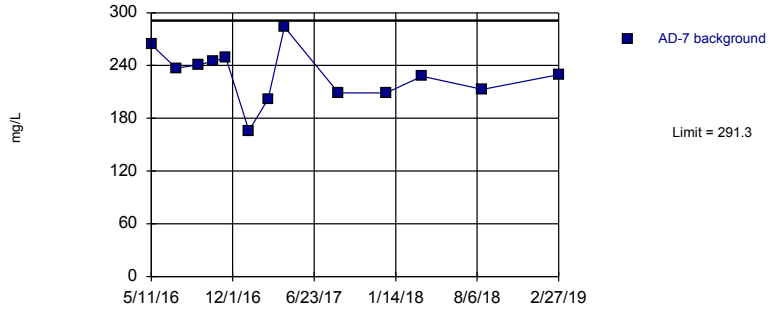
Background Data Summary: Mean=461.5, Std. Dev.=91.38, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9344, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS], Alt. Values Analysis Run 12/9/2019 8:05 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-7



Background Data Summary: Mean=228.8, Std. Dev.=30.1, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9799, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS], Alt. Values Analysis Run 12/9/2019 8:06 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Trend Tests Summary Table - Upgradient Wells

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/6/2019, 11:26 AM

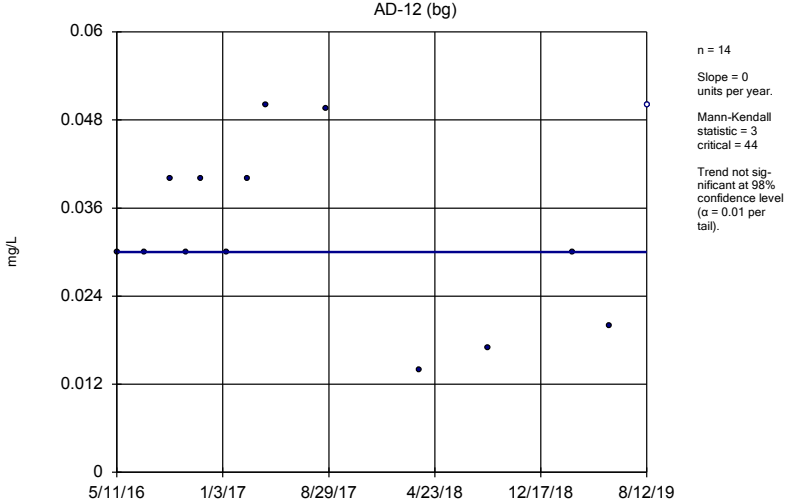
Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-12 (bg)	0	3	44	No	14	7.143	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-13 (bg)	0.002834	32	44	No	14	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-12 (bg)	0.1051	23	44	No	14	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-13 (bg)	4.358	32	44	No	14	0	n/a	n/a	0.02	NP
Fluoride, total (mg/L)	**AD-12 (bg)**	**-0.08118**	**-46**	**-44**	**Yes**	**14**	**64.29**	**n/a**	**n/a**	**0.02**	**NP**
Fluoride, total (mg/L)	AD-13 (bg)	-0.08825	-23	-44	No	14	28.57	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.7952	-35	-44	No	14	0	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-13 (bg)	7.178	38	44	No	14	0	n/a	n/a	0.02	NP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = 0 units per year.

Mann-Kendall statistic = 3 critical = 44

Trend not significant at 98% confidence level (α = 0.01 per tail).

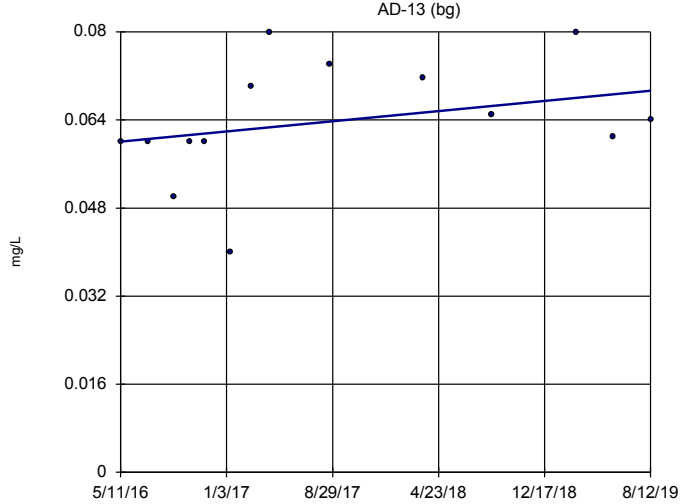
Constituent: Boron, total Analysis Run 12/6/2019 11:25 AM View: Interwell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 14

Slope = 0.002834 units per year.

Mann-Kendall statistic = 32 critical = 44

Trend not significant at 98% confidence level (α = 0.01 per tail).

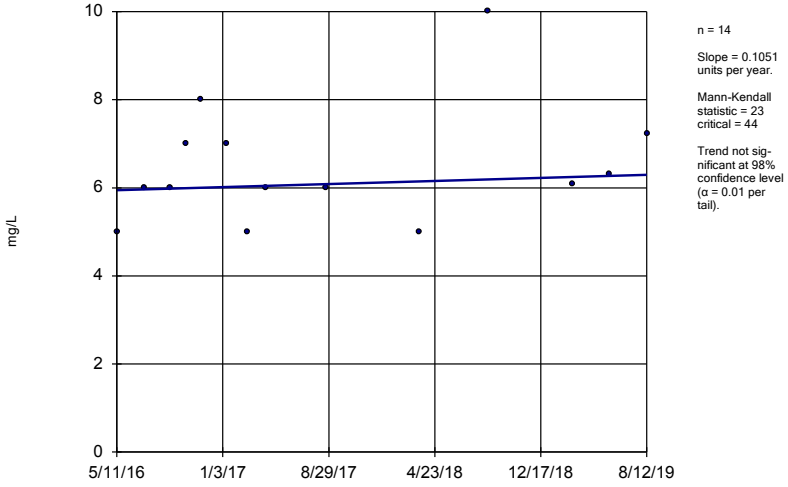
Constituent: Boron, total Analysis Run 12/6/2019 11:25 AM View: Interwell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = 0.1051 units per year.

Mann-Kendall statistic = 23 critical = 44

Trend not significant at 98% confidence level (α = 0.01 per tail).

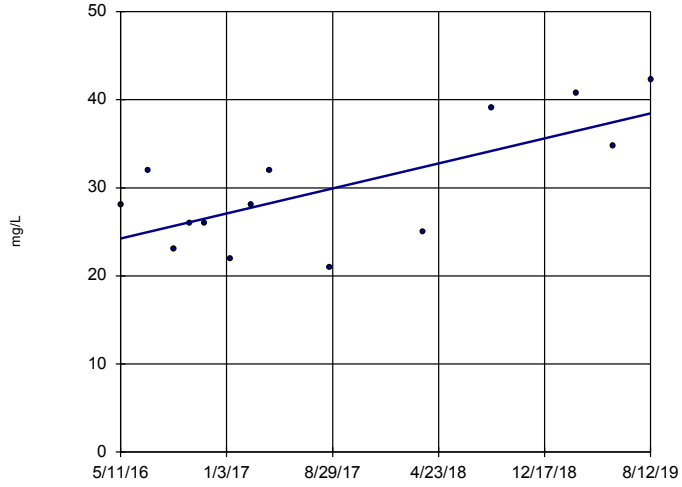
Constituent: Chloride, total Analysis Run 12/6/2019 11:25 AM View: Interwell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 14

Slope = 4.358 units per year.

Mann-Kendall statistic = 32 critical = 44

Trend not significant at 98% confidence level (α = 0.01 per tail).

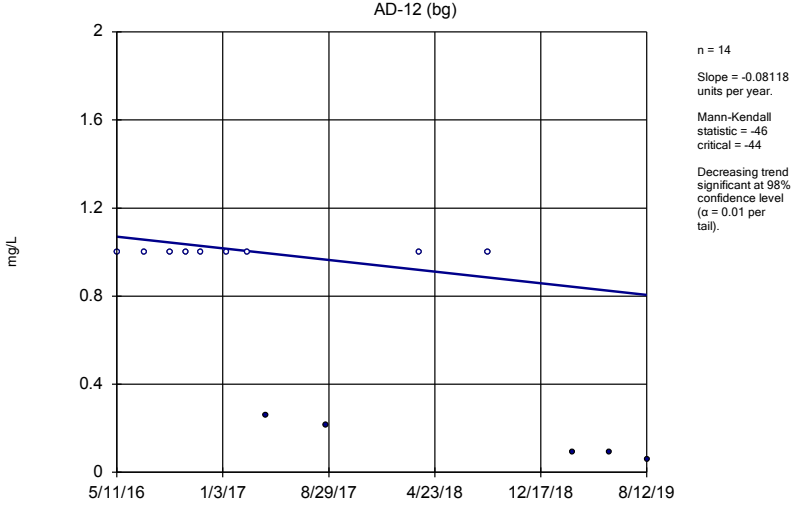
Constituent: Chloride, total Analysis Run 12/6/2019 11:25 AM View: Interwell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.08118 units per year.

Mann-Kendall statistic = -46
critical = -44

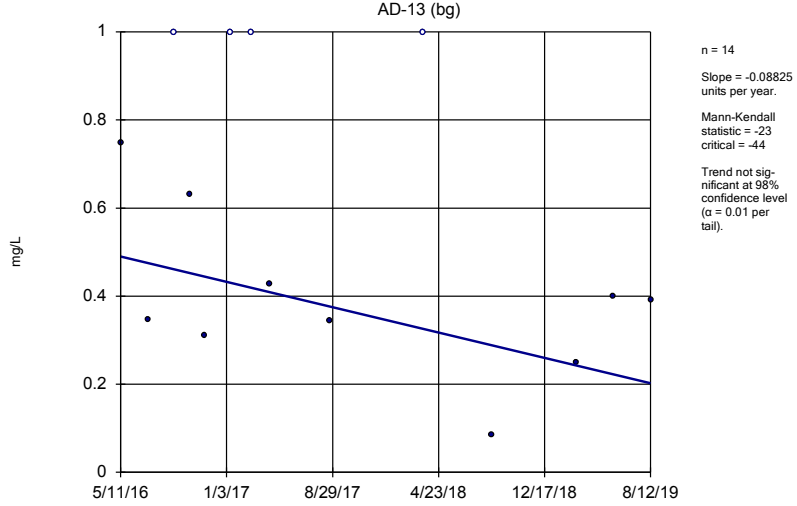
Decreasing trend significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-13 (bg)



n = 14

Slope = -0.08825 units per year.

Mann-Kendall statistic = -23
critical = -44

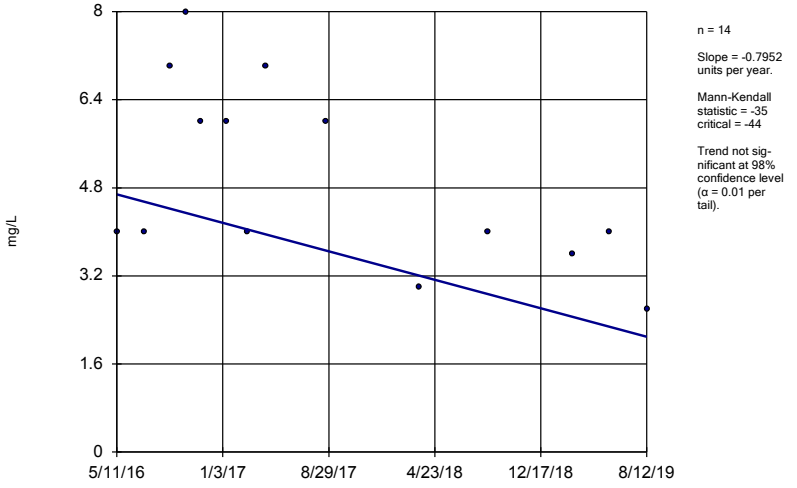
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.7952 units per year.

Mann-Kendall statistic = -35
critical = -44

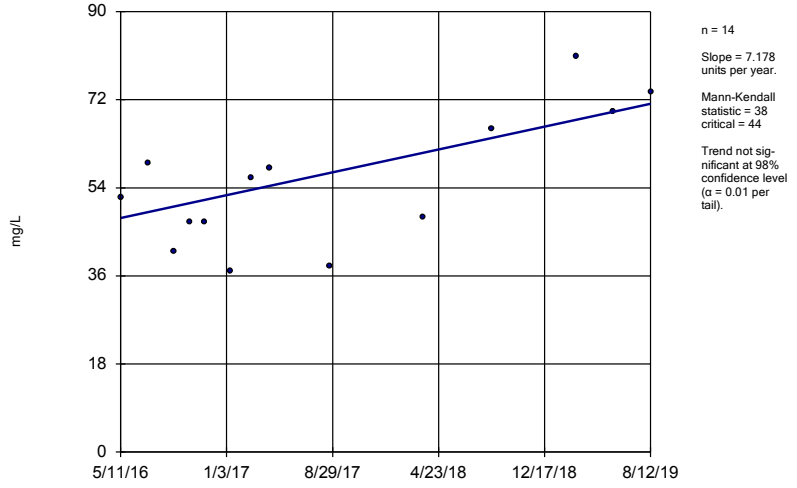
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Sulfate, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 14

Slope = 7.178 units per year.

Mann-Kendall statistic = 38
critical = 44

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Sulfate, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Interwell Prediction Limit Summary Table - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 8:08 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	n/a	0.08453	n/a	n/a	3 future	n/a	24	0.0488	0.01937	0	None	No	0.002505	Param Inter 1 of 2
Chloride, total (mg/L)	n/a	40.8	n/a	n/a	3 future	n/a	24	n/a	n/a	0	n/a	n/a	0.003036	NP Inter (normality) 1 of 2
Fluoride, total (mg/L)	n/a	1	n/a	n/a	3 future	n/a	24	n/a	n/a	54.17	n/a	n/a	0.003036	NP Inter (NDs) 1 of 2
Sulfate, total (mg/L)	n/a	80.8	n/a	n/a	3 future	n/a	24	n/a	n/a	0	n/a	n/a	0.003036	NP Inter (normality) 1 of 2

Upper Tolerance Limits - App IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/6/2019, 11:38 AM

Constituent	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.005	26	n/a	n/a	92.31	n/a	n/a	0.2635	NP Inter(NDs)
Arsenic, total (mg/L)	0.006425	25	0.002391	0.00176	48	Kaplan-Meier	No	0.05	Inter
Barium, total (mg/L)	0.0514	26	0.03266	0.008226	0	None	No	0.05	Inter
Beryllium, total (mg/L)	0.002	26	n/a	n/a	15.38	n/a	n/a	0.2635	NP Inter(normality)
Cadmium, total (mg/L)	0.001	24	n/a	n/a	75	n/a	n/a	0.292	NP Inter(normality)
Chromium, total (mg/L)	0.001869	26	-7.997	0.7528	50	Kaplan-Meier	ln(x)	0.05	Inter
Cobalt, total (mg/L)	0.056	26	n/a	n/a	0	n/a	n/a	0.2635	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	2.935	26	1.183	0.769	0	None	No	0.05	Inter
Fluoride, total (mg/L)	1	28	n/a	n/a	46.43	n/a	n/a	0.2378	NP Inter(normality)
Lead, total (mg/L)	0.005	26	n/a	n/a	88.46	n/a	n/a	0.2635	NP Inter(NDs)
Lithium, total (mg/L)	0.165	26	n/a	n/a	3.846	n/a	n/a	0.2635	NP Inter(normality)
Mercury, total (mg/L)	0.000025	26	n/a	n/a	84.62	n/a	n/a	0.2635	NP Inter(NDs)
Molybdenum, total (mg/L)	0.005	22	n/a	n/a	95.45	n/a	n/a	0.3235	NP Inter(NDs)
Selenium, total (mg/L)	0.005	26	n/a	n/a	73.08	n/a	n/a	0.2635	NP Inter(normality)
Thallium, total (mg/L)	0.002	24	n/a	n/a	75	n/a	n/a	0.292	NP Inter(normality)

Tolerance Limit

Interwell Non-parametric

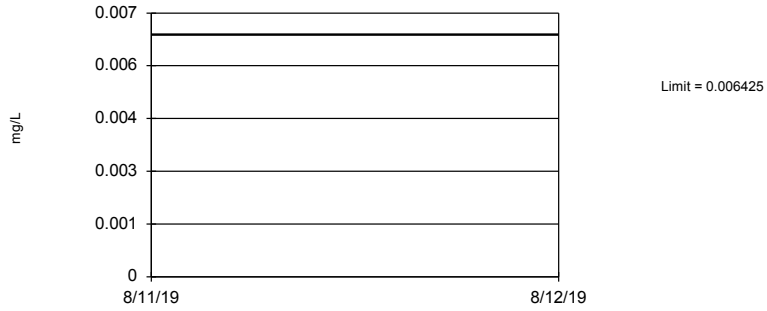
Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 75%. Limit is highest of 26 background values. 92.31% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Antimony, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Parametric



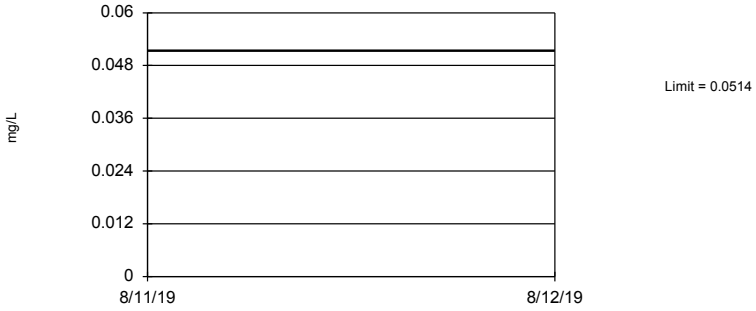
95% coverage. Background Data Summary (after Kaplan-Meier Adjustment): Mean=0.002391, Std. Dev.=0.00176, n=25, 48% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8904, critical = 0.888. Report alpha = 0.05.

Constituent: Arsenic, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Parametric



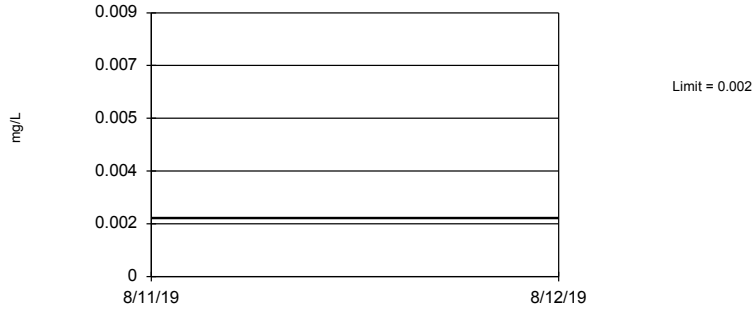
95% coverage. Background Data Summary: Mean=0.03266, Std. Dev.=0.008226, n=26. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9085, critical = 0.891. Report alpha = 0.05.

Constituent: Barium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric

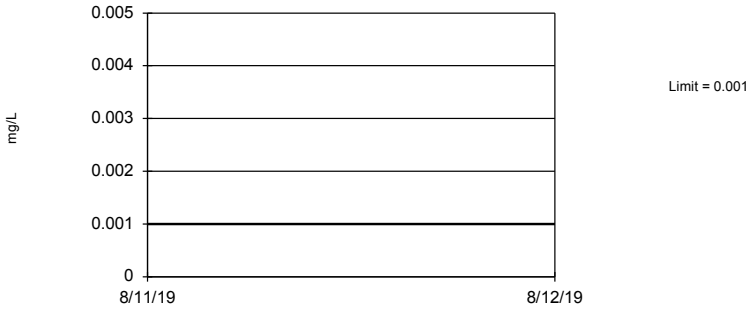


Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. 15.38% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Beryllium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Non-parametric

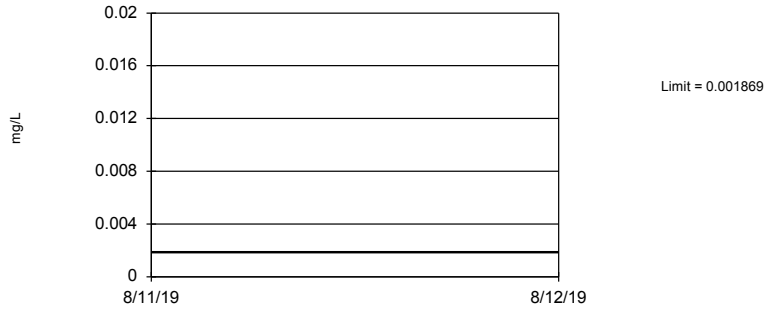


Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 24 background values. 75% NDs. 82.62% coverage at alpha=0.01; 88.09% coverage at alpha=0.05; 97.07% coverage at alpha=0.5. Report alpha = 0.292.

Constituent: Cadmium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Parametric

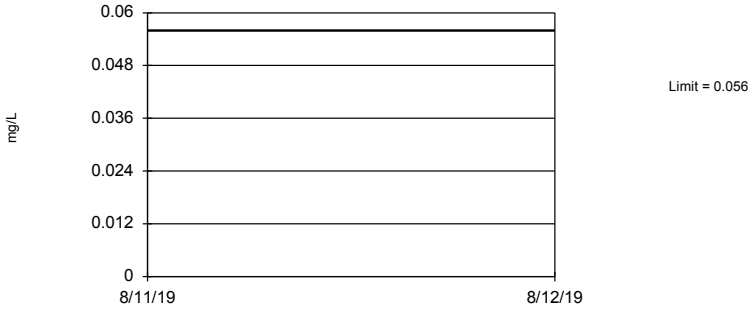


95% coverage. Background Data Summary (based on natural log transformation) (after Kaplan-Meier Adjustment): Mean=-7.997, Std. Dev.=0.7528, n=26, 50% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9156, critical = 0.891. Report alpha = 0.05.

Constituent: Chromium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Non-parametric

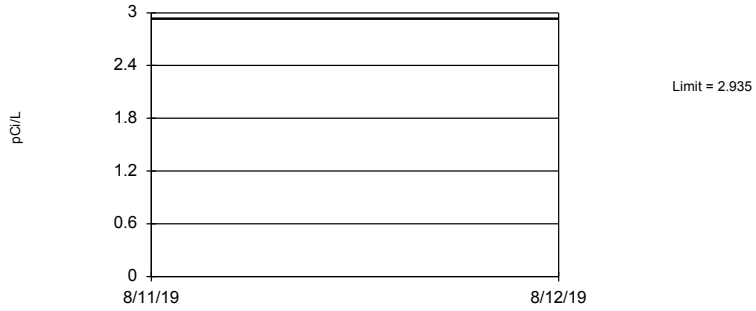


Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Cobalt, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Parametric



95% coverage. Background Data Summary: Mean=1.183, Std. Dev.=0.769, n=26. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9406, critical = 0.891. Report alpha = 0.05.

Constituent: Combined Radium 226 + 228 Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Non-parametric

Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 28 background values. 46.43% NDs. 84.96% coverage at alpha=0.01; 90.04% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2378.

Constituent: Fluoride, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric

Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 75%. Limit is highest of 26 background values. 88.46% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

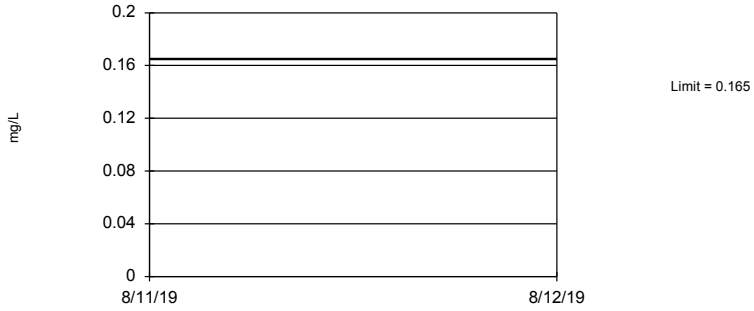
Constituent: Lead, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. 3.846% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

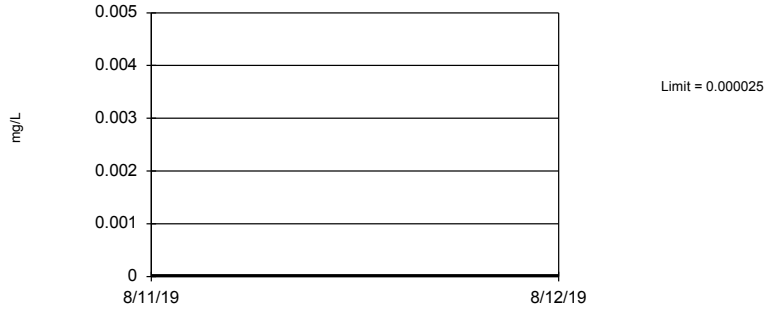
Constituent: Lithium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 75%. Limit is highest of 26 background values. 84.62% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Mercury, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Non-parametric

Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 75%. Limit is highest of 22 background values. 95.45% NDs. 81.05% coverage at alpha=0.01; 87.3% coverage at alpha=0.05; 97.07% coverage at alpha=0.5. Report alpha = 0.3235.

Constituent: Molybdenum, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric

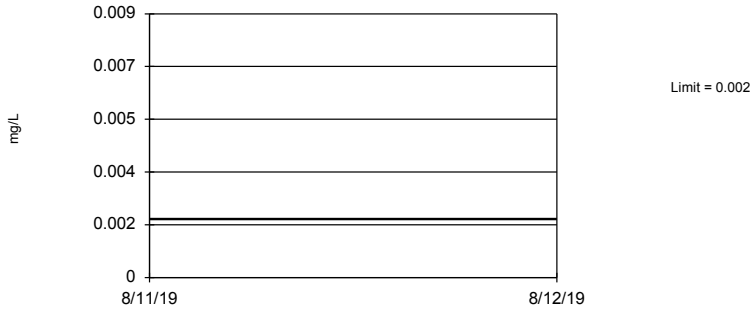
Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. 73.08% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Selenium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 24 background values. 75% NDs. 82.62% coverage at alpha=0.01; 88.09% coverage at alpha=0.05; 97.07% coverage at alpha=0.5. Report alpha = 0.292.

Constituent: Thallium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

PIRKEY STACKOUT GWPS				
Constituent Name	**MCL**	**CCR-Rule Specified**	**Background Limit**	**GWPS**
Antimony, Total (mg/L)	0.006		0.005	0.006
Arsenic, Total (mg/L)	0.01		0.006	0.01
Barium, Total (mg/L)	2		0.051	2
Beryllium, Total (mg/L)	0.004		0.002	0.004
Cadmium, Total (mg/L)	0.005		0.001	0.005
Chromium, Total (mg/L)	0.1		0.002	0.1
Cobalt, Total (mg/L)	n/a	0.006	0.056	0.056
Combined Radium, Total (pCi/L)	5		2.94	5
Fluoride, Total (mg/L)	4		1	4
Lead, Total (mg/L)	0.015		0.005	0.015
Lithium, Total (mg/L)	n/a	0.04	0.17	0.17
Mercury, Total (mg/L)	0.002		0.000025	0.002
Molybdenum, Total (mg/L)	n/a	0.1	0.005	0.1
Selenium, Total (mg/L)	0.05		0.005	0.05
Thallium, Total (mg/L)	0.002		0.002	0.002

**Grey cell indicates ACL is higher than MCL.*

**MCL = Maximum Contaminant Level*

**GWPS = Groundwater Protection Standard*

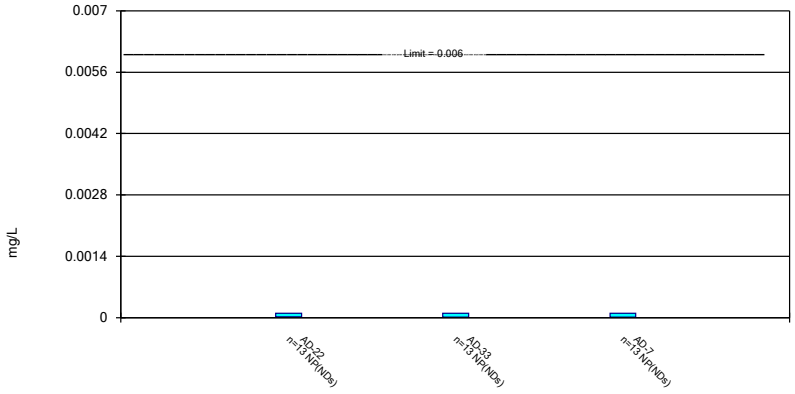
Confidence Intervals - All Results (No Significant Results)

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 4:00 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	AD-22	0.0001	0.00002	0.006	No	13	0.00009385	0.00002219	92.31	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-33	0.0001	0.00001	0.006	No	13	0.00009308	0.00002496	92.31	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-7	0.0001	0.00001	0.006	No	13	0.00009308	0.00002496	92.31	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-22	0.0119	0.003558	0.01	No	13	0.008725	0.007096	0	None	ln(x)	0.01	Param.
Arsenic, total (mg/L)	AD-33	0.002226	0.0007882	0.01	No	12	0.001759	0.001185	16.67	Kaplan-...	ln(x)	0.01	Param.
Arsenic, total (mg/L)	AD-7	0.00212	0.00064	0.01	No	13	0.001606	0.000583	46.15	None	No	0.01	NP (normality)
Barium, total (mg/L)	AD-22	0.06983	0.02348	2	No	13	0.05145	0.03652	0	None	ln(x)	0.01	Param.
Barium, total (mg/L)	AD-33	0.059	0.04908	2	No	12	0.05355	0.007029	0	None	x^4	0.01	Param.
Barium, total (mg/L)	AD-7	0.05491	0.04271	2	No	13	0.04881	0.008201	0	None	No	0.01	Param.
Beryllium, total (mg/L)	AD-33	0.002	0.000905	0.004	No	13	0.001408	0.0008662	0	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-22	0.001419	0.0005284	0.005	No	13	0.001051	0.0006467	0	None	ln(x)	0.01	Param.
Cadmium, total (mg/L)	AD-33	0.001	0.00015	0.005	No	13	0.0007857	0.0004051	69.23	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-7	0.0008453	0.0006926	0.005	No	13	0.0007716	0.0001049	0	None	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-22	0.006766	0.0005802	0.1	No	13	0.007602	0.009954	23.08	Kaplan-...	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-33	0.003782	0.0004179	0.1	No	12	0.003324	0.002412	25	Kaplan-...	sqrt(x)	0.01	Param.
Chromium, total (mg/L)	AD-7	0.0005141	0.0001399	0.1	No	13	0.001829	0.001811	38.46	Kaplan-...	ln(x)	0.01	Param.
Cobalt, total (mg/L)	AD-33	0.01095	0.008577	0.056	No	12	0.009762	0.001509	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-22	5.243	3.065	5	No	13	4.266	1.616	0	None	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-33	3.871	1.394	5	No	13	2.945	2.369	0	None	ln(x)	0.01	Param.
Fluoride, total (mg/L)	AD-22	0.9636	0.3593	4	No	15	0.8634	0.3438	40	Kaplan-...	x^2	0.01	Param.
Fluoride, total (mg/L)	AD-33	1	0.25	4	No	14	0.7641	0.3458	64.29	None	No	0.01	NP (normality)
Fluoride, total (mg/L)	AD-7	1	0.5	4	No	14	0.8172	0.2657	64.29	None	No	0.01	NP (normality)
Lead, total (mg/L)	AD-22	0.00273	0.000386	0.015	No	13	0.001583	0.0008065	53.85	None	No	0.01	NP (normality)
Lead, total (mg/L)	AD-33	0.002	0.000151	0.015	No	12	0.001688	0.0007297	83.33	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-7	0.002	0.000529	0.015	No	13	0.001592	0.0006531	69.23	None	No	0.01	NP (normality)
Lithium, total (mg/L)	AD-22	0.2166	0.1302	0.17	No	13	0.1776	0.06412	0	None	ln(x)	0.01	Param.
Lithium, total (mg/L)	AD-33	0.029	0.0178	0.17	No	13	0.02515	0.01008	7.692	None	No	0.01	NP (normality)
Lithium, total (mg/L)	AD-7	0.1054	0.09375	0.17	No	13	0.09663	0.01678	0	None	x^6	0.01	Param.
Mercury, total (mg/L)	AD-22	0.005651	0.0003861	0.002	No	9	0.003167	0.003618	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-33	0.0007483	0.0002828	0.002	No	13	0.0005656	0.0004313	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-7	0.0002192	0.00007226	0.002	No	13	0.0001458	0.00009883	0	None	No	0.01	Param.
Molybdenum, total (mg/L)	AD-22	0.002	0.002	0.1	No	11	0.001825	0.0005819	90.91	None	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-33	0.002	0.002	0.1	No	11	0.001885	0.000381	90.91	None	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-7	0.002	0.002	0.1	No	12	0.002	0	100	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-22	0.0059	0.001866	0.05	No	12	0.003778	0.001715	50	None	No	0.01	NP (normality)
Selenium, total (mg/L)	AD-33	0.005	0.0011	0.05	No	13	0.003724	0.001742	61.54	None	No	0.01	NP (normality)
Selenium, total (mg/L)	AD-7	0.0071	0.001047	0.05	No	13	0.004142	0.001857	61.54	None	No	0.01	NP (normality)
Thallium, total (mg/L)	AD-22	0.0009472	0.0002236	0.002	No	12	0.0005724	0.0003552	50	Kaplan-...	x^(1/3)	0.01	Param.
Thallium, total (mg/L)	AD-33	0.001192	0.00005	0.002	No	12	0.0006091	0.0003905	75	None	No	0.01	NP (normality)
Thallium, total (mg/L)	AD-7	0.001032	0.0002	0.002	No	12	0.0004926	0.0002079	75	None	No	0.01	NP (normality)

Non-Parametric Confidence Interval

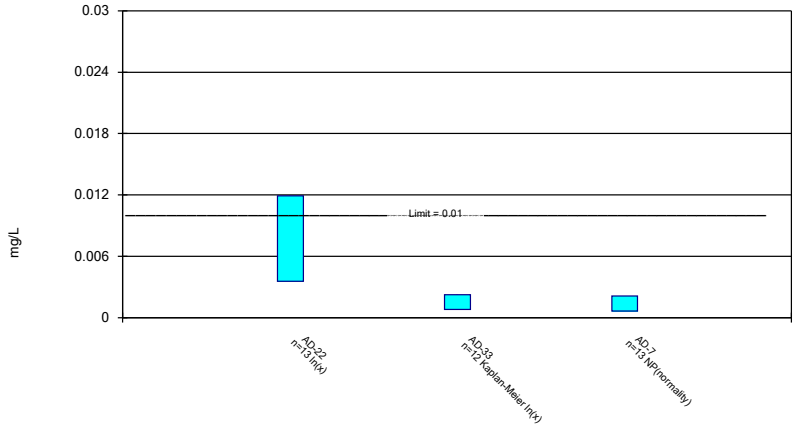
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Antimony, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

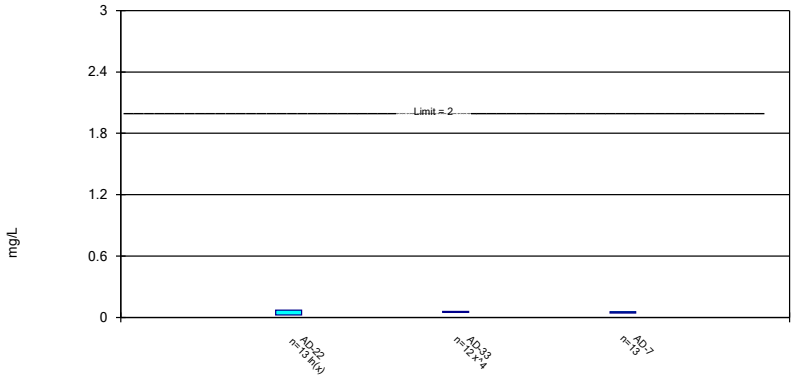
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Arsenic, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

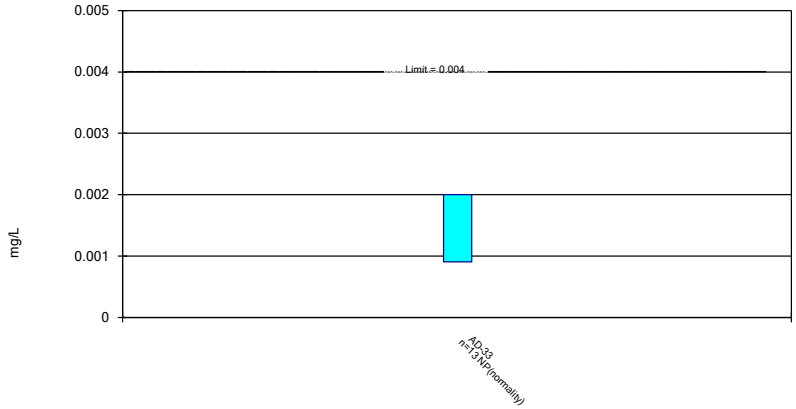
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Barium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

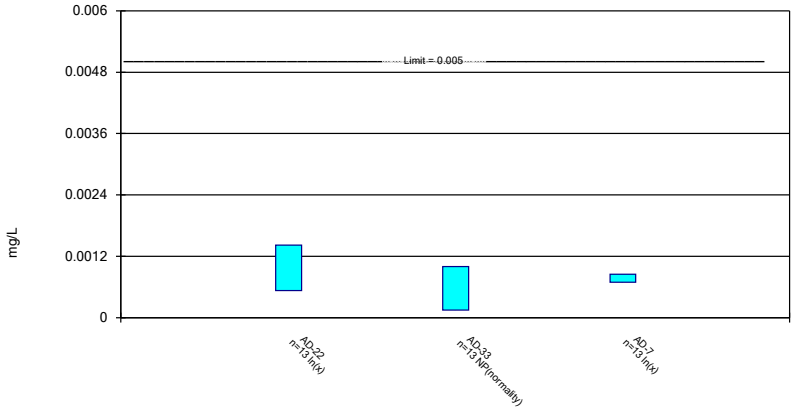
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Beryllium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

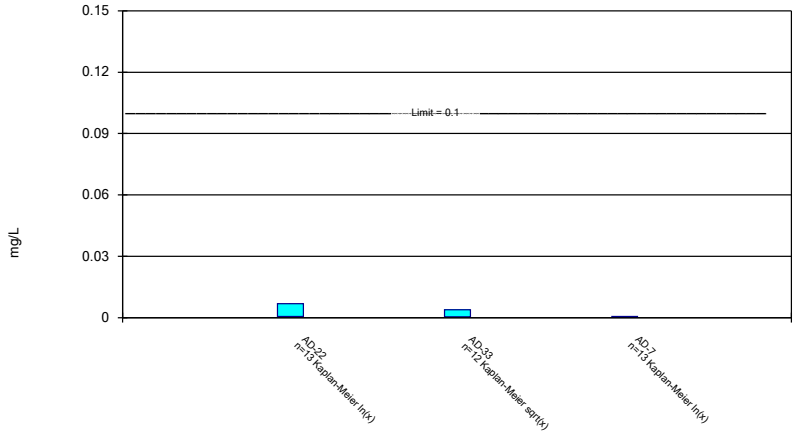
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cadmium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

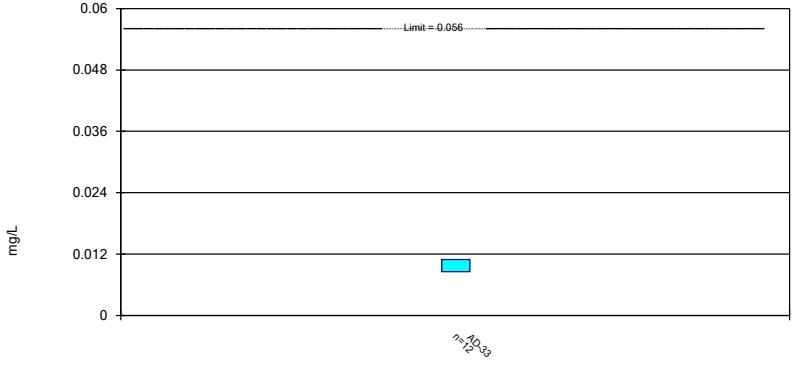
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chromium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

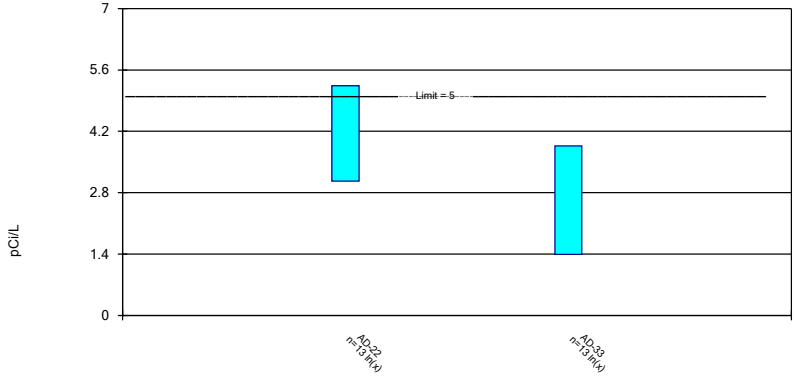
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cobalt, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

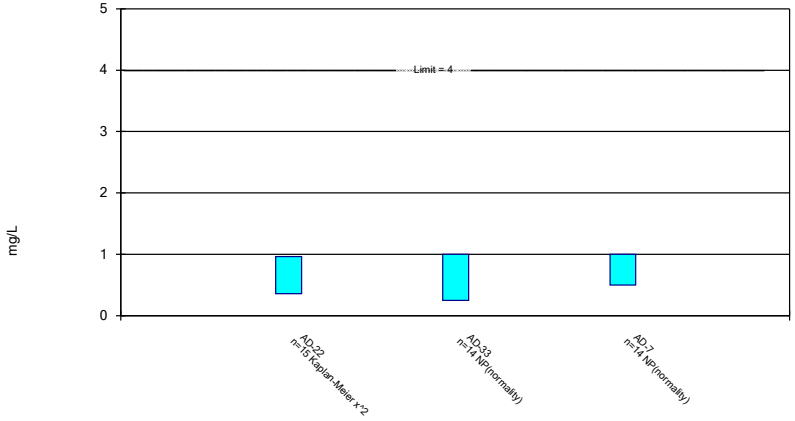
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

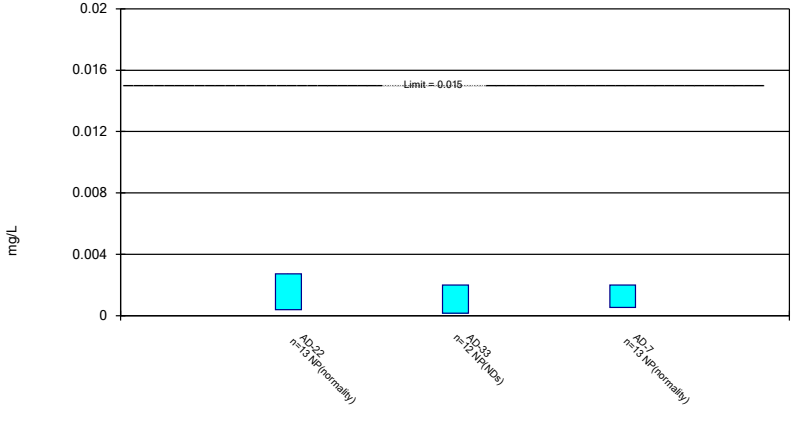
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Fluoride, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

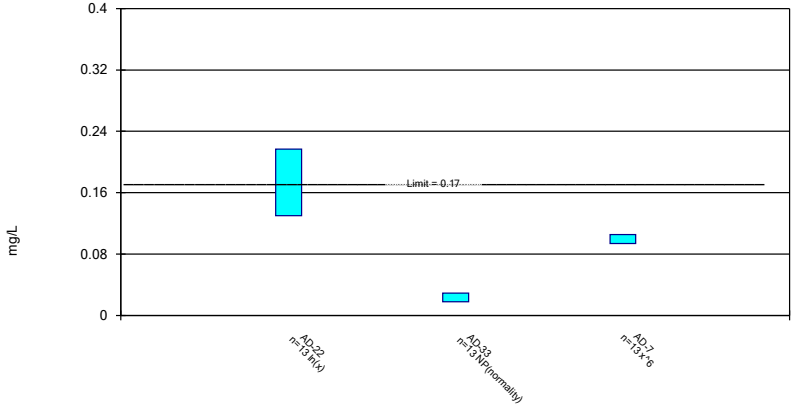
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Lead, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

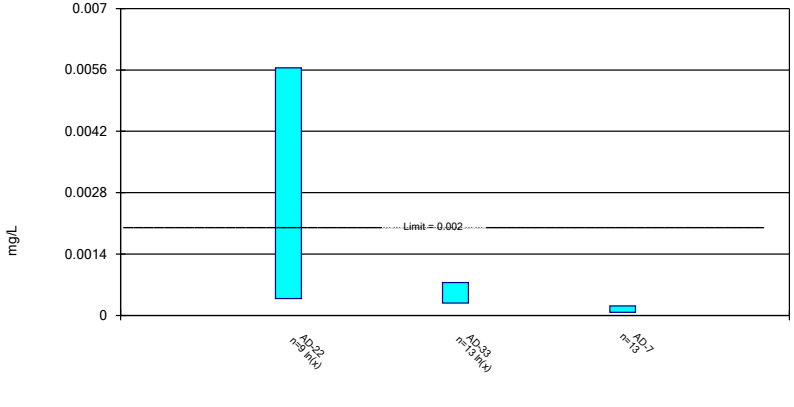
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Lithium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

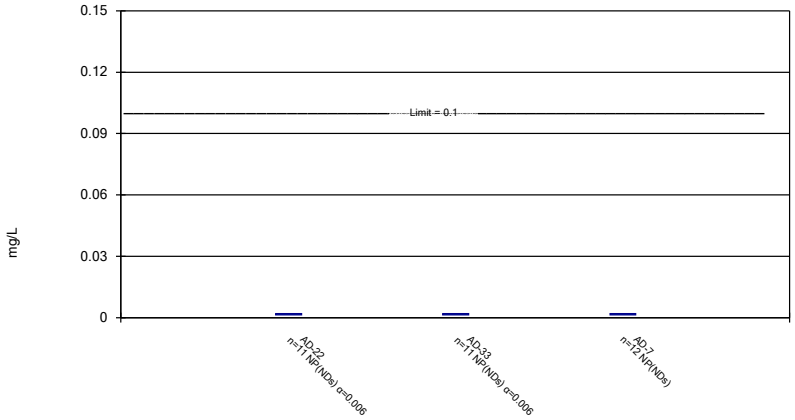
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Mercury, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted.

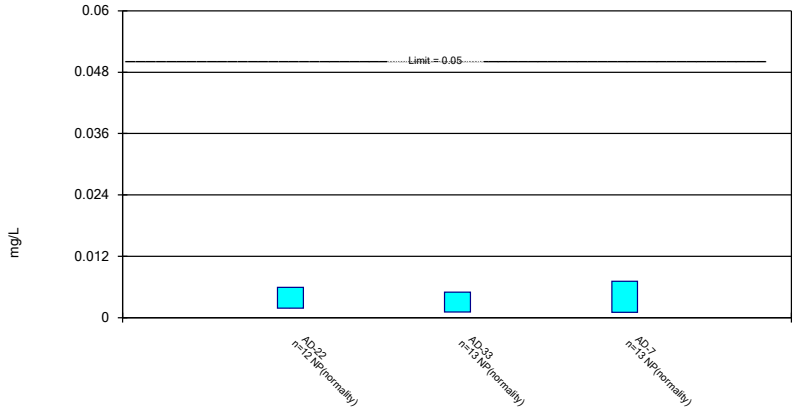


Constituent: Molybdenum, total Analysis Run 12/9/2019 4:00 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

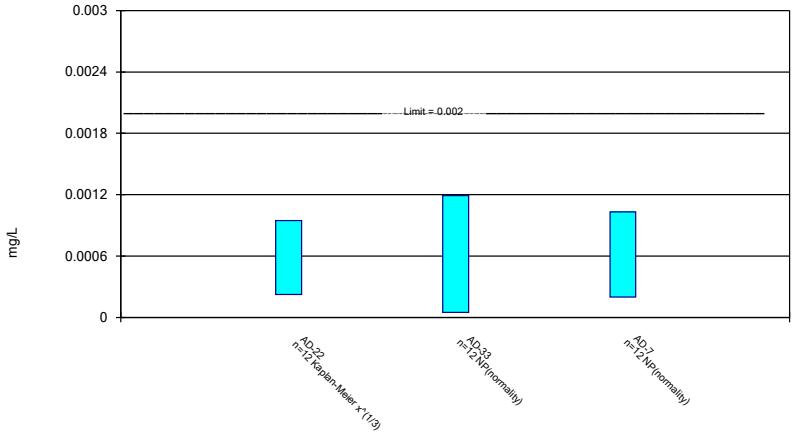


Constituent: Selenium, total Analysis Run 12/9/2019 4:00 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Thallium, total Analysis Run 12/9/2019 4:00 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Deseasonalized Confidence Intervals - Significant Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 3:57 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Beryllium, total (mg/L)	**AD-22**	**0.009355**	**0.006032**	**0.004**	**Yes**	**13**	**0.007429**	**0.002706**	**0**	**None**	**x^2**	**0.01**	**Param.**
Beryllium, total (mg/L)	**AD-7**	**0.005761**	**0.004471**	**0.004**	**Yes**	**13**	**0.005046**	**0.0009302**	**0**	**None**	**x^3**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-22**	**0.09829**	**0.07274**	**0.056**	**Yes**	**13**	**0.08234**	**0.02336**	**0**	**None**	**x^3**	**0.01**	**Param.**

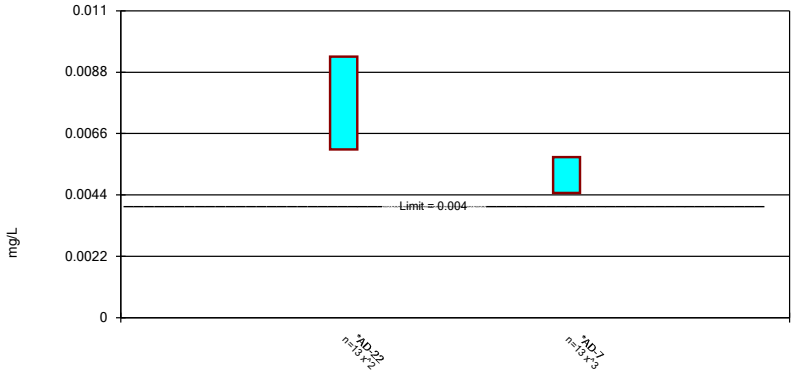
Deseasonalized Confidence Intervals - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 3:56 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Beryllium, total (mg/L)	**AD-22**	**0.009355**	**0.006032**	**0.004**	**Yes**	**13**	**0.007429**	**0.002706**	**0**	**None**	**x^2**	**0.01**	**Param.**
Beryllium, total (mg/L)	**AD-7**	**0.005761**	**0.004471**	**0.004**	**Yes**	**13**	**0.005046**	**0.0009302**	**0**	**None**	**x^3**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-22**	**0.09829**	**0.07274**	**0.056**	**Yes**	**13**	**0.08234**	**0.02336**	**0**	**None**	**x^3**	**0.01**	**Param.**
Cobalt, total (mg/L)	AD-7	0.03833	0.03041	0.056	No	13	0.0342	0.005454	0	None	x^2	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-7	4.162	3.027	5	No	13	3.487	0.9136	0	None	x^3	0.01	Param.

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

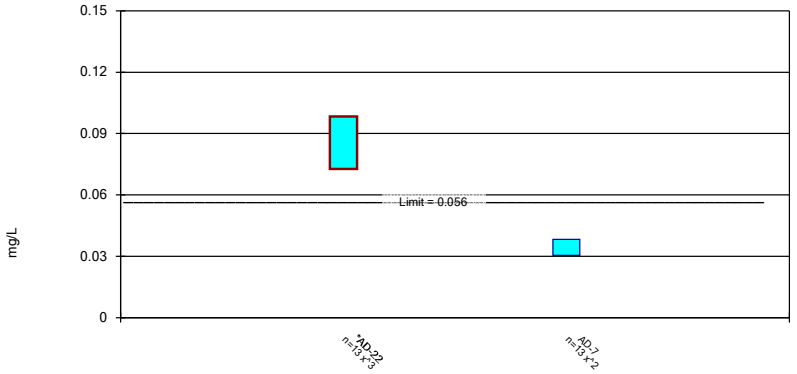


Constituent: Beryllium, total, Alt. Values Analysis Run 12/9/2019 3:55 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

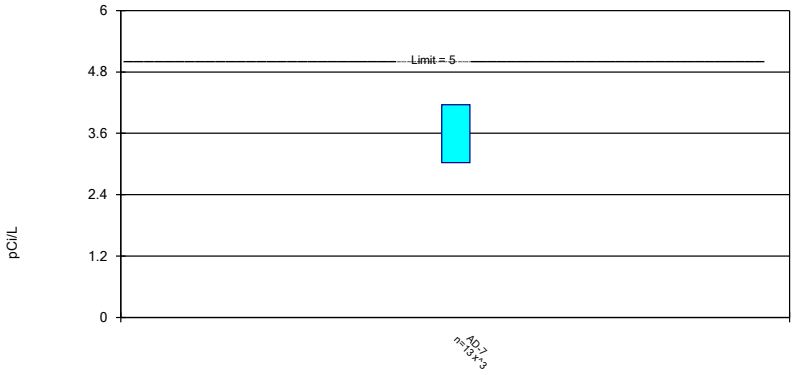


Constituent: Cobalt, total, Alt. Values Analysis Run 12/9/2019 3:55 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228, Alt. Values Analysis Run 12/9/2019 3:55 PM View: Appendix I
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant Flue Gas Desulfurization (FGD) Stackout Area Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

February 14, 2019

CHA8473

TABLE OF CONTENTS

FIGURES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FGD	Flue Gas Desulfurization
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION AND SUMMARY

In 2018, two assessment monitoring events were conducted at the FGD Stackout Area at the H.W. Pirkey Plant in accordance with 40 CFR 257.95. The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or regional screening level (RSL). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). An SSL was identified for mercury at AD-22 at the FGD Stackout Area (Geosyntec, 2018).

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSL identified for mercury at AD-22 should not be attributed to the Pirkey FGD Stackout Area.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSL identified for mercury at AD-22 was based on a Type III cause at AD-22 and not by a release from the Pirkey FGD Stackout Area.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSL identified for mercury and the proposed alternative source are described below.

2.1 Proposed Alternative Source

Initial review of site geochemistry, site historical data, and laboratory QA/QC data did not identify ASDs due to a Type I (sampling causes) or Type II (laboratory causes) issue. As described below, the SSL was attributed to a statistical evaluation cause, which is a Type III issue.

A review of mercury results at AD-22 suggests that mercury concentrations have decreased at AD-22 over time (Figure 1). As indicated by the Unified Guidance (USEPA, 2009), collecting "data over time and successively re-computing confidence limits is appropriate for stable (i.e., stationary) populations", but "can give misleading or false results when the underlying population is changing". In such cases, Section 7.4.4 of the Unified Guidance recommends the following:

> *An important preliminary step is to track the individual compliance point measurements on a time series plot. If a discrete shift in concentration level is evident, a confidence limit should be computed on the most recent stable measurements. Limiting the observations in this fashion to a specific time period is often termed a 'moving window.' The reduction in sample size will often be more than offset by the gain in statistical power. More recent measurements may exhibit less variation around the shifted mean value, resulting in a shorter confidence interval. The sample size included in the moving window should be sufficient to achieve the desired statistical power…However, measurements that are clearly unrepresentative of the newly shifted distribution should not be included, even if the sample size suffers.*

Based on the above recommendations, the mercury results at AD-22 were visually inspected on a time series plot and were tested for statistically significant trends via Mann-Kendall analysis. While the Mann-Kendall analysis indicated no significant increasing or decreasing trend ($\alpha = 0.02$) using all of the data, decreasing concentrations over time were observed on the time series plot (Figure 1). As a result, the statistical evaluation was limited to the "moving window" of the seven most recent data points (i.e., results collected from October 2016 onward), which were observed to exhibit similar behavior in terms of trend, average concentration, and variance. A confidence interval was calculated using this truncated dataset. The calculated LCL for mercury at AD-22 is 0.22 µg/L ($\alpha = 0.008$), which is below the GWPS for mercury of 2 µg/L. This confidence limit is considered more representative of current conditions at AD-22, and therefore there is no SSL for mercury at AD-22. The results of the statistical tests are included as Appendix A.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSL is not due to a release from the Pirkey FGD Stackout Area, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of mercury for AD-22 identified during assessment monitoring in 2018 was not due to a release from the Pirkey FGD Stackout Area. The identified SSL was, instead, attributed to an error in the statistical evaluation. Therefore, no further action is warranted, and the Pirkey FGD Stackout Area will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment B.

SECTION 4

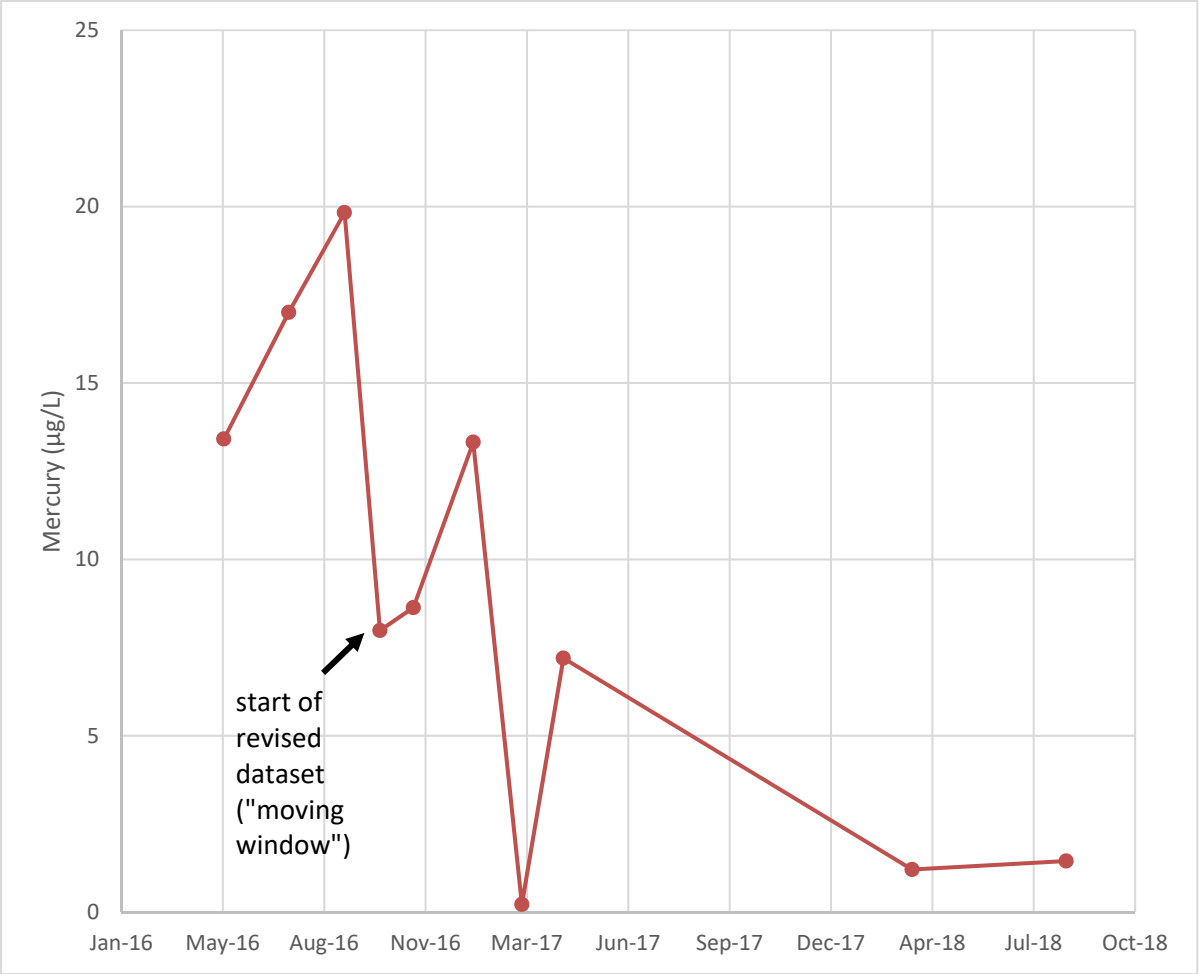
REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.

Geosyntec Consultants, 2018. Statistical Analysis Summary – H.W. Pirkey Power Plant. Hallsville, Texas. December.

United States Environmental Protection Agency (USEPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.



Notes: The dataset was truncated to all values after October 2016 based on similar behavior in terms of trend, average, concentration, and variance.

Mercury Time Series Graph for AD-22

Pirkey FGD Stackout Pad

Geosyntec consultants

AMERICAN ELECTRIC POWER

Figure 1

Columbus, Ohio

14-Feb-2019

internal info: path, date revised, author

ATTACHMENT A
Statistical Analysis Output

Trend Test Summary Table

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 2/5/2019, 8:16 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Mercury, total (mg/L)	AD-22	-0.00738	-25	-27	No	10	0	n/a	n/a	0.02	NP

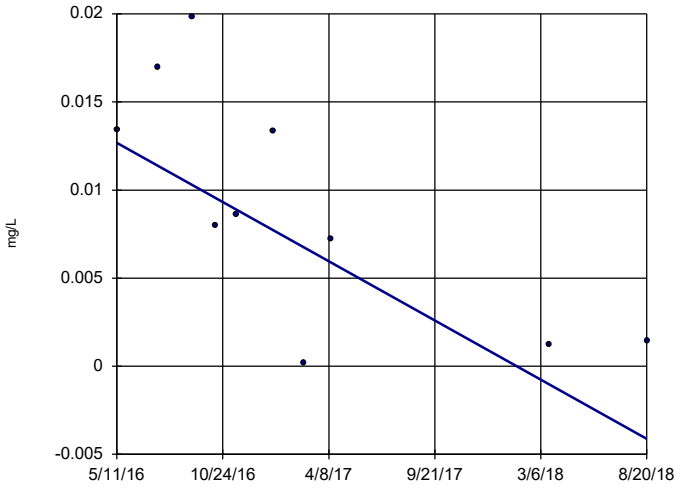
Confidence Interval Summary Table

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 2/5/2019, 8:16 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Mercury, total (mg/L)	AD-22	0.01332	0.00022	0.002	No	7	0	No	0.008	NP (selected)

Sen's Slope Estimator

AD-22



n = 10

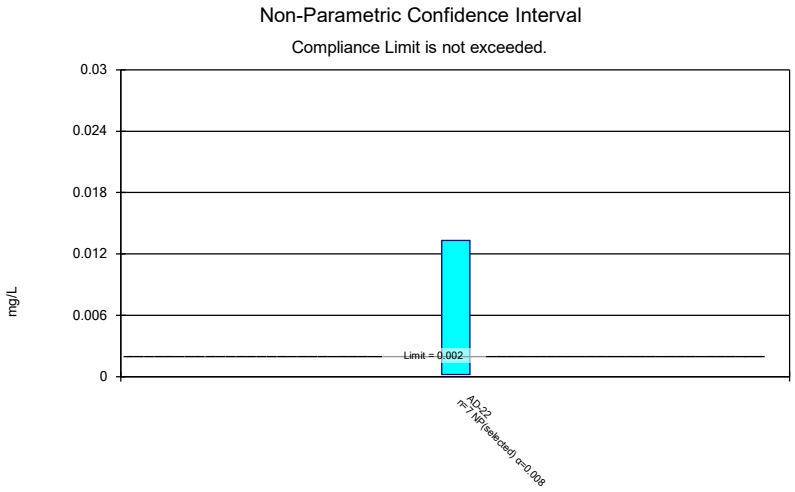
Slope = -0.00738 units per year.

Mann-Kendall statistic = -25 critical = -27

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Mercury, total Analysis Run 2/5/2019 12:58 PM

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout



Normality testing disabled.

Constituent: Mercury, total Analysis Run 2/5/2019 8:15 AM

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

ATTACHMENT B
Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD Stackout Area CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd , Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No F-1182

79864	Texas	February 18, 2019
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant Flue Gas Desulfurization (FGD) Stackout Area Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

October 3, 2019

CHA8462

TABLE OF CONTENTS

FIGURES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
FGD	Flue Gas Desulfurization
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the Flue Gas Desulfurization (FGD) Stackout Area (Figure 1). In February 2019, a semi-annual assessment monitoring event was conducted at the FGD Stackout Area in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were previously established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether these parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). At the FGD Stackout Area, an SSL was identified for beryllium at AD-22, where the LCL of 0.00413 milligrams per liter (mg/L) was above the calculated GWPS of 0.00400 mg/L (Geosyntec, 2019). No other SSLs were identified.

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSL identified for beryllium at AD-22 should not be attributed to the FGD Stackout Area.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSL identified for beryllium at AD-22 was based on a Type IV cause and not by a release from the Pirkey FGD Stackout Area.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSL identified for beryllium and the proposed alternative source are described below.

2.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSL has been attributed to natural variation associated with the seasonal effects, which is a Type IV issue.

As shown in Figure 2, beryllium concentrations at AD-22 appear to correlate with groundwater elevations in the well. These changes approximately correspond to annual cycles, with higher beryllium concentrations occurring in early spring and lower concentrations in early fall. EPRI guidance suggests evaluating major ion chemistry to assess if natural variability is due to seasonal change (EPRI, 2017). As shown in a Schoeller diagram in Figure 3, concentrations of almost all major ions tends to be higher in the early spring, with declining concentrations later in the year. A Kruskal-Wallis test, in which non-parametric analysis of variance testing for differences between seasons is completed, was performed to evaluate seasonality. The Kruskal-Wallis test found significant results at the 5% significance level (Attachment A).

Additional evidence shows that the beryllium concentration at AD-22 is correlated with seasonal changes in other constituents, including lithium and calcium (Figure 4). The correlation between beryllium and both monovalent (lithium) and divalent (calcium) cations suggests that the increases in beryllium concentration are related to cation exchange phenomenon in the native soil.

A review of the boring log for AD-22 shows that clay is present from 0.5 to 12 feet below ground surface (ft bgs), which corresponds to elevations of 343 to 354.5 feet above mean sea level (ft amsl) (Attachment B). Groundwater elevations during the background monitoring period fluctuated between approximately 344 and 351 ft amsl, resulting in variation in the amount of the clay that was in contact with groundwater. At higher groundwater elevations, more clay material is in contact with groundwater, allowing greater desorption of cations from the cation exchange sites on the clay. As shown in Figure 2, higher groundwater elevations correlated with higher beryllium concentrations.

A groundwater sample was collected from AD-22 and then passed through a 1.5-micron filter. The solid material retained on the filter was submitted for analysis of total metals and by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS).

The SEM/EDS analysis showed that the solid material separated from groundwater was composed of abundant clay-size particles with mainly aluminum and silicon identified in the EDS output (Attachment C). The presence of these clay particles provides evidence to support the hypothesis that elevated beryllium is due to desorption from the cation exchange sites on the clays.

The exceedance for beryllium at AD-22 was attributed to the effects of seasonal groundwater elevation changes, and the resulting cation exchange between groundwater and the confining clay above the aquifer material, on groundwater quality. Additionally, the lack of other Appendix IV exceedances and the marginal difference between the LCL for AD-22 and the GWPS provides additional evidence that the beryllium exceedance should not be attributed to the FGD Stackout Area.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSL is not due to a release from the Pirkey FGD Stackout Area, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of beryllium at AD-22 identified during assessment monitoring in February 2019 was not due to a release from the FGD Stackout Area. The identified SSL was, instead, attributed to seasonal effects on groundwater quality, which is an effect of natural variation. Therefore, no further action is warranted, and the Pirkey FGD Stackout Area will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment D.

SECTION 4

REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.

Geosyntec Consultants, 2019. Statistical Analysis Summary, FGD Stackout Area. H.W. Pirkey Power Plant. Hallsville, Texas. July.

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

FIGURES

Monitoring Well Network

- Downgradient Sampling Location
- Upgradient Sampling Locatoin
- FGD Stackout Pad

Notes
- Monitoring well coordinates and water level data provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.

500 250 0 500 Feet

Site Layout
FGD Stackout **Area**

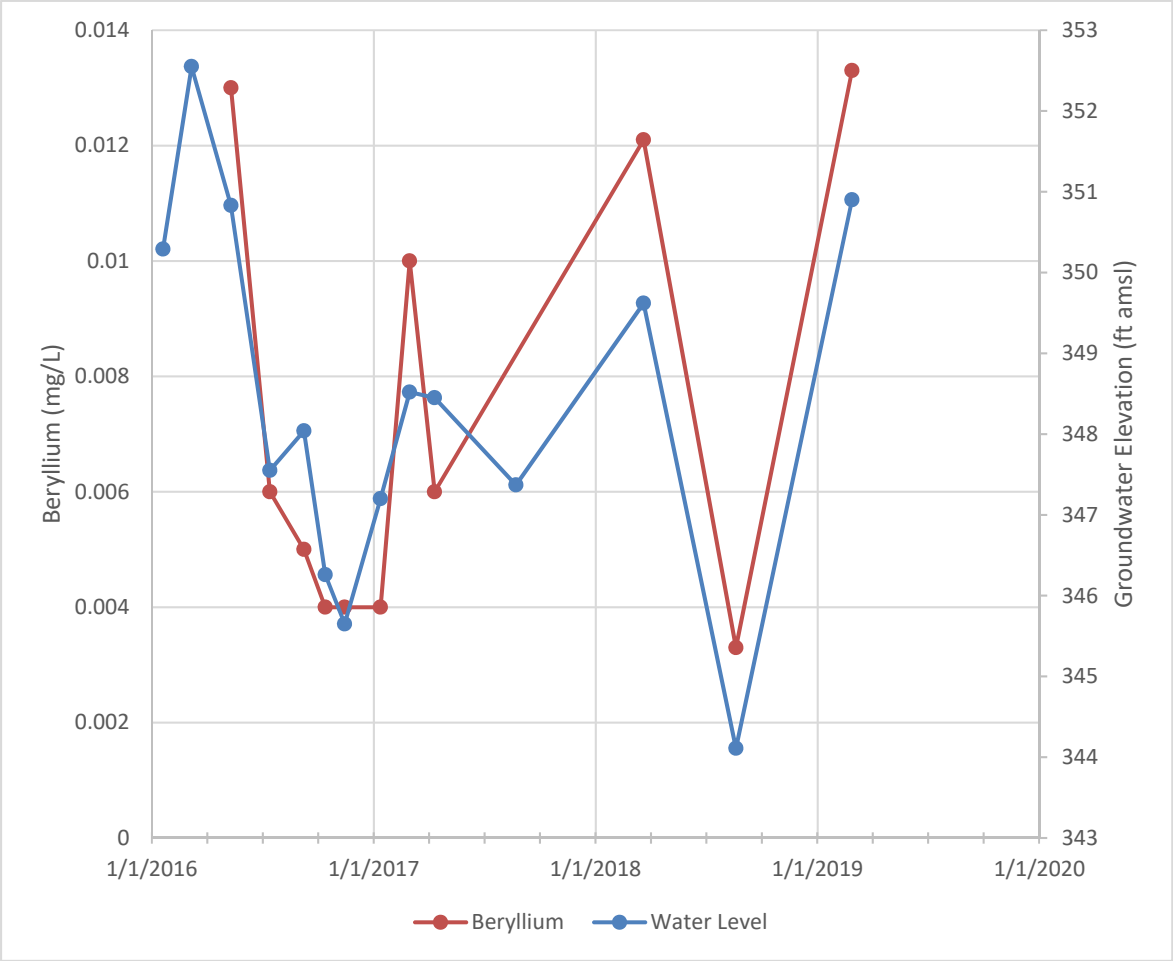
AEP Pirkey Power Plant Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2018/01/26

Figure 1

C:\Users\mmuenich\Documents\local_projects\AEP_GIS\Pirkey\MXDs\AEP-Pirkey_Stacker_Site_Layout.mxd. MMuenich. 1/26/2018. Project/Phase/Task.



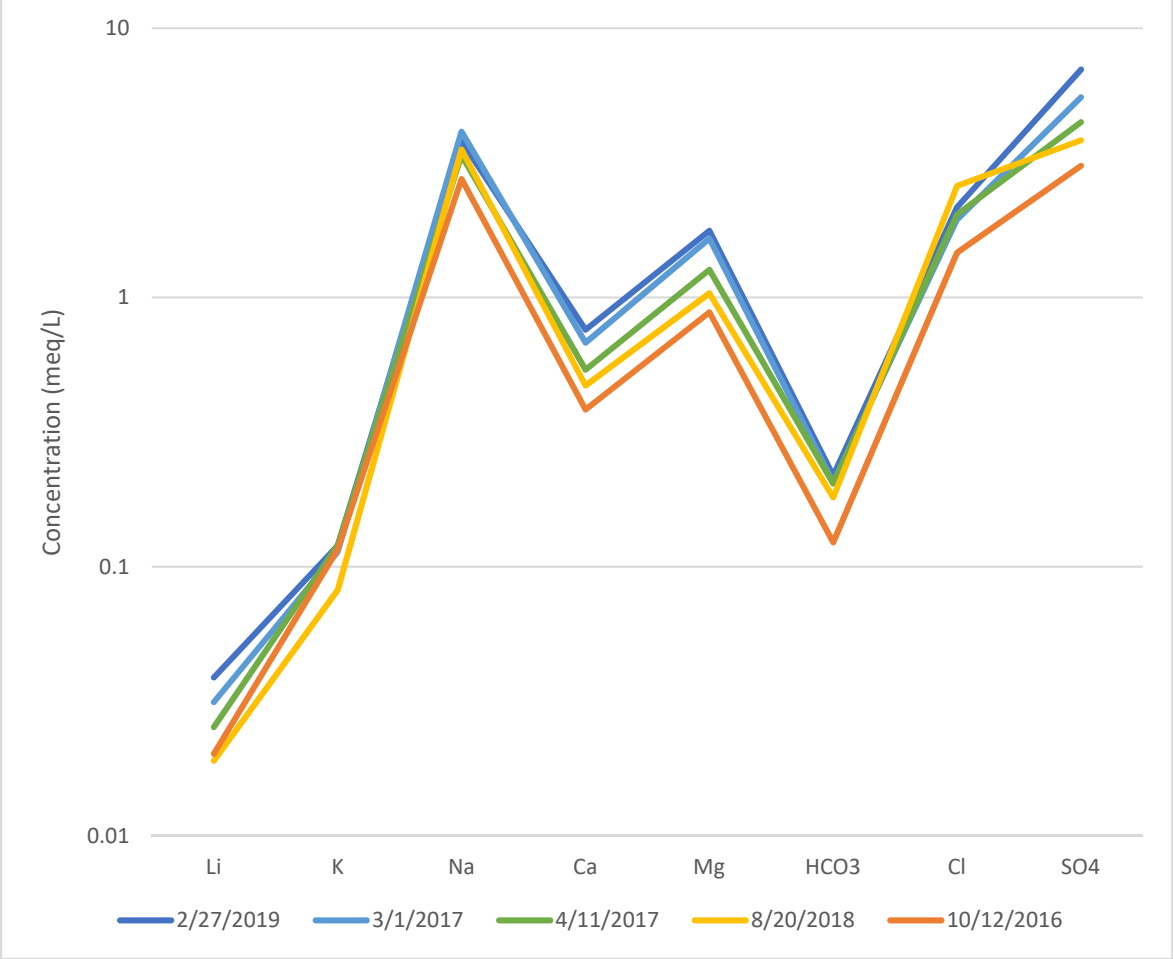
Notes: Beryllium concentrations are shown in milligrams per liter (mg/L). Groundwater elevation is shown as feet above mean sea level (ft amsl).

Beryllium v. Groundwater Elevation
Pirkey FGD Stackout Pad

Geosyntec consultants | AMERICAN ELECTRIC POWER | Figure 2

Columbus, Ohio | 23-Sep-2019

internal info: path, date revised, author



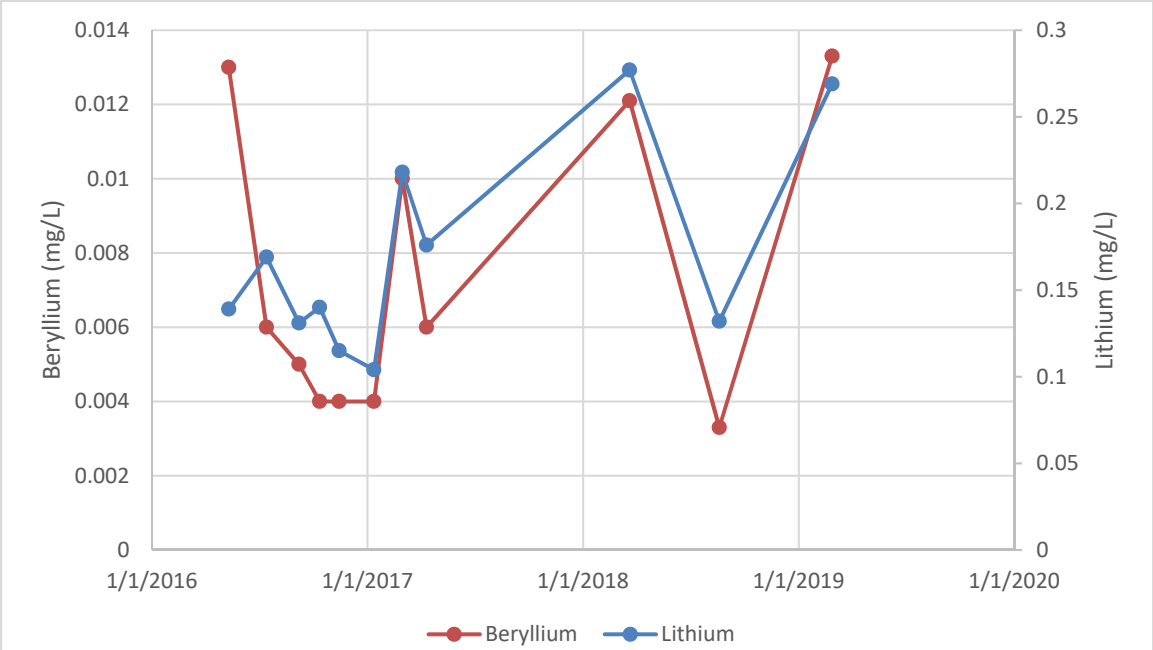
Notes: Concentrations are shown in milliequivalents per liter (meq/L).

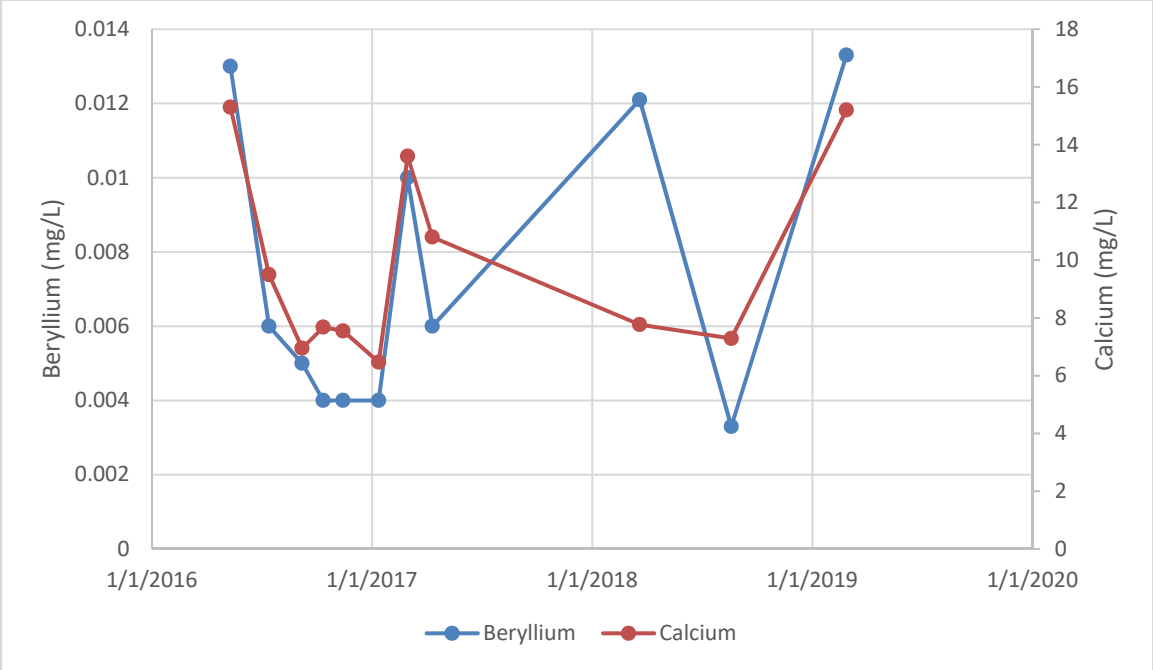
AD-22 Schoeller Diagram
Pirkey FGD Stackout Pad

Geosyntec consultants | AMERICAN ELECTRIC POWER | Figure 3

Columbus, Ohio | 23-Sep-2019

internal info: path, date revised, author





Notes: Beryllium, lithium, and calcium concentrations are shown in milligrams per liter (mg/L).

Beryllium v. Cations
Pirkey FGD Stackout Pad

Geosyntec consultants

AMERICAN ELECTRIC POWER

Figure 4

Columbus, Ohio

23-Sep-2019

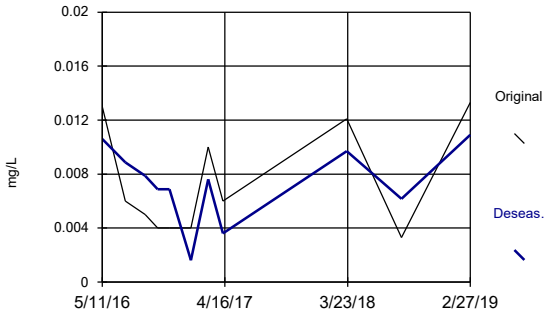
internal info: path, date revised, author

ATTACHMENT A

Statistical Evaluation - Seasonality at AD-22

Seasonality: AD-22

For the selected data, the Kruskal-Wallis test indicates SEASONALITYat the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one season has a significantly different median concentration of this constituent than any other season.
Calculated Kruskal-Wallis statistic = 4.511
Tabulated Chi-Squared value = 3.841 with 1 degrees of freedom at the 5% significance level.
There were 2 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 4.408
Adjusted Kruskal-Wallis statistic (H') = 4.511



Constituent: Beryllium, total Analysis Run 9/22/2019 7:11 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

ATTACHMENT B
AD-22 Boring Log

☐ BORING ■ MONITOR WELL

APEX PROJECT NO.: 110-089 BORING NUMBER: ____ MONITOR WELL NUMBER: AD-22

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/16/2010

PREPARED BY: David Bedford LOGGED BY: David Bedford

LATTITUDE: N 32°27'03.3" Datum: WGS-84 WELL LOCATION: Triangle- South side Quansit Hut

LONGITUDE: W94°29'41.3"

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-0.5	SC	Clayey sand, light brown, very fine grained	None	Moist
2			0.5-12	CL	Lean clay, light brown mottled with light gray	None	Slightly Moist
3							
4					Few iron ore (small) pebbles in clayey sandy streaks		
5							
6							
7							
8							
9							
10							
11							
12							
13			▽	12-20	SC	Clayey sand, grayish brown with orangish brown streaks, very fine grained	None	Slightly Wet
14					Slightly wet @ 12.5' from seepage		
15					Large amount of iron ore 15-17'		
16							
17							
18							
19					Very firm 18-18.5'		
20							
21				20-25	SC	(Dense crystalline rock 21-21.1'), light brown clayey sand, greenish black, mica, black clay streaks, very fine grained, wet @ 20'	None	Wet
22							
23							
24							
25							
26				25-30	SM	Sand, greenish brown (1') grading to orangish brown, silty, very fine grained	None	Wet
27							
28							
29							
30							
31					Boring Terminated at 30'		
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cement Bentonite Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet Riser Interval: +3 (ags)-10'

Filter Sand (Size/Interval): 8-30' Screen Interval: 10-30'

Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8' Water level: 12.5'

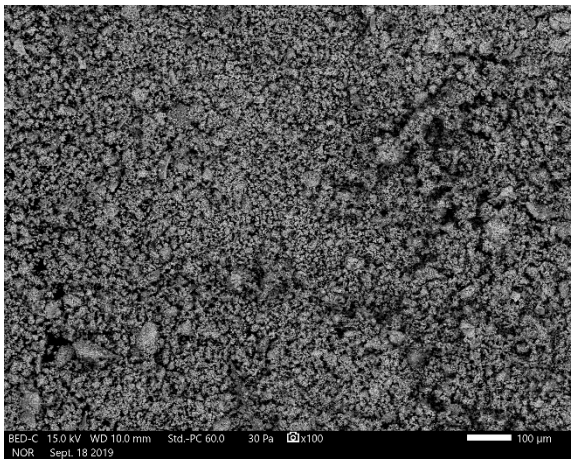
Surface Completion ☐ Flush ■ Above Ground 3'

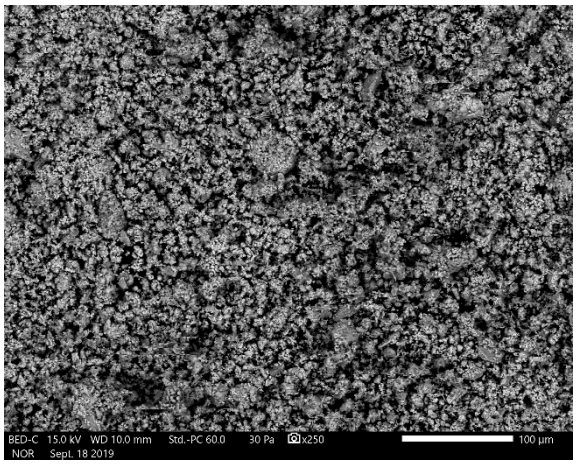
Note: This log is not to be used separate from this report.

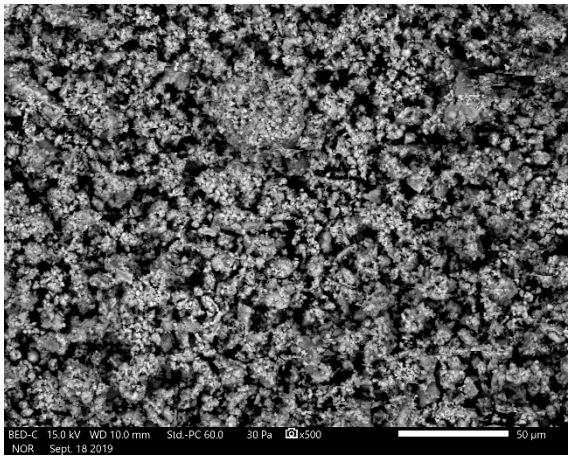
ATTACHMENT C
SEM/EDS Analysis

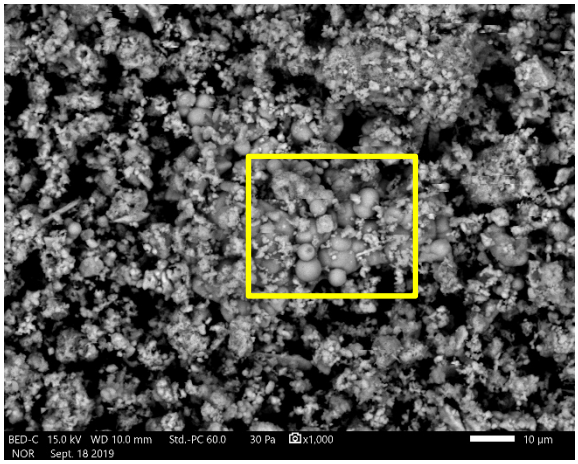
September 22, 2019

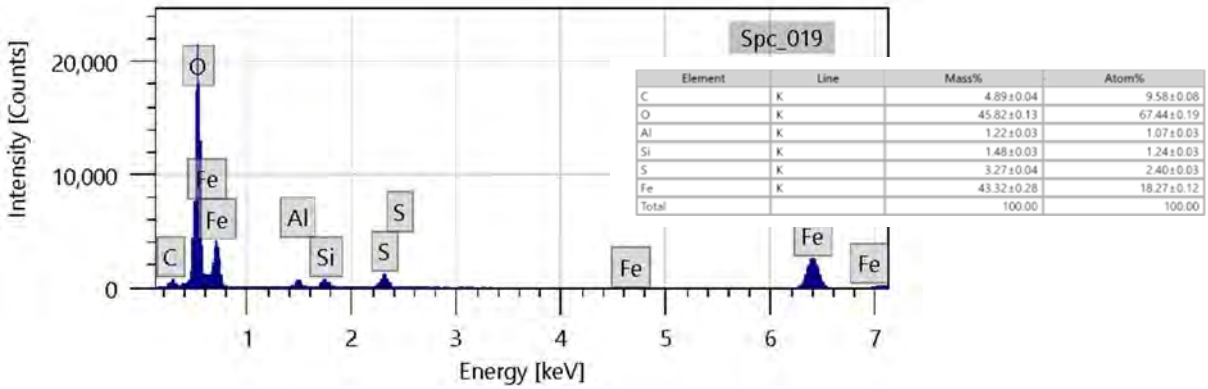
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221
via Email: BSass@geosyntec.com











Sample AD-22. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 1000 X. EDS spectrum at bottom is an area scan of the region shown in the 1000X micrograph. The analysis is shown on the right. The globular phase appears to consist mainly of iron oxide/hydroxide.

ATTACHMENT D
Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD Stackout Area CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864	Texas	10/3/2019
License Number	Licensing State	Date

APPENDIX IV

Notices of groundwater monitoring program transitions are included in this appendix.

APPENDIX V

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #506035

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.08" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 58.82" W**
Well County:	**Harrison**	Elevation:	**No Data**
			****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #185184**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/19/2019** Drilling End Date: **2/20/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**31**	**38**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

	Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Plug Information:	**SAND**	**50**	**60**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**clay brown**
1	**5**	**silty sand**
5	**9.5**	**clay**
9.5	**11**	**sand**
11	**32**	**clay**
32	**39**	**sand and clay**
39	**55**	**sand**
55	**60**	**fine sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**40**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**40**	**50**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS PLUGGING REPORT for Tracking #185184

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.08" N**
		Longitude:	**094° 29' 58.82" W**
	LOCATED ON OWNERS PROPERTY	Elevation:	**No Data**
Well County:	**Harrison**		

Well Type: **Monitor**

Drilling Information

Company: **Plains Environmental Services** Date Drilled: **2/20/2019**

Driller: **Jesse Kalvig** License Number: **5025**

Well Report Tracking #506035

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Plugging Information

Date Plugged: **2/21/2019** Plugger: **Jesse Kalvig**

Plug Method: **Pour in 3/8 bentonite chips when standing water in well is less than 100 feet depth, cement top 2 feet**

Casing Left in Well:

DIa (in.)	*Top (ft.)*	*Bottom (ft.)*
2	**15**	**50**

Plug(s) Placed in Well:

Top (ft.)	*Bottom (ft.)*	*Description (number of sacks & material)*
1	**40**	**Bentonite 10 Bags/Sacks**

Certification Data: The driller certified that the driller plugged this well (or the well was plugged under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the reports(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

STATE OF TEXAS WELL REPORT for Tracking #506039

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD37**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Latitude:	**32° 27' 56.32" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 41.78" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**17**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**10**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**8.5**	**CLAYS WITH SOME SAND**
8.5	**10.5**	**SAND**
10.5	**13**	**CLAY SOME SAND**
13	**15**	**SAND WITH SOME CLAYS**
15	**17**	**CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**12**	**17**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506038

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD38**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 46.12" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 43.34" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/21/2019** Drilling End Date: **2/21/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**CLAY RED**
5	**7**	**CLAY GRAY/RED**
7	**11.5**	**SAND/CLAY**
11.5	**17.5**	**SAND SOME CLAYS**
17.5	**18**	**CLAY SLITS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506037

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD39**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.05" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 58.84" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/20/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**12**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**5**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**CLAY**
1	**5**	**CLAY/SAND**
5	**9.5**	**CLAY**
9.5	**12**	**SAND/CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**7**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**7**	**12**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508688

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**AD-40 (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/10/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**40**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
27	**40**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**13**	**Cement**
13	**27**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**40**	**red and grey sand with occasional clay intervals**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**30**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**30**	**40**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508686

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB(MW)-01A**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/9/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**100**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
86	**100**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**86**	**Bentonite 17 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**85**	**red and grey sand with occasional clay intervals**
85	**88**	**grey clay**
88	**100**	**grey sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**90**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**90**	**100**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508703

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**22**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**22**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**3**	**Cement**
3	**8**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**22**	**red and grey sand w/occ. lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**12**	**22**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508695

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**80**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
56	**80**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**56**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**36**	**red and grey sand w/occ. lignite layers**
36	**41**	**red and tan clay**
41	**69**	**red and grey sand with occasional clay iand lignite layers**
69	**80**	**grey sandy clay with lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**59**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**59**	**69**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508712

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/24/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**25**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
12	**25**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**12**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**25**	**brown sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**15**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**15**	**25**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508708

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
45	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**45**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**28**	**brown sand**
28	**41**	**brown and grey silty clay**
41	**70**	**grey sand with occasional lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506040

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6S**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 30.34" N**
		Longitude:	**094° 29' 27.76" W**
	LOCAATED ON OWNERS PROPERTY	Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**18**	**SANDS AND CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506041

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6D**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 30.28" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 27.75" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**65**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**53**	**Bentonite 19 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**24**	**SANDS AND CLAYS**
24	**29**	**CLAYS**
29	**42.5**	**SANDS AND CLAYS**
42.5	**48.5**	**SANDS WITH SOME CLAY**
48.5	**56**	**CLAYS WITH SOME SAND**
56	**65**	**SILY SANDS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508722

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/3/2019** Drilling End Date: **3/3/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**45**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
32	**45**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**32**	**Bentonite 6 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**45**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**35**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**35**	**45**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508720

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
57	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**57**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**70**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**60**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**60**	**70**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508724

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**35**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**35**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**23**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**35**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**25**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**25**	**35**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508729

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 medium (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**65**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
52	**65**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**53**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**65**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508777

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/26/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**93**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
77	**93**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**77**	**Bentonite 15 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**90**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**
90	**93**	**gray clay (old pit base?)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**80**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**80**	**90**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508781

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/5/2019** Drilling End Date: **3/5/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**30**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
17	**30**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**17**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**30**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**20**	**30**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508779

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/4/2019** Drilling End Date: **3/4/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**60**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
48	**60**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**48**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**60**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508718

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/8/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**15**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**15**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement**
1	**3**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**5**	**15**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508717

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/7/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**43**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
30	**43**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**30**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**
18	**43**	**red and grey sand w/occ. clay layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**33**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**33**	**43**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Annual Groundwater Monitoring Report

Southwestern Electric Power Company

H. W. Pirkey Power Plant

Landfill CCR Management Unit

Hallsville, Texas

January 2020

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY

An AEP Company

BOUNDLESS ENERGY

Page

Table of Contents

I. Summary

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2020.

In general, the following activities were completed:

- Groundwater samples were collected for the wells the landfill groundwater monitoring network in February, May, and August 2019 and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- The unit was in Assessment monitoring at the beginning and end of 2019;
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cadmium and cobalt at wells AD-34 on December 26, 2018. Since the Alternate source demonstration was not completed, and assessment of corrective measures was initiated on March 26, 2019. An alternate source for cadmium and cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 22, 2019. As a result, assessment of corrective measure work stopped, and the unit stayed in assessment monitoring;
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt and lithium at wells AD-34 on July 11, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 24, 2019;
- An alternate source for the statistically significant increases (SSI) over background that caused this unit to transition to assessment monitoring was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on January 7, 2020. As a result, the unit is returning to detection monitoring;
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

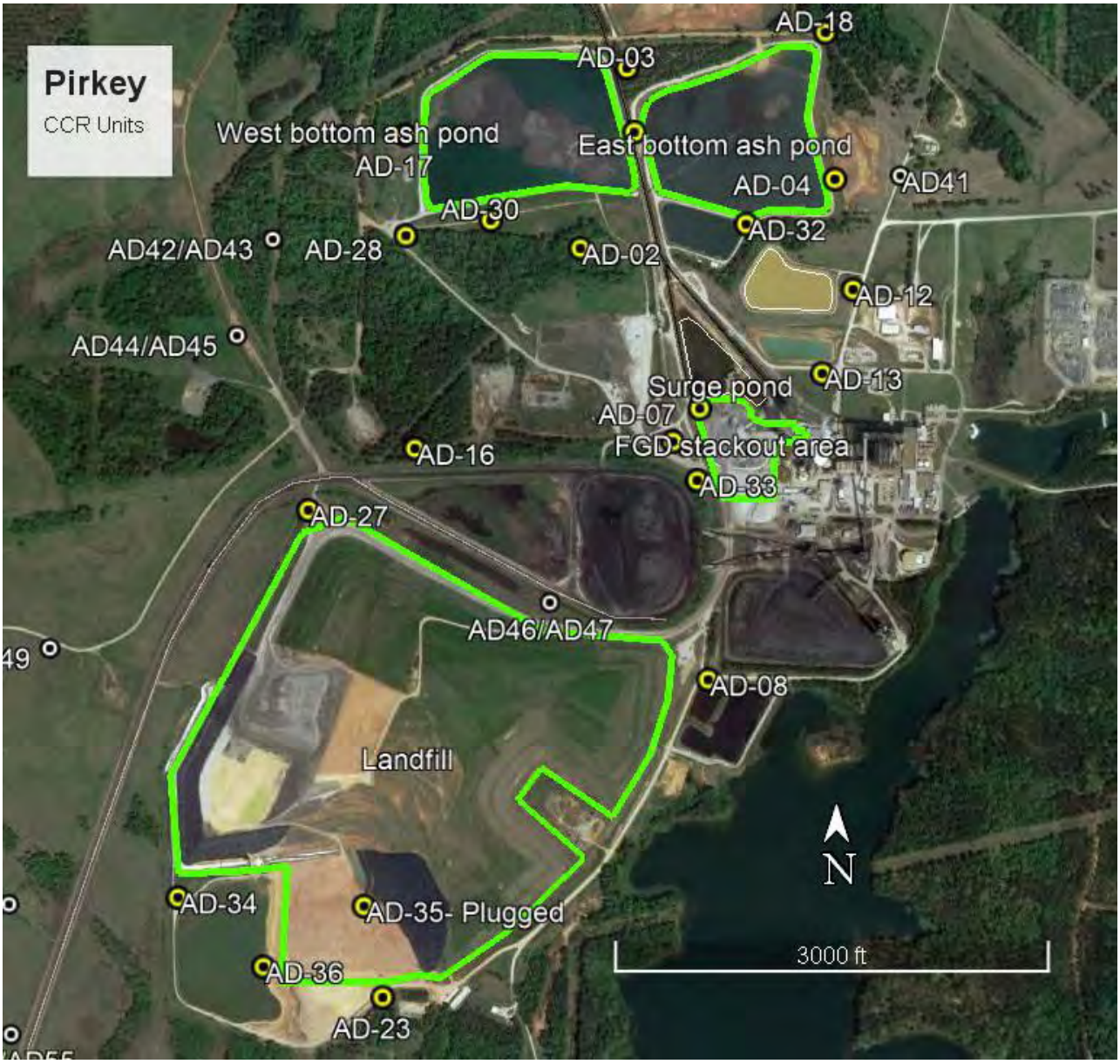
- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in Appendix I;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations (Appendix IV).
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

Landfill Monitoring Wells	
Up Gradient	Down Gradient
AD-8	AD-23
AD-12	AD-34
AD-16	AD-35 (decommissioned)
AD-27	AD-36 (installed 2019)



III. Monitoring Wells Installed or Decommissioned

There was one monitoring well (AD-36) installed in 2019 to replace AD-35 that was plugged in 2018. The well installation report can be found in Appendix V. The AD-35 was in the footprint of a new cell for the landfill. The network design has been updated, as summarized in the *Groundwater Monitoring System Design and Construction Certification Report*.

Several monitoring wells were installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry in mine spoils. Please see a list below.

Soil Boring ID	Monitor Well ID
	AD-37
	AD-38
	AD-39
	AD-40
SB-01A	AD-41
SB-04	AD-42
SB-04	AD-43
SB-05	AD-44
SB-05	AD-45
SB-06	AD-46
SB-06	AD-47
SB-07	AD-48
SB-07	AD-49
SB-08	AD-50
SB-08	AD-52
SB-08	AD-53
SB-09	AD-54
SB-09	AD-55
SB-11	AD-56
SB-11	AD-57

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event also are shown in Appendix I, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., one round of sampling was conducted in February from wells AD-8, AD-12, AD-16, AD-23, AD-27, and AD-34 in accordance with 40 CFR 257.95(d)(1). A May sampling event from wells AD-8, AD-12, AD-16, AD-23, AD-27, and AD-34 was conducted in accordance with 40 CFR 257.95(b) including all

Appendix III parameters and those Appendix IV constituents parameters. Wells AD-8, AD-12, AD-16, AD-23, AD-27, AD-34, and AD-36 were sampled in August in accordance with 40 CFR 257.95(d)(1). Detection monitoring will continue in 2020.

V. Statistical Evaluation of 2019 Events

The one statistical analysis report available for this reporting period is included in Appendix II.

Statistically significant levels (SSLs) above the groundwater protection standard were identified for lithium and cobalt at AD-34 as summarized in *Statistical Analysis Summary Landfill Report* on July 11, 2019 in Appendix II.

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the cadmium and cobalt SSLs above the GWPS at AD-34. An alternate source for cadmium and cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 22, 2019. As a result, assessment of corrective measure work stopped, and the unit stayed in assessment monitoring;

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt and lithium at wells AD-34 on July 11, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 24, 2019.

An alternate source for the statistically significant increases (SSI) over background that caused to unit to transition to assessment monitoring was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on January 7, 2020. As a result, the unit is returning to detection monitoring.

Documentation supporting these findings are found in Appendix III.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

On April 3, 2018, no alternate source was found for SSIs over background, so the unit transitioned to assessment monitoring. On December 26, 2019, SSLs above GWPS were identified. On March 26, 2019, no alternate sources were identified for the unit, so it transitioned into assessment of corrective measures. On April 22, 2019, an alternate source was identified, so the unit did not continue assessment of corrective measures work and remained in assessment monitoring.

On January 7, 2020, an alternate source was found for the SSIs determined for boron, total dissolved solids (TDS), and sulfate as summarized in *Groundwater Monitoring Statistical Evaluation Report* (1/3/2018), so the unit returned to detection monitoring.

Detection monitoring will continue in 2020.

Regarding defining an alternate monitoring frequency, no modification of the twice-per-year detection monitoring effort is needed.

VIII. Other Information Required

No other information applies at this time.

IX. Description of Any Problems Encountered in 2019 and Actions Taken

No problems were encountered this year.

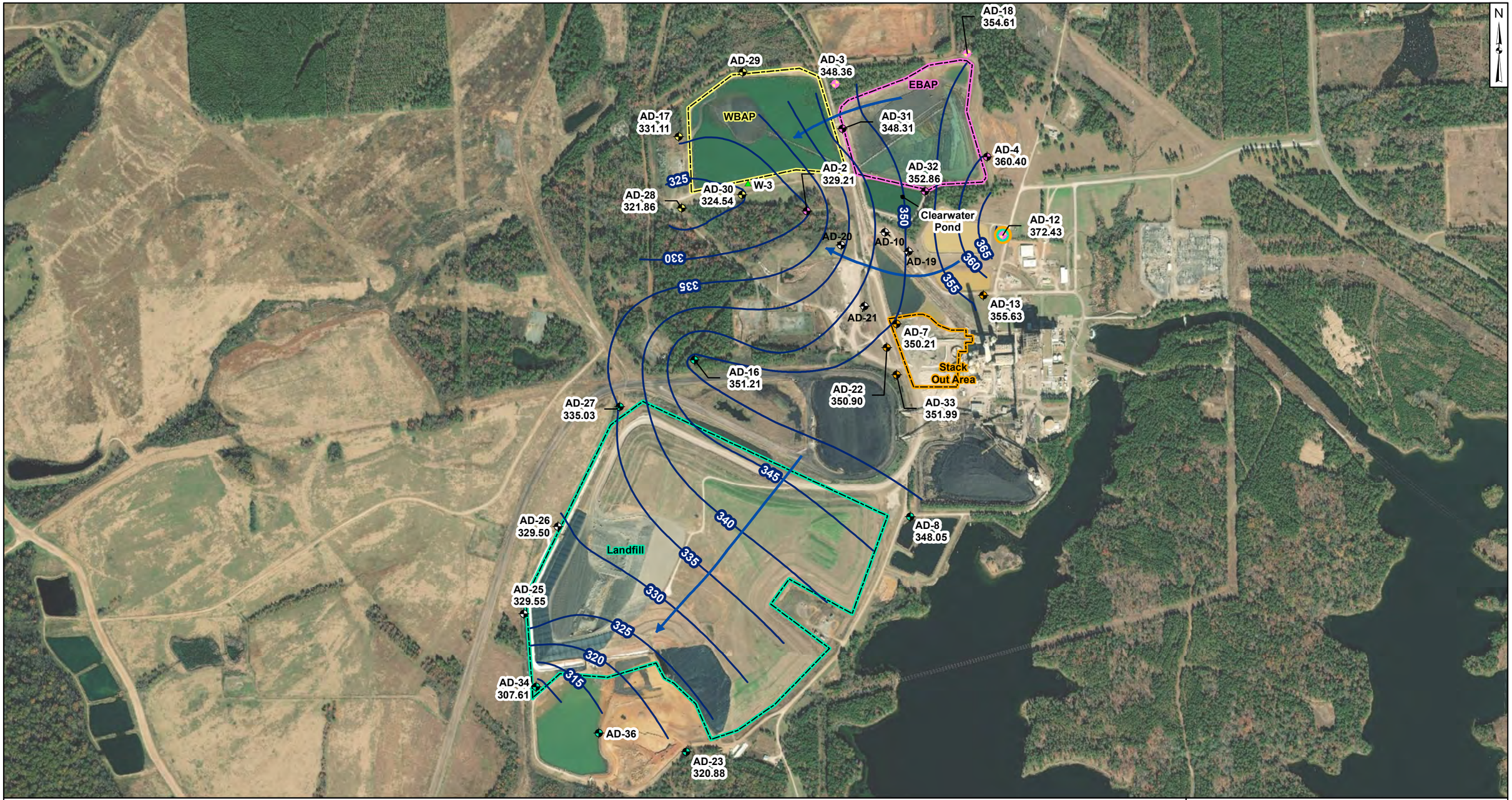
X. A Projection of Key Activities for the Upcoming Year

Key activities for 2020 include:

- Detection monitoring sampling will be conducted;
- Evaluation of the detection monitoring results from a statistical analysis viewpoint, looking for any SSIs over background;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the fourth annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on February 23-28, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in February 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer February 2019

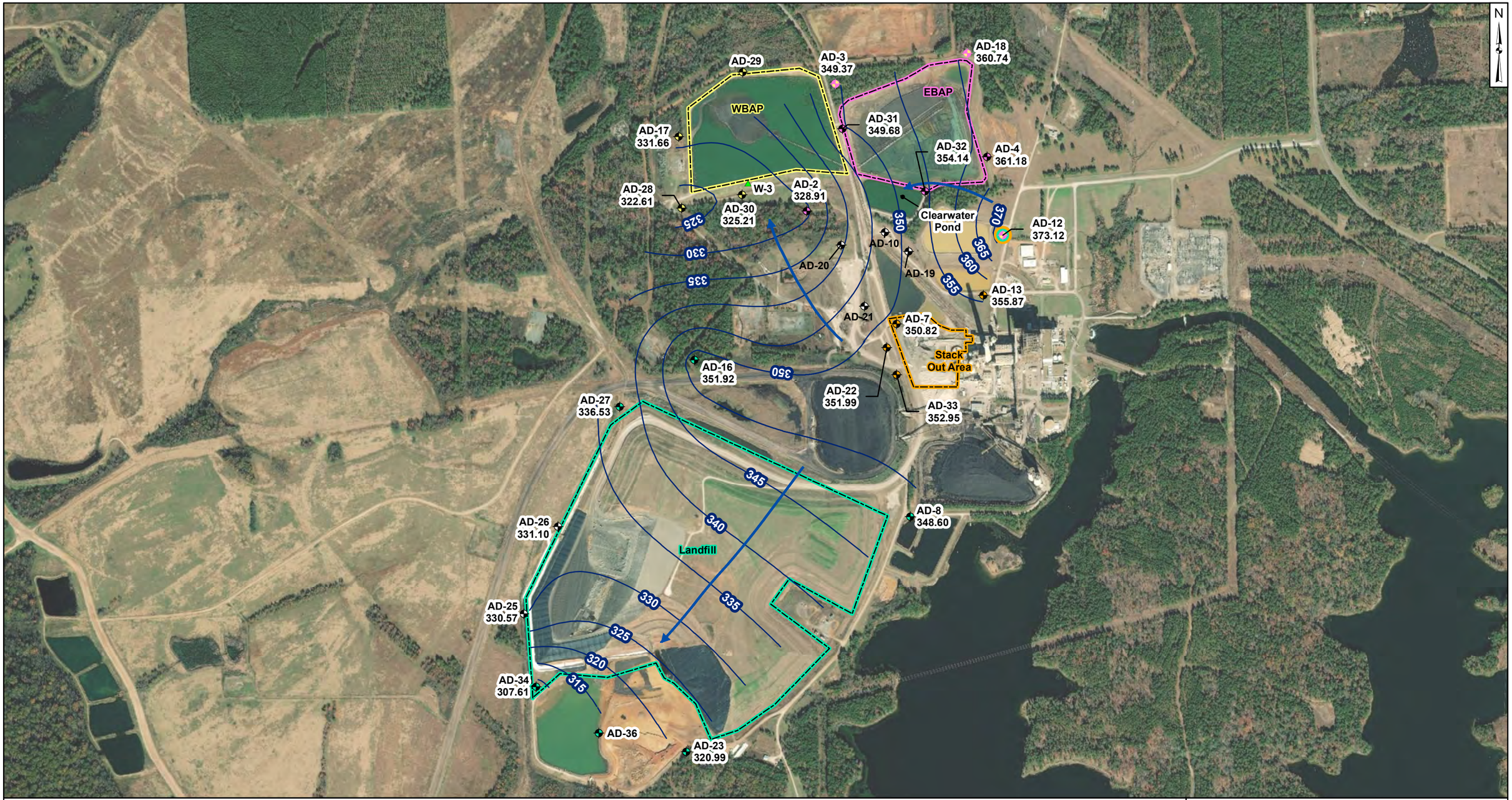
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201902-February.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 21-23, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in May 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer May 2019

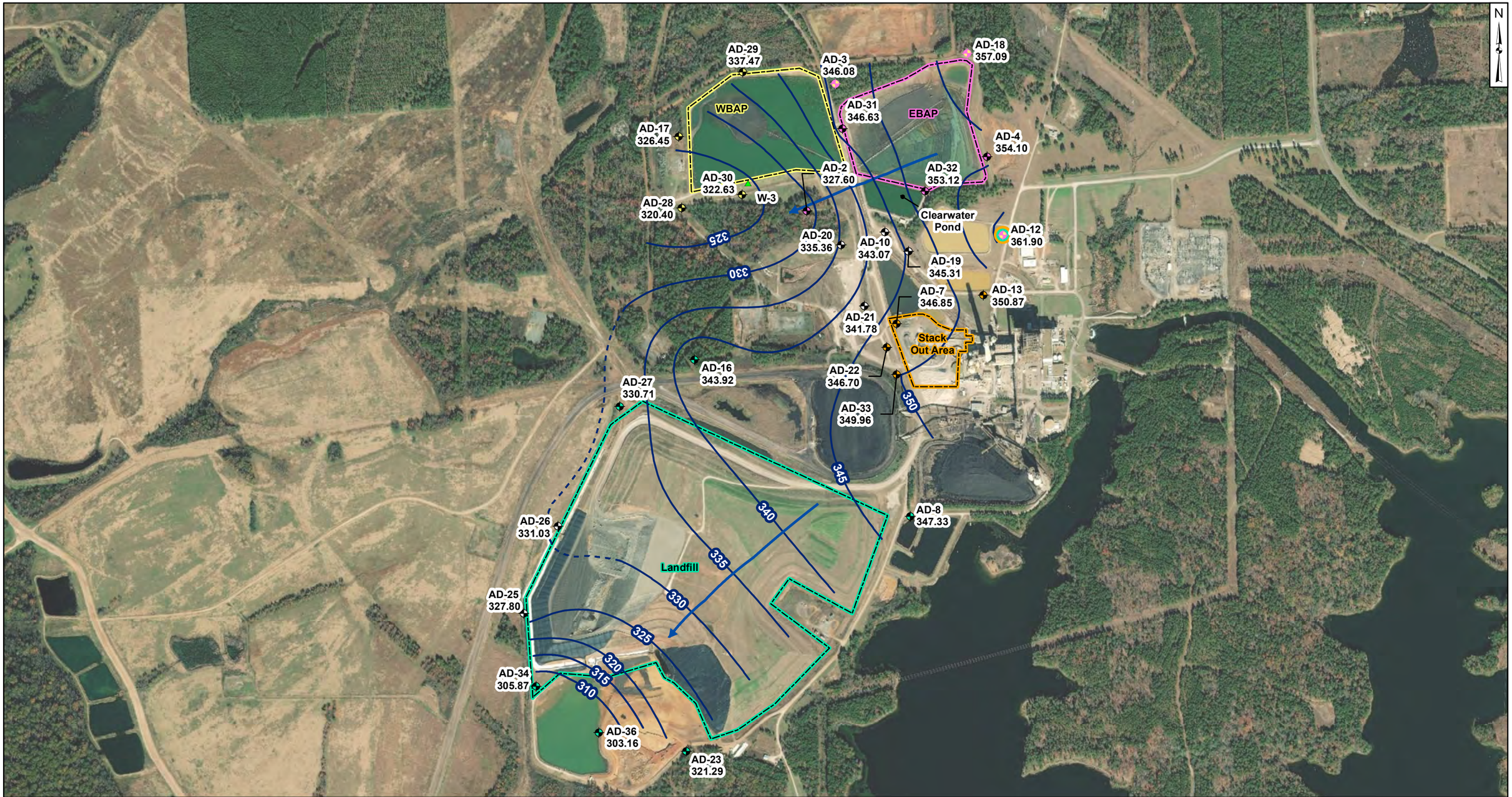
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure **2**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201905-May.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on August 12-16, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in August 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure 3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201908-August.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.

Table 1: Residence Time Calculation Summary
Pirkey Landfill

Geosyntec Consultants, Inc.

CCR Management Unit	Monitoring Well	Well Diameter (inches)	2019-02		2019-05		2019-08	
			Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
Landfill	AD-8 [1]	4.0	10.4	11.7	6.6	18.5	6.8	17.8
	AD-12 [1]	4.0	34.2	3.6	35.0	3.5	21.4	5.7
	AD-16 [1]	2.0	26.4	2.3	28.3	2.2	22.6	2.7
	AD-23 [2]	2.0	10.8	5.6	10.3	5.9	10.9	5.6
	AD-27 [1]	2.0	19.4	3.1	18.4	3.3	16.7	3.6
	AD-34 [2]	2.0	32.3	1.9	33.6	1.8	28.5	2.1
	AD-36 [2]	2.0	NC	NC	NC	NC	34.4	1.8

Notes:
[1] - Background Well
[2] - Downgradient Well

Table 1 - Groundwater Data Summary: AD-8
Pirkey - Landfill
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	1.58	109	9	<0.083 U	6.1	432	181
7/13/2016	Background	0.775	20.7	13	2	6.2	280	131
9/8/2016	Background	1.04	50.7	12	2	5.1	285	121
10/12/2016	Background	0.793	20.8	13	2	3.7	276	184
11/15/2016	Background	0.769	17.2	13	3	3.7	296	208
1/11/2017	Background	0.734	18.6	13	3	3.6	280	228
2/28/2017	Background	0.777	18.1	10	2	3.7	250	157
4/11/2017	Background	0.779	17.1	12	3	3.9	284	168
8/23/2017	Detection	0.411	19.4	9	0.587 J	3.9	110	56
3/21/2018	Assessment	1.03	56.1	8	1.1987	5.7	278	140
8/20/2018	Assessment	0.714	14.5	18	5.1991	3.7	300	168
2/28/2019	Assessment	1.05	103	6.83	0.40	5.7	462	175
5/21/2019	Assessment	1.11	85.5	4.48	0.33	5.9	296	127
8/13/2019	Assessment	0.818	27.6	12.7	3.39	4.6	260	128

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-8
Pirkey - Landfill
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	<0.93 U	<1.05 U	38	1	<0.07 U	1	1.80288 J	0.9155	<0.083 U	1.02541 J	<0.00013 U	0.027	<0.29 U	15	1.19926 J
7/13/2016	Background	<0.93 U	1.16508 J	61	7	0.175996 J	1	20	6.75	2	1.46729 J	0.032	0.211	<0.29 U	<0.99 U	<0.86 U
9/8/2016	Background	<0.93 U	<1.05 U	48	2	<0.07 U	0.835837 J	9	1.658	2	<0.68 U	0.018	0.048	<0.29 U	3.84567 J	<0.86 U
10/12/2016	Background	<0.93 U	1.46586 J	61	6	<0.07 U	0.74214 J	18	6.72	2	2.30733 J	0.032	0.112	<0.29 U	2.51464 J	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	52	6	0.118693 J	0.805286 J	18	6.14	3	2.85553 J	0.03	0.16	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	1.53134 J	60	6	0.108717 J	2	18	6.29	3	2.99592 J	0.032	0.157	<0.29 U	1.4083 J	<0.86 U
2/28/2017	Background	<0.93 U	1.68597 J	52	6	0.13889 J	0.633257 J	18	7.64	2	3.26919 J	0.031	0.153	<0.29 U	1.78549 J	<0.86 U
4/11/2017	Background	<0.93 U	<1.05 U	51	6	0.128137 J	0.887504 J	19	5.56	3	2.44168 J	0.031	0.01068 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	37.9	2.57	<0.07 U	<0.23 U	9.38	2.499	1.1987	0.95 J	0.01503	0.049	<0.29 U	27.68	<0.86 U
8/20/2018	Assessment	0.02 J	4.05	33.4	4.55	0.18	0.759	15.9	0.145	5.1991	4.46	0.0221	0.105	0.02 J	9.8	0.083
2/28/2019	Assessment	<0.4 U	<0.6 U	46.8	<0.4 U	<0.2 U	<0.8 U	0.8 J	1.066	0.40	<0.4 U	0.002 J	<0.005 U	<8 U	30.8	<2 U
5/21/2019	Assessment	<0.4 U	1 J	42.8	1 J	<0.2 U	<0.8 U	<0.4 U	1.786	0.33	<0.4 U	0.0003 J	0.009 J	<8 U	23.9	<0.1 U
8/13/2019	Assessment	0.03 J	2.13	44.1	4.05	0.16	0.368	12.7	3.77	3.39	1.31	0.0255	0.059	<0.4 U	7.5	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - Landfill
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	<0.083 U	4.4	94	4
7/13/2016	Background	0.03	0.26	6	<0.083 U	3.1	75	4
9/7/2016	Background	0.04	0.343	6	<0.083 U	3.9	63	7
10/12/2016	Background	0.03	0.271	7	< 1 U	3.4	92	8
11/14/2016	Background	0.04	0.331	8	<0.083 U	2.6	80	6
1/11/2017	Background	0.03	0.315	7	<0.083 U	4.8	76	6
2/28/2017	Background	0.04	0.434	5	<0.083 U	3.6	50	4
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	72	7
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	52	6
3/21/2018	Assessment	0.01397	0.269	5	<0.083 U	4.2	<2 U	3
8/20/2018	Assessment	0.017	0.338	10	<0.083 U	4.4	94	4
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	36	3.6
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	80	4.0
8/12/2019	Assessment	<0.02 U	0.278	7.24	0.06 J	4.9	90	2.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - Landfill
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	26	0.219521 J	<0.07 U	0.710981 J	1.58207 J	0.2073	<0.083 U	<0.68 U	<0.00013 U	<0.005 U	<0.29 U	1.73953 J	<0.86 U
7/13/2016	Background	<0.93 U	<1.05 U	23	0.190337 J	<0.07 U	0.68835 J	1.29444 J	2.909	<0.083 U	<0.68 U	0.008	<0.005 U	<0.29 U	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	30	0.232192 J	<0.07 U	0.353544 J	1.66591 J	0.881	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	<1.05 U	27	0.149553 J	<0.07 U	0.529033 J	1.56632 J	0.257	< 1 U	<0.68 U	0.012	<0.005 U	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	28	0.152375 J	<0.07 U	0.32826 J	1.47282 J	0.767	<0.083 U	<0.68 U	0.013	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	<1.05 U	23	0.126621 J	<0.07 U	0.650158 J	1.09495 J	1.536	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	<1.05 U	26	0.149219 J	<0.07 U	0.325811 J	1.29984 J	0.416	<0.083 U	<0.68 U	0.009	<0.005 U	<0.29 U	<0.99 U	0.994913 J
4/11/2017	Background	<0.93 U	<1.05 U	24	0.159412 J	<0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	<0.68 U	0.008	0.01364 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	25.82	0.16 J	<0.07 U	1.05	1.49 J	0.784	<0.083 U	<0.68 U	0.00722	<0.005 U	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	<0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	<0.083 U	0.089	0.0143	<0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	<0.4 U	<0.6 U	22.5	<0.4 U	<0.2 U	<0.8 U	1.37	0.225	0.09	<0.4 U	0.00688	<0.005 U	<8 U	<0.6 U	<2 U
5/21/2019	Assessment	<0.4 U	<0.6 U	21.7	<0.4 U	<0.2 U	<0.8 U	1.15	0.201	0.09	<0.4 U	0.00576	<0.005 U	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.07 J	23.8	0.154	<0.01 U	0.204	1.3	0.237	0.06 J	0.08 J	0.00829	<0.005 U	<0.4 U	0.2 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-16
Pirkey - Landfill
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.02	1.21	8	<0.083 U	3.9	116	16
7/14/2016	Background	0.03	2	9	<0.083 U	3.8	148	45
9/8/2016	Background	0.03	1.83	9	<0.083 U	3.9	133	33
10/13/2016	Background	0.03	1.15	9	<0.083 U	3.9	124	16
11/14/2016	Background	0.03	1.58	9	<0.083 U	4.4	124	23
1/12/2017	Background	0.02	1.76	10	<0.083 U	3.7	112	43
3/1/2017	Background	0.03	1.29	9	<0.083 U	3.2	108	22
4/10/2017	Background	0.02	1.21	11	<0.083 U	3.4	106	24
8/24/2017	Detection	0.03648	0.945	12	<0.083 U	4.3	96	14
3/22/2018	Assessment	0.0171	1.03	14	<0.083 U	4.0	96	13
8/21/2018	Assessment	0.020	1.17	17	<0.083 U	4.0	128	15
2/27/2019	Assessment	0.03 J	0.704	20.3	0.07 J	4.1	76	17.7
5/23/2019	Assessment	0.022	1.06	20.8	0.06 J	4.6	128	26.9
8/15/2019	Assessment	<0.02 U	0.874	20.0	0.06 J	5.1	110	15.4

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-16
Pirkey - Landfill
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	<0.93 U	1.83497 J	61	0.453643 J	0.0817904 J	1	4.23727 J	1.294	<0.083 U	<0.68 U	0.006	0.01506 J	<0.29 U	2.26113 J	1.3697 J
7/14/2016	Background	<0.93 U	<1.05 U	64	0.565692 J	<0.07 U	1	6	1.438	<0.083 U	<0.68 U	0.036	0.02395 J	1.1177 J	<0.99 U	<0.86 U
9/8/2016	Background	8.00	<1.05 U	70	0.810547 J	0.0926258 J	2	8	1.931	<0.083 U	<0.68 U	0.032	0.00753 J	<0.29 U	<0.99 U	1.75243 J
10/13/2016	Background	<0.93 U	1.52475 J	56	0.250902 J	<0.07 U	1	3.33761 J	1.843	<0.083 U	<0.68 U	0.033	<0.005 U	<0.29 U	1.70284 J	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	55	0.38481 J	<0.07 U	0.561291 J	4.34297 J	2.123	<0.083 U	<0.68 U	0.028	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	58	0.70928 J	<0.07 U	0.406161 J	8	2.629	<0.083 U	<0.68 U	0.031	0.01045 J	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	1.50766 J	76	0.487946 J	<0.07 U	0.558767 J	5	1.417	<0.083 U	<0.68 U	0.021	<0.005 U	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	77	0.435552 J	<0.07 U	0.822329 J	5	0.932	<0.083 U	<0.68 U	0.019	0.00733 J	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	83.66	0.27 J	<0.07 U	1.59	3.6 J	2.11	<0.083 U	<0.68 U	0.02224	0.018 J	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	0.03 J	0.42	69.0	0.213	0.03	0.211	3.78	1.92	<0.083 U	0.082	0.0347	0.014 J	<0.02 U	0.1	0.051
2/27/2019	Assessment	<0.4 U	7.74	56.2	<0.4 U	<0.2 U	<0.8 U	3.21	0.848	0.07 J	<0.4 U	0.0154	0.011 J	<8 U	<0.6 U	<2 U
5/23/2019	Assessment	<0.4 U	5.80	83.4	<0.4 U	<0.2 U	<0.8 U	3.16	1.957	0.06 J	<0.4 U	0.0227	<0.005 U	<8 U	<0.6 U	<0.1 U
8/15/2019	Assessment	<0.02 U	1.40	80.1	0.203	0.02 J	0.215	2.95	2.108	0.06 J	0.1 J	0.0208	0.024 J	<0.4 U	0.1 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-23
Pirkey - Landfill
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.01	0.535	4	<0.083 U	4.0	72	10
7/13/2016	Background	0.03	0.317	4	<0.083 U	2.7	59	11
9/8/2016	Background	0.02	0.26	5	<0.083 U	3.5	64	12
10/12/2016	Background	0.03	0.321	6	<0.083 U	3.7	68	13
11/15/2016	Background	0.03	0.249	5	<0.083 U	3.5	100	14
1/11/2017	Background	0.02	0.319	6	<0.083 U	3.7	60	13
2/28/2017	Background	0.03	0.217	4	<0.083 U	4.0	48	9
4/11/2017	Background	0.03	0.543	7	0.2688 J	4.2	76	11
8/23/2017	Detection	0.04021	0.276	6	0.198 J	4.1	64	11
12/21/2017	Detection	0.04498	0.469	- -	- -	- -	- -	- -
3/21/2018	Assessment	0.01762	0.227	4	<0.083 U	3.9	72	10
8/20/2018	Assessment	0.017	0.247	9	<0.083 U	3.8	92	11
2/28/2019	Assessment	0.02 J	0.3 J	6.94	0.04 J	5.1	70	7.2
5/23/2019	Assessment	0.017	0.3 J	6.82	0.04 J	4.8	54	9.1
8/13/2019	Assessment	<0.02 U	0.325	7.12	0.03 J	5.0	126	7.4

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-23
Pirkey - Landfill
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	2.89148 J	1.65098 J	48	0.186855 J	0.0739811 J	2	2.29646 J	6.86	<0.083 U	<0.68 U	0.000135818 J	0.01188 J	<0.29 U	1.91991 J	<0.86 U
7/13/2016	Background	3.79558 J	<1.05 U	48	0.192156 J	0.0925427 J	2	2.72879 J	5.69	<0.083 U	<0.68 U	0.006	0.01721 J	1.34973 J	2.00038 J	<0.86 U
9/8/2016	Background	<0.93 U	<1.05 U	53	0.20435 J	<0.07 U	5	2.01019 J	6.68	<0.083 U	2.23756 J	0.006	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	1.29835 J	7	120	0.463688 J	0.13648 J	41	3.91303 J	12.89	<0.083 U	31	1.01	0.095	0.563586 J	2.10924 J	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	50	0.129296 J	<0.07 U	6	1.66943 J	7.54	<0.083 U	3.21271 J	0.006	0.02438 J	0.403857 J	1.34763 J	<0.86 U
1/11/2017	Background	<0.93 U	2.03681 J	73	0.159 J	<0.07 U	15	2.25934 J	8.06	<0.083 U	11	0.009	0.092	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	1.65681 J	<1.05 U	41	0.116844 J	<0.07 U	0.295768 J	1.05228 J	5.74	<0.083 U	<0.68 U	0.005	<0.005 U	<0.29 U	1.3076 J	<0.86 U
4/11/2017	Background	<0.93 U	3.9673 J	86	0.318917 J	0.107977 J	22	2.60853 J	10.31	0.2688 J	15	0.01	0.118	0.31517 J	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	56.1	0.17 J	<0.07 U	5.7	1.09 J	7.55	<0.083 U	3.52 J	0.00709	0.02 J	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	0.03 J	0.87	53.5	0.147	0.01 J	1.77	0.803	11	<0.083 U	4.79	0.00634	0.025	0.07 J	1.0	0.176
2/28/2019	Assessment	<0.4 U	1 J	46.9	<0.4 U	<0.2 U	4.16	1 J	6.14	0.04 J	3.46	0.00646	0.035	<8 U	1 J	<2 U
5/23/2019	Assessment	<0.4 U	0.7 J	56.4	<0.4 U	<0.2 U	3 J	0.7 J	9.66	0.04 J	8.99	0.00537	0.058 J	<8 U	<0.6 U	0.2 J
8/13/2019	Assessment	<0.02 U	0.67	49.3	0.137	0.01 J	1.25	0.837	7.65	0.03 J	4.65	0.00527	0.039	<0.4 U	0.8	0.1 J

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-27
Pirkey - Landfill
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.02	4.41	8	0.6176 J	3.9	198	51
7/13/2016	Background	0.03	4.43	8	<0.083 U	2.7	192	54
9/8/2016	Background	0.03	4.17	8	<0.083 U	2.9	196	52
10/12/2016	Background	0.03	4.09	8	<0.083 U	3.0	216	58
11/15/2016	Background	0.03	4.52	8	<0.083 U	3.5	216	92
1/11/2017	Background	0.02	3.74	9	<0.083 U	4.1	180	58
3/1/2017	Background	0.03	4.31	8	<0.083 U	2.8	216	56
4/10/2017	Background	0.03	4.01	9	<0.083 U	3.3	180	54
8/24/2017	Detection	0.0358	3.58	9	0.197 J	3.7	168	52
3/22/2018	Assessment	0.03901	5.58	11	<0.083 U	3.9	192	78
8/21/2018	Assessment	0.024	4.58	10	<0.083 U	3.5	196	65
2/28/2019	Assessment	0.07 J	4.02	11.7	0.20	4.7	42	52.8
5/23/2019	Assessment	0.023	3.89	11.4	0.20	4.4	204	55.2
8/16/2019	Assessment	0.02 J	3.94	10.5	0.18	3.9	198	53.2

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-27
Pirkey - Landfill
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	1.20808 J	2.15232 J	43	5	0.431235 J	0.87101 J	20	2.031	0.6176 J	<0.68 U	0.066	<0.005 U	<0.29 U	1.10872 J	<0.86 U
7/13/2016	Background	0.956365 J	1.27952 J	45	5	0.434627 J	2	21	2.406	<0.083 U	<0.68 U	0.097	0.02241 J	0.434679 J	<0.99 U	<0.86 U
9/8/2016	Background	<0.93 U	<1.05 U	47	6	0.398469 J	2	20	2.71	<0.083 U	<0.68 U	0.095	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	2.14429 J	46	5	0.424977 J	2	20	4.43	<0.083 U	<0.68 U	0.096	<0.005 U	<0.29 U	1.35863 J	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	41	5	0.419182 J	2	22	3.69	<0.083 U	<0.68 U	0.095	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	1.56781 J	46	5	0.30207 J	1	18	2.62	<0.083 U	<0.68 U	0.1	0.00659 J	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	43	5	0.286804 J	2	21	3.48	<0.083 U	<0.68 U	0.1	<0.005 U	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	45	5	0.414787 J	0.954802 J	21	2.58	<0.083 U	<0.68 U	0.104	<0.005 U	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	40.53	5.29	0.48 J	3.09	25.63	2.808	<0.083 U	<0.68 U	0.108	0.012 J	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	0.02 J	1.71	39.5	4.90	0.46	1.14	24.6	2.619	<0.083 U	0.296	0.0921	0.006 J	0.07 J	3.7	0.137
2/28/2019	Assessment	<0.4 U	1 J	39.5	5.32	0.5 J	<0.8 U	18.9	2.95	0.20	<0.4 U	0.0892	<0.005 U	<8 U	2 J	<2 U
5/23/2019	Assessment	<0.4 U	<0.6 U	41.0	5.22	0.3 J	<0.8 U	19.9	3.93	0.20	<0.4 U	0.0885	<0.005 U	<8 U	0.6 J	0.2 J
8/16/2019	Assessment	<0.02 U	0.71	34.1	4.27	0.39	0.313	19.0	4.69	0.18	0.2 J	0.0897	0.012 J	<0.4 U	1.9	0.1 J

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-34
Pirkey - Landfill
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.08	37.8	7	<0.083 U	4.0	1516	974
7/13/2016	Background	0.111	33.2	8	<0.083 U	3.6	1396	837
9/8/2016	Background	0.09	39.5	8	<0.083 U	3.3	1520	870
10/12/2016	Background	0.09	35.8	7	0.6272 J	3.6	1464	1084
11/15/2016	Background	0.1	36.3	7	0.9978 J	3.7	1428	1006
1/11/2017	Background	0.07	39.9	8	<0.083 U	3.2	1378	1334
2/28/2017	Background	0.08	37	6	<0.083 U	3.7	1402	993
4/10/2017	Background	0.09	38.2	8	0.5241 J	3.0	1490	1016
8/23/2017	Detection	0.107	36.2	7	0.619 J	3.7	1128	1231
12/21/2017	Detection	- -	- -	8	0.6669 J	- -	1260	1020
3/21/2018	Assessment	0.171	40.1	6	<0.083 U	3.7	1424	956
8/20/2018	Assessment	0.067	37.0	10	<0.083 U	3.7	1462	1064
2/27/2019	Assessment	0.08 J	39.9	7.64	0.86	2.9	1470	970
5/21/2019	Assessment	0.060	42.0	7.34	0.69	3.3	1154	1080
8/13/2019	Assessment	0.070	39.8	7.46	1.13	3.7	1648	1060

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-34
Pirkey - Landfill
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	<0.93 U	12	72	3	6	34	301	9.64	<0.083 U	12	0.176	0.105	0.688222 J	<0.99 U	<0.86 U
7/13/2016	Background	<0.93 U	25	177	4	6	81	296	7.75	<0.083 U	39	0.183	0.313	2.11044 J	7	<0.86 U
9/8/2016	Background	<0.93 U	9	31	3	8	12	306	7.91	<0.083 U	1.01746 J	0.158	0.064	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	10	39	3	5	15	297	10.12	0.6272 J	3.69632 J	0.174	0.036	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	7	23	2	8	6	292	13.21	0.9978 J	<0.68 U	0.154	0.025	<0.29 U	4.50827 J	<0.86 U
1/11/2017	Background	<0.93 U	6	29	2	7	8	284	11.9	<0.083 U	<0.68 U	0.164	0.032	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	7	11	2	6	<0.23 U	294	9.87	<0.083 U	<0.68 U	0.158	<0.005 U	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	4.49903 J	23	2	11	7	299	2.407	0.5241 J	<0.68 U	0.167	0.0164 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	6.51	10.6	2.24	11.97	<0.23 U	279	8.85	<0.083 U	<0.68 U	0.156	<0.005 U	<0.29 U	3.24 J	<0.86 U
8/20/2018	Assessment	0.01 J	14.4	7.77	1.77	4.34	0.977	249	10.17	<0.083 U	1.32	0.114	0.005 J	0.03 J	13.0	0.070
2/27/2019	Assessment	<0.4 U	15.9	9.93	2.42	4.57	0.9 J	260	8.56	0.86	1 J	0.153	0.015 J	<8 U	14.8	<2 U
5/21/2019	Assessment	<0.4 U	12.7	10.5	2.25	4.48	0.8 J	272	10.82	0.69	1 J	0.158	<0.005 U	<8 U	4.9	<0.1 U
8/13/2019	Assessment	<0.02 U	11.2	9.28	1.82	4.27	0.758	262	11.11	1.13	1.16	0.180	<0.005 U	<0.4 U	8.1	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-35
Pirkey - Landfill
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.109	17.4	17	<0.083 U	4.7	162	50
7/13/2016	Background	0.07	5.35	18	<0.083 U	4.6	114	28
9/8/2016	Background	0.04	3.42	14	<0.083 U	4.0	104	21
10/12/2016	Background	0.05	2.43	14	0.3552 J	3.6	116	23
11/15/2016	Background	0.06	2	14	<0.083 U	4.3	142	29
1/11/2017	Background	0.06	10.4	18	<0.083 U	4.7	128	62
2/28/2017	Background	0.123	22.5	19	<0.083 U	3.5	140	84
4/11/2017	Background	0.07	10.8	25	<0.083 U	4.8	160	75
8/23/2017	Detection	0.04134	4.33	16	<0.083 U	4.9	92	35
3/21/2018	Assessment	0.142	24.5	28	<0.083 U	4.6	228	102
8/20/2018	Assessment	0.156	12.5	38	2.9285	4.2	290	149

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-35
Pirkey - Landfill
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	<0.93 U	11	124	0.327886 J	0.109137 J	21	10	2.465	<0.083 U	7	<0.00013 U	0.061	0.439174 J	<0.99 U	<0.86 U
7/13/2016	Background	<0.93 U	9	185	0.394115 J	<0.07 U	19	6	4.21	<0.083 U	4.37246 J	0.013	0.11	<0.29 U	<0.99 U	<0.86 U
9/8/2016	Background	<0.93 U	1.13012 J	116	0.19327 J	<0.07 U	5	3.44039 J	2.065	<0.083 U	<0.68 U	0.011	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	4.07365 J	110	0.141123 J	<0.07 U	6	2.98973 J	6.01	0.3552 J	1.53293 J	0.012	0.01021 J	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	12	143	0.304515 J	0.241047 J	30	7	4.83	<0.083 U	7	0.019	0.073	0.583418 J	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	2.14698 J	115	0.0923255 J	0.0922067 J	5	4.0586 J	3.65	<0.083 U	<0.68 U	0.01	0.01907 J	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	4.03612 J	94	0.0943688 J	<0.07 U	3	4.75282 J	2.02	<0.083 U	1.23627 J	0.008	0.02305 J	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	1.39833 J	92	0.0696 J	0.329193 J	1	6	2.707	<0.083 U	<0.68 U	0.007	<0.005 U	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	5.28	53.17	0.18 J	0.61 J	4.24	11.63	2.013	<0.083 U	0.77 J	0.00401	0.023 J	<0.29 U	1.4 J	<0.86 U
8/20/2018	Assessment	0.02 J	2.90	111	0.702	0.12	0.770	11.9	6.27	2.9285	1.43	0.00876	0.005 J	0.04 J	4.5	0.128

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-36
Pirkey - Landfill
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
8/13/2019	Background	0.065	0.240	9.46	0.05 J	4.71	92	2.2

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-36
Pirkey - Landfill
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
8/13/2019	Background	<0.02 U	0.15	10.8	0.234	<0.01 U	0.203	0.901	1.298	0.05 J	<0.05 U	0.0161	<0.005 U	<0.4 U	0.09 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
LANDFILL
H. W. Pirkey Power Plant
Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

July 11, 2019

CHA8473

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LF	Landfill
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the Landfill (LF), an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, sulfate, and total dissolved solids (TDS) at the LF. An alternative source was not identified at the time, so two assessment monitoring events were conducted at the LF in 2018, in accordance with 40 CFR 257.95. SSLs for cadmium and cobalt were identified at well AD-34. An ASD was successfully completed (Burns & McDonnell, 2019); thus, the unit remained in assessment monitoring.

A semi-annual assessment monitoring event was also completed in February 2019, with the results of the February 2019 event documented in this report. Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The February 2019 monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. SSLs were identified for cobalt and lithium. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

LANDFILL EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, one set of samples was collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(d)(1). AD-35 was decommissioned in November 2018 and replaced with AD-36, which was installed in April 2019. Thus, only two downgradient wells were sampled for this assessment event. Although antimony, molybdenum, and thallium were not detected at any locations during the March 2018 screening event, samples from the February 2019 semi-annual sampling event were analyzed for all Appendix III and Appendix IV parameters. A summary of data collected during this assessment monitoring event may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.14 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the LF were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained to meet the requirements of 40 CFR 257.95(d)(1) were screened for potential outliers. No outliers were identified.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from

the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for arsenic, beryllium, cadmium, cobalt, fluoride, lead, lithium, mercury, and selenium due to apparent non-normal distributions and for antimony, molybdenum, and thallium due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey LF:

- LCLs for cobalt exceeded the GWPS of 0.026 mg/L at AD-34 (0.272 mg/L).
- LCLs for lithium exceeded the GWPS of 0.110 mg/L at AD-34 (0.145 mg/L).

As a result, the Pirkey LF will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring

2.2.3 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations. Prediction limits were calculated for the Appendix III parameters to represent background values. As described in the January 2018 *Statistical Analysis Summary* report (Geosyntec, 2018), intrawell tests were used to evaluate potential SSIs for boron, calcium, chloride, and fluoride, whereas interwell tests were used to evaluate potential SSIs for pH, sulfate, and TDS.

Prediction limits for the interwell tests were recalculated using data collected during the February 2019 assessment monitoring event. Five data points (i.e., one sample from five background wells) were added to the background dataset for each interwell test. New data were tested for outliers prior to being added to the background dataset. The updated prediction limits were calculated for a one-of-two retesting procedure, as during detection monitoring. The values of the updated prediction limits were similar to the values of the prediction limits calculated during detection monitoring. The revised interwell prediction limits were used to evaluate potential SSIs for pH, sulfate, and TDS.

For the intrawell tests, limited data made it possible to add only one data point (i.e., one sample from each compliance well) to each background dataset. Because one sample result is insufficient to compare against the existing background dataset, the prediction limits were not updated for the intrawell tests at this time. The intrawell prediction limits calculated during detection monitoring were used to evaluate potential SSIs for boron, calcium, chloride, and fluoride.

Data collected during the February 2019 assessment monitoring event were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Sulfate concentrations exceeded the interwell UPL of 228 mg/L at AD-34 (970 mg/L).
- TDS concentrations exceeded the interwell UPL of 348 mg/L at AD-34 (1476 mg/L).

While the prediction limits were calculated assuming a one-of-two testing procedure, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the UPL based on previous results. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey LF during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the February 2019 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. SSLs were identified for cobalt and lithium. Appendix III parameters were also evaluated, with exceedances identified for sulfate and TDS.

Based on this evaluation, the Pirkey LF unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – Pirkey Plant. January 2017.

Burns & McDonnell Engineering Company, Inc. 2019. Alternative Source Demonstration Evaluation Report. April.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Landfill, H. W. Pirkey Power Plant, Hallsville, Texas. January 3, 2018.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - Landfill

Geosyntec Consultants

Parameter	Unit	AD-8	AD-12	AD-16	AD-23	AD-27	AD-34
		2/28/2019	2/27/2019	2/27/2019	2/28/2019	2/28/2019	2/27/2019
Antimony	µg/L	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
Arsenic	µg/L	2.00 U	2.00 U	7.74	1.00 J	1.00 J	15.9
Barium	µg/L	46.8	22.5	56.2	46.9	39.5	9.93
Beryllium	µg/L	2.00 U	2.00 U	2.00 U	2.00 U	5.32	2.42
Boron	mg/L	1.05	0.0300 J	0.0300 J	0.0200 J	0.0700 J	0.0800 J
Cadmium	µg/L	1.00 U	1.00 U	1.00 U	1.00 U	0.500 J	4.57
Calcium	mg/L	103	0.400 J	0.704	0.300 J	4.02	39.9
Chloride	mg/L	6.83	6.08	20.3	6.94	11.7	7.64
Chromium	µg/L	4.00 U	4.00 U	4.00 U	4.16	4.00 U	0.900 J
Cobalt	µg/L	0.800 J	1.37	3.21	1.00 J	18.9	260
Combined Radium	pCi/L	1.07	0.225	0.848	6.14	2.95	8.56
Fluoride	mg/L	0.400	0.0900	0.0700 J	0.0400 J	0.200	0.860
Lead	µg/L	2.00 U	2.00 U	2.00 U	3.46	2.00 U	1.00 J
Lithium	mg/L	0.00200 J	0.00688	0.0154	0.00646	0.0892	0.153
Mercury	mg/L	0.0000250 U	0.0000250 U	0.0000110 J	0.0000350	0.0000250 U	0.0000150 J
Molybdenum	µg/L	40.0 U	40.0 U	40.0 U	40.0 U	40.0 U	40.0 U
Selenium	µg/L	30.8	4.00 U	4.00 U	1.00 J	2.00 J	14.8
Total Dissolved Solids	mg/L	462	36.0	76.0	70.0	42.0	1470
Sulfate	mg/L	175	3.60	17.7	7.20	52.8	970
Thallium	µg/L	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
pH	SU	5.69	5.17	4.13	5.11	4.67	2.92

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.
J: Estimated value. Parameter was detected in concentrations below the reporting limit.

Table 2: Groundwater Protection Standards
Pirkey Plant - Landfill

Geosyntec Consultants, Inc.

Constituent Name	MCL	CCR Rule Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.008
Arsenic, Total (mg/L)	0.01		0.0077
Barium, Total (mg/L)	2		0.080
Beryllium, Total (mg/L)	0.004		0.007
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.0051
Cobalt, Total (mg/L)	n/a	0.006	0.026
Combined Radium, Total (pCi/L)	5		7.36
Fluoride, Total (mg/L)	4		5.2
Lead, Total (mg/L)	n/a	0.015	0.0045
Lithium, Total (mg/L)	n/a	0.04	0.11
Mercury, Total (mg/L)	0.002		0.00021
Molybdenum, Total (mg/L)	n/a	0.1	0.0050
Selenium, Total (mg/L)	0.05		0.031
Thallium, Total (mg/L)	0.002		0.002

Notes:
Grey cell indicates calculated UTL is higher than MCL.
MCL = Maximum Contaminant Level
Calculated UTL (Upper Tolerance Limit) represents site-specific background values.
The higher of the calculated UTL or MCL/RSL is used as the GWPS.

Table 3: Appendix III Data Summary
Pirkey Plant - Landfill

Geosyntec Consultants, Inc.

Parameter	Units	Description	AD-23	AD-34
			2/28/2019	2/27/2019
Boron	mg/L	Intrawell Background Value (UPL)	0.030	0.120
		Detection Monitoring Result	0.02	0.08
Calcium	mg/L	Intrawell Background Value (UPL)	0.65	42.5
		Detection Monitoring Result	0.3	39.9
Chloride	mg/L	Intrawell Background Value (UPL)	7.89	9.20
		Detection Monitoring Result	6.94	7.64
Fluoride	mg/L	Intrawell Background Value (UPL)	1.0	1.0
		Detection Monitoring Result	0.04	0.86
pH	SU	Interwell Background Value (UPL)	5.5	
		Interwell Background Value (LPL)	2.5	
		Detection Monitoring Result	5.1	2.9
Sulfate	mg/L	Interwell Background Value (UPL)	228	
		Detection Monitoring Result	7.2	**970**
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	348	
		Detection Monitoring Result	70	**1476**

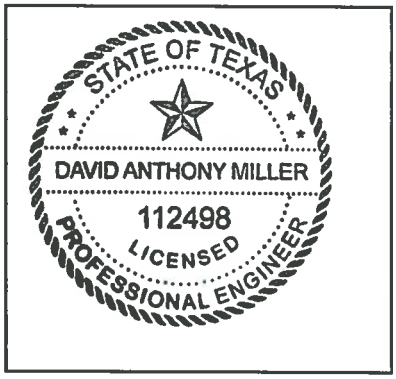
Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey Landfill CCR management area and that the requirements of 40 CFR 257.93(f) have been met.



DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

112498	TEXAS	07.11.19
License Number	Licensing State	Date

ATTACHMENT B
Statistical Analysis Output

GROUNDWATER STATS CONSULTING

July 11, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey Landfill
Assessment Monitoring Event – February 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis of the groundwater data for the February 2019 sample event for American Electric Power Company's Pirkey Landfill. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, is listed below. Note that downgradient well AD-35 was originally in the well network but has been abandoned and replaced with a new well. No data are currently available from the new well but will be included in future analyses.

- **Upgradient wells:** AD-8, AD-12, AD-16 and AD-27; and
- **Downgradient wells:** AD-23 and AD-34

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS;
- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Values previously flagged during the screening as outliers may be seen in a lighter font and disconnected symbol on the time series graphs. A summary of flagged values follows this letter (Figure B).

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for pH, sulfate and TDS; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, calcium, chloride and fluoride (Figures C and D, respectively). The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data are screened for any newly suspected outliers or obvious trending patterns using time series plots. All values flagged as outliers may be seen on the Outlier Summary report following this letter. No obvious trending patterns were observed in the upgradient wells.

Intrawell prediction limits utilize the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the background data set will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an

off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. No exceedances were noted except for chloride at wells AD-16 and AD-27; and sulfate and TDS at well AD-34. Downgradient well AD-35 had exceedances for the August 2018 event as previously noted in that report for boron, chloride and fluoride. The results of those findings may be found in the Prediction Limit Summary tables following this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable. Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site which is an indication of natural variability in groundwater unrelated to practices at the site.

No statistically significant increasing or decreasing trends were found for any of the downgradient well/parameter pairs with prediction limit exceedances. Statistically significant increasing trends were noted for chloride in upgradient wells AD-16 and AD-27, which is an indication groundwater concentrations are changing naturally upgradient of the facility.

Evaluation of Appendix IV Parameters

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure F). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure G).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, CCR-rule specified levels or ACL as discussed above (Figure H). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. Two exceedances were noted which included cobalt and lithium in well AD-34. A summary of the confidence interval results follows this letter.

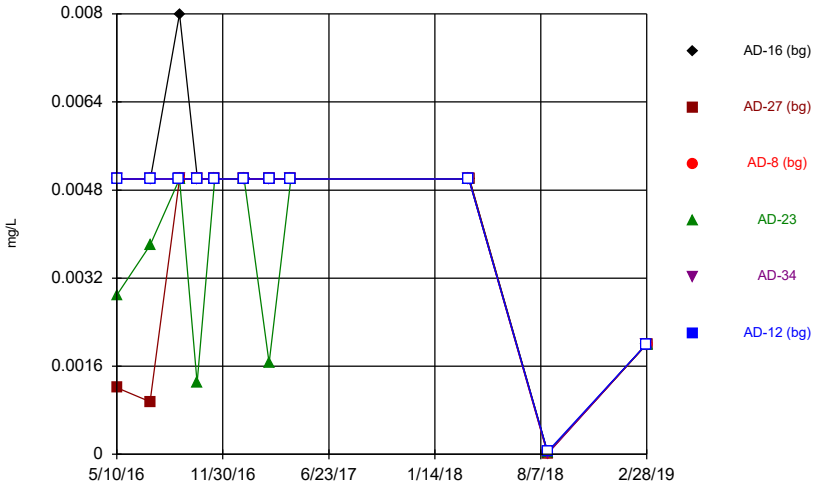
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Landfill. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

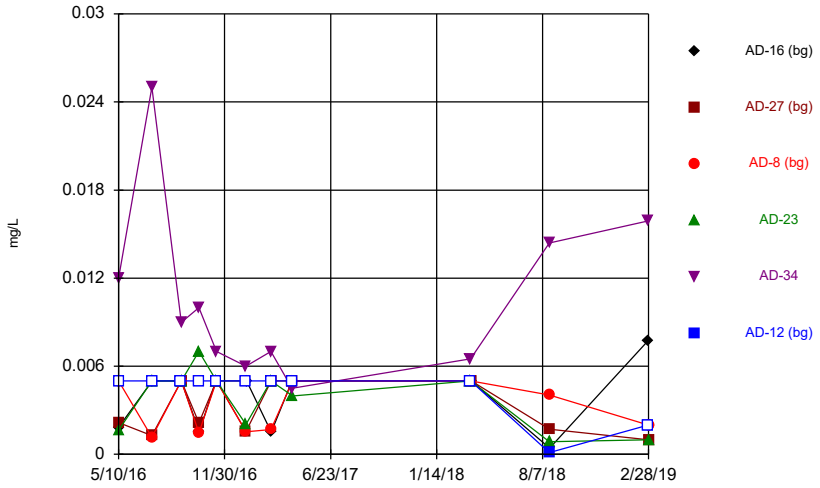
Time Series



Constituent: Antimony, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

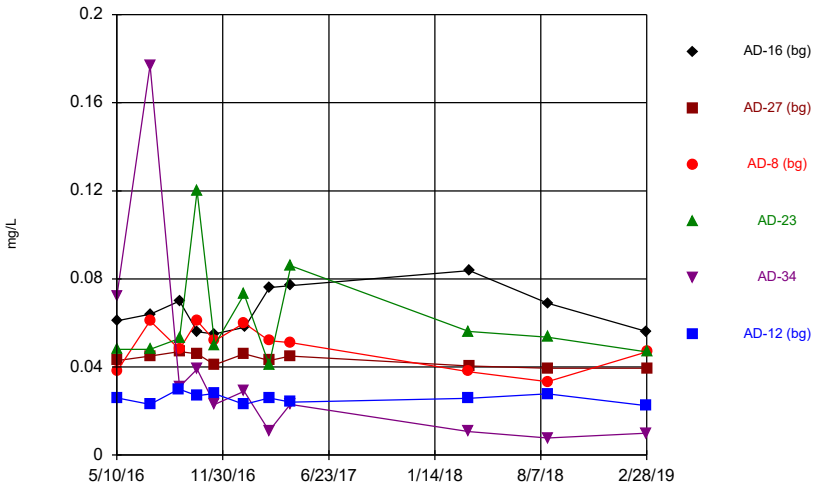
Time Series



Constituent: Arsenic, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

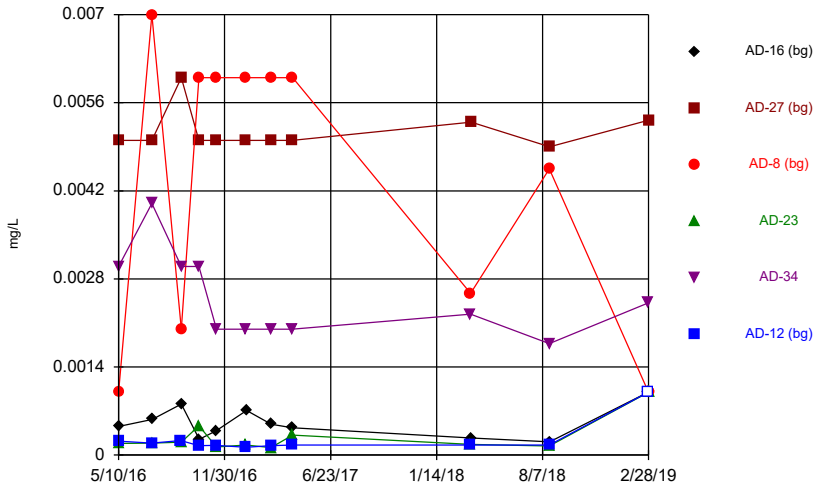
Time Series



Constituent: Barium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

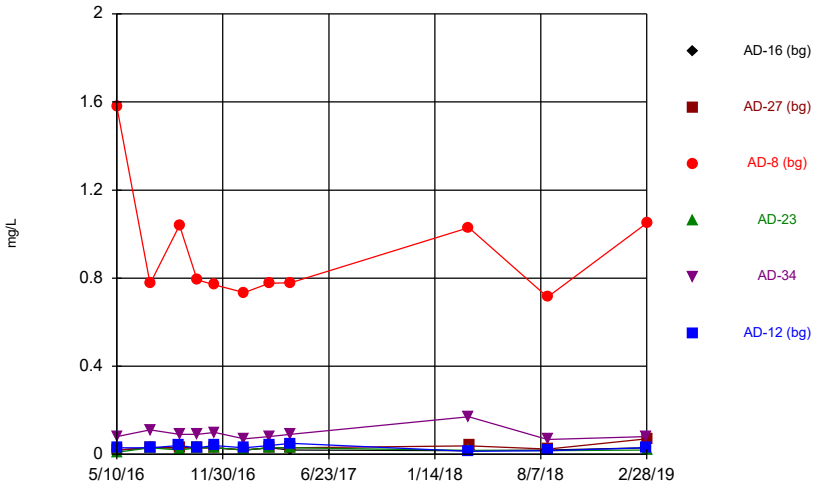
Time Series



Constituent: Beryllium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

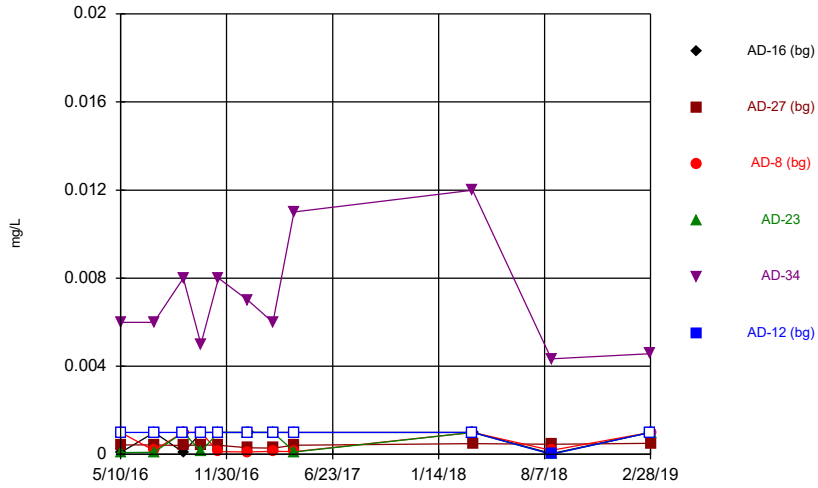
Time Series



Constituent: Boron, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

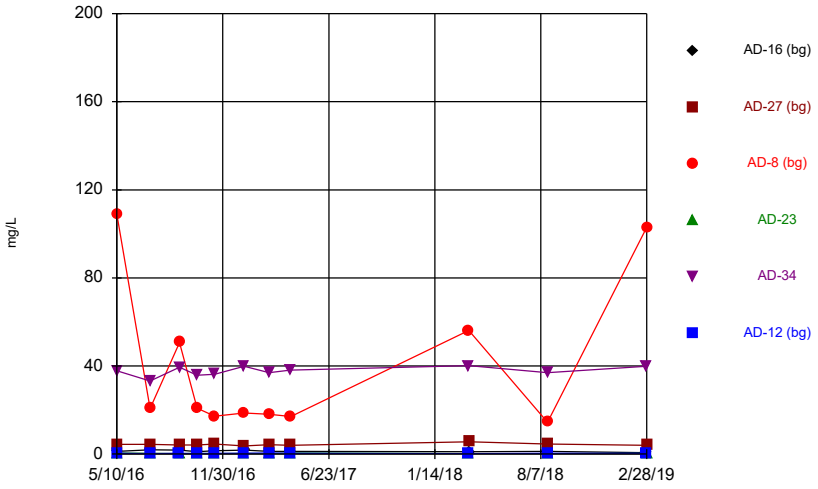
Time Series



Constituent: Cadmium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

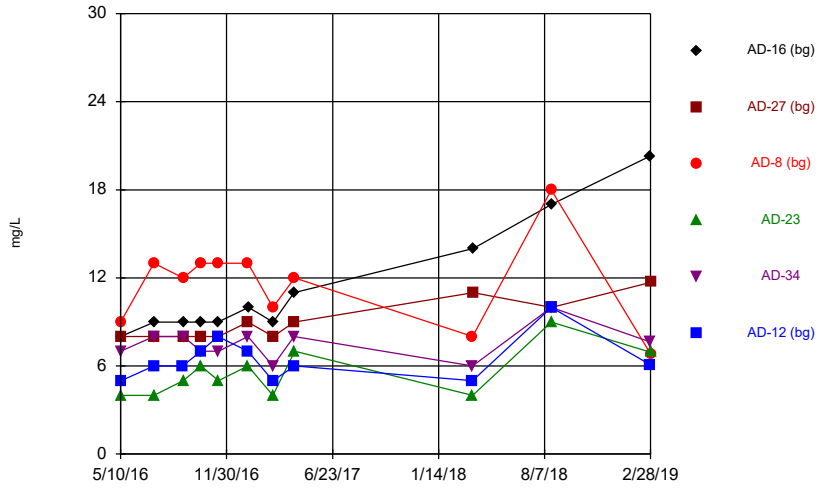
Time Series



Constituent: Calcium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

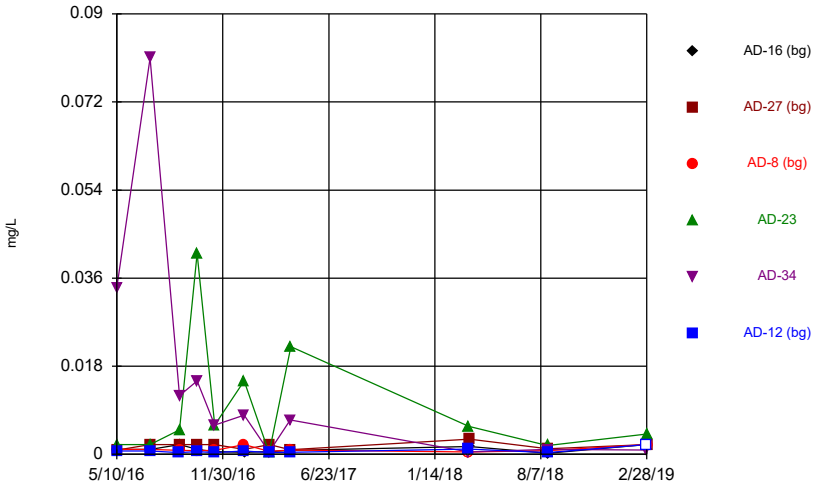
Time Series



Constituent: Chloride, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

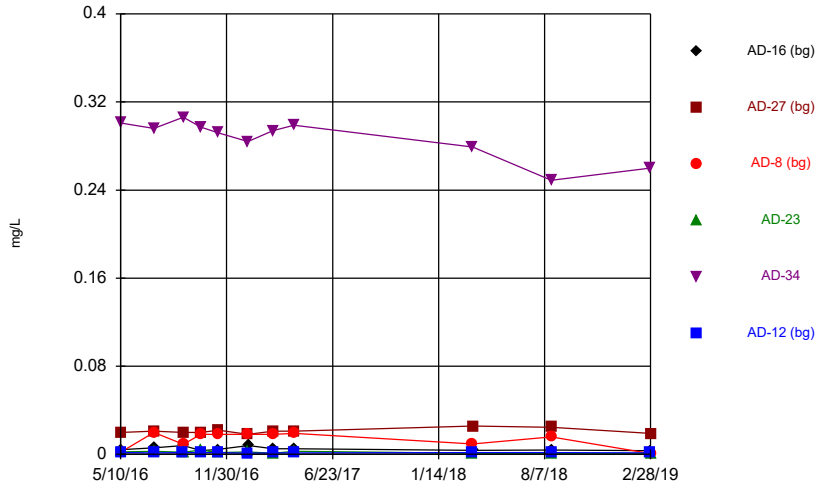
Time Series



Constituent: Chromium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

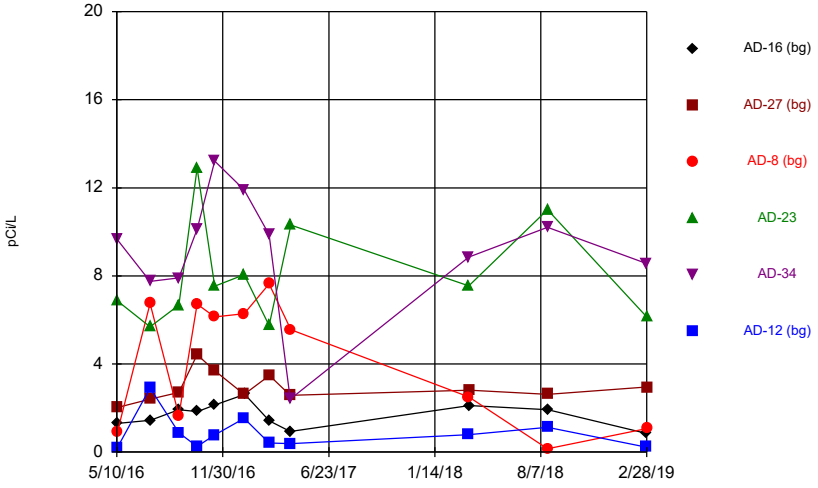
Time Series



Constituent: Cobalt, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

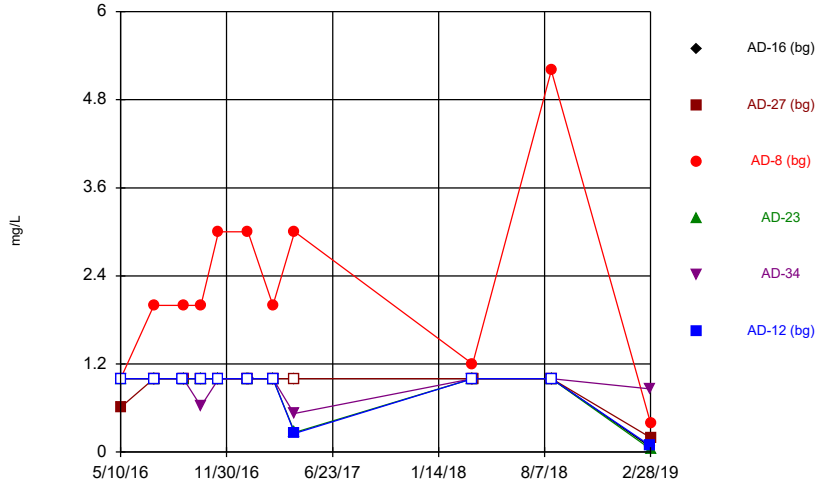
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

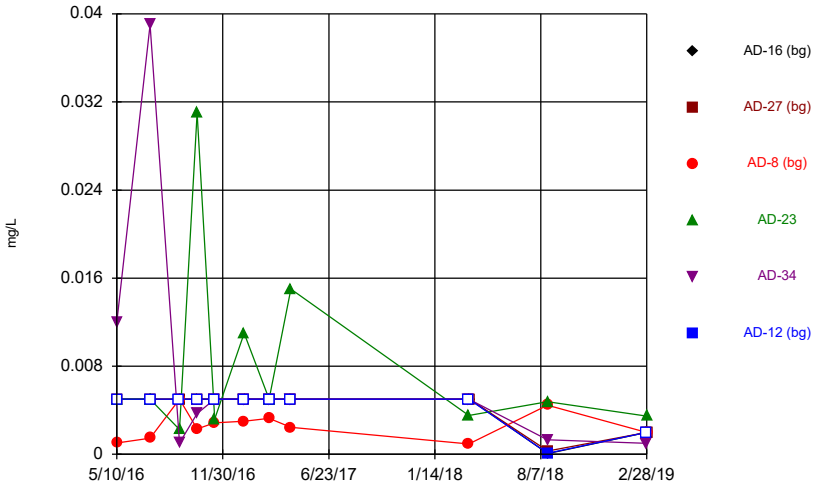
Time Series



Constituent: Fluoride, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

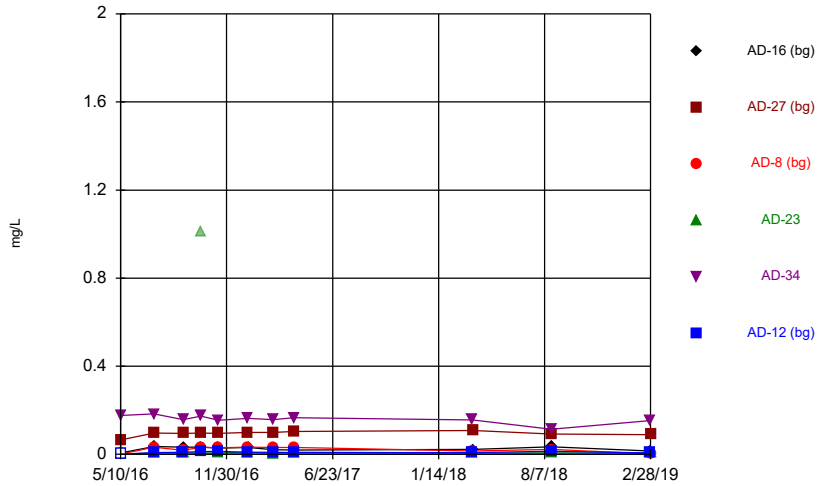
Time Series



Constituent: Lead, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

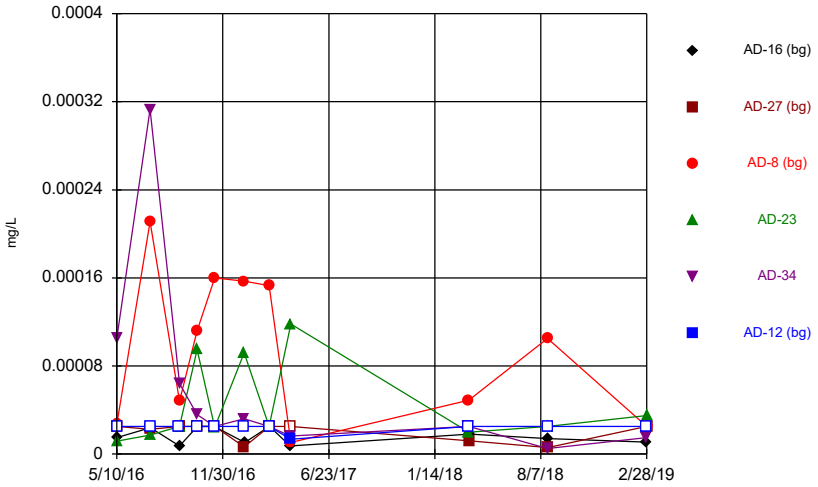
Time Series



Constituent: Lithium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

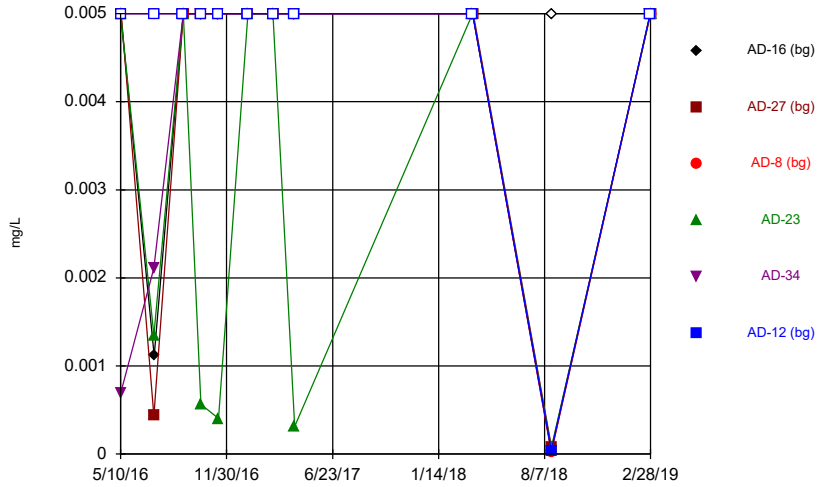
Time Series



Constituent: Mercury, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

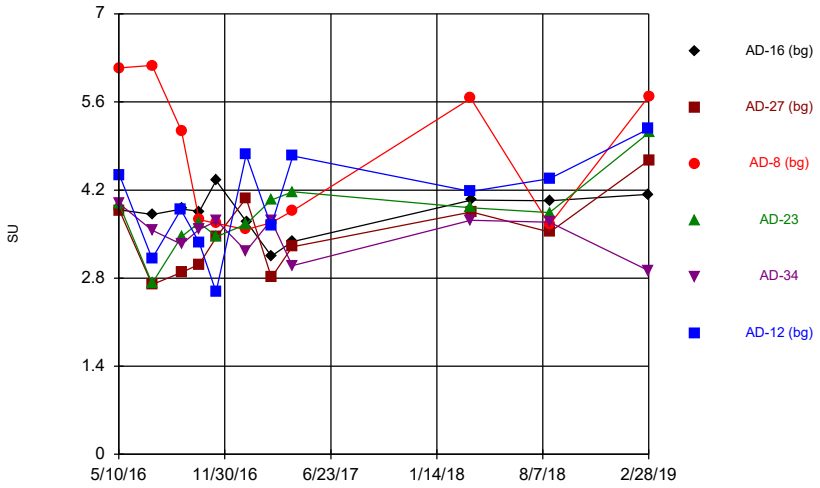
Time Series



Constituent: Molybdenum, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

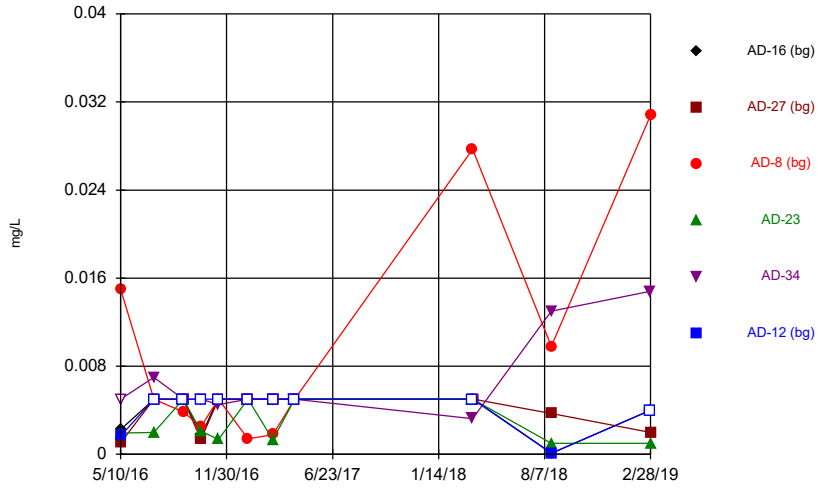
Time Series



Constituent: pH, field Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

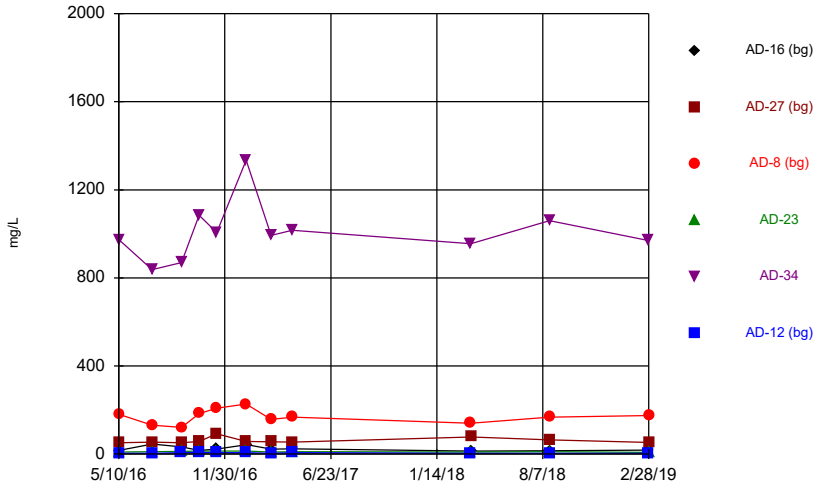
Time Series



Constituent: Selenium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

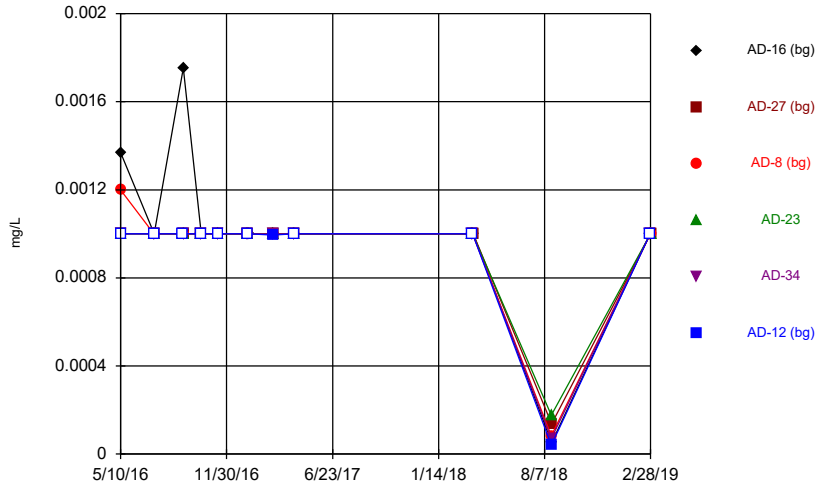
Time Series



Constituent: Sulfate, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

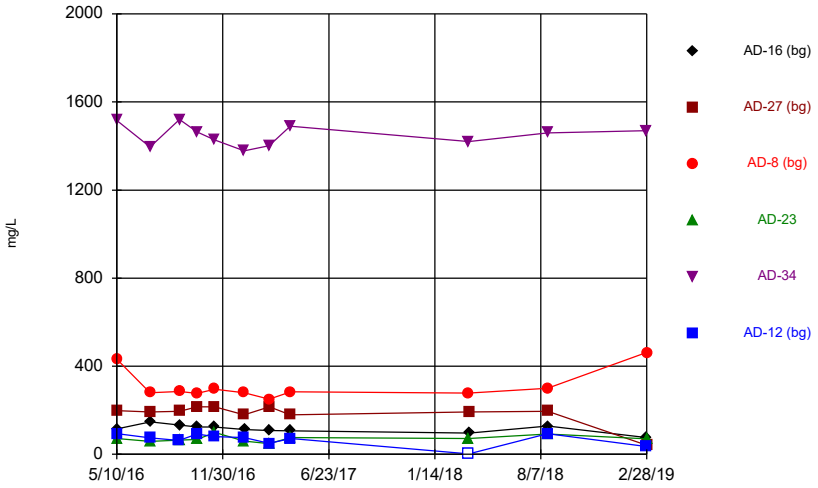
Time Series



Constituent: Thallium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Hollow symbols indicate censored values.

Time Series



Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:49 PM View: Time Series

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Outlier Summary

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/1/2019, 10:17 AM

	AD-23 Lithium, total (mg/L)
10/12/2016	1.01 (o)

Interwell Prediction Limit Summary - Significant Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/11/2019, 1:46 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Sulfate, total (mg/L)	**AD-34**	**228**	**n/a**	**2/27/2019**	**970**	**Yes**	**44**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0009861**	NP (normality) 1 of 2
Total Dissolved Solids [TDS] (mg/L)	**AD-34**	**348**	**n/a**	**2/27/2019**	**1470**	**Yes**	**44**	**169.4**	**102.7**	**2.273**	**None**	**No**	**0.002505**	Param 1 of 2

Interwell Prediction Limit Summary - All Results

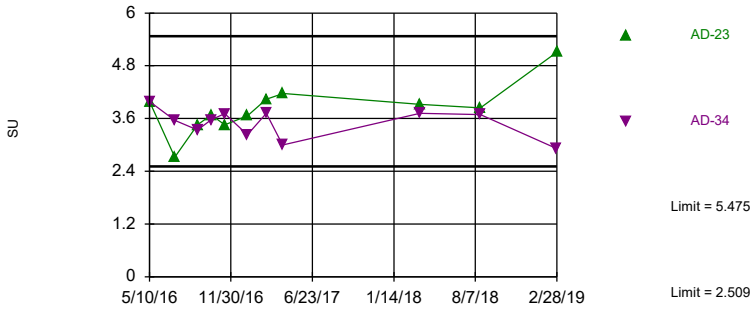
Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/11/2019, 1:46 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH, field (SU)	AD-23	5.475	2.509	2/28/2019	5.11	No	44	3.992	0.8529	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-34	5.475	2.509	2/27/2019	2.92	No	44	3.992	0.8529	0	None	No	0.001253	Param 1 of 2
Sulfate, total (mg/L)	AD-23	228	n/a	2/28/2019	7.2	No	44	n/a	n/a	0	n/a	n/a	0.0009861	NP (normality) 1 of 2
Sulfate, total (mg/L)	**AD-34**	**228**	**n/a**	**2/27/2019**	**970**	**Yes**	**44**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0009861**	NP (normality) 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-23	348	n/a	2/28/2019	70	No	44	169.4	102.7	2.273	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	**AD-34**	**348**	**n/a**	**2/27/2019**	**1470**	**Yes**	**44**	**169.4**	**102.7**	**2.273**	**None**	**No**	**0.002505**	Param 1 of 2

Within Limits

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=3.992, Std. Dev.=0.8529, n=44. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9258, critical = 0.924. Kappa = 1.739 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001253. Comparing 2 points to limit. Assumes 1 future value.

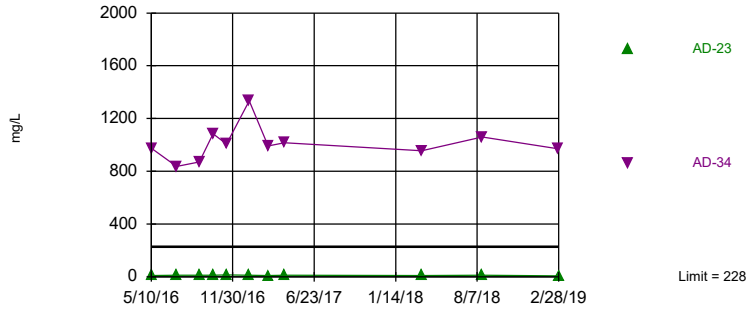
Constituent: pH, field Analysis Run 7/11/2019 1:42 PM View: PL's - Interwell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Exceeds Limit: AD-34

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 44 background values. Annual per-constituent alpha = 0.005902. Individual comparison alpha = 0.0009861 (1 of 2). Comparing 2 points to limit. Assumes 1 future value.

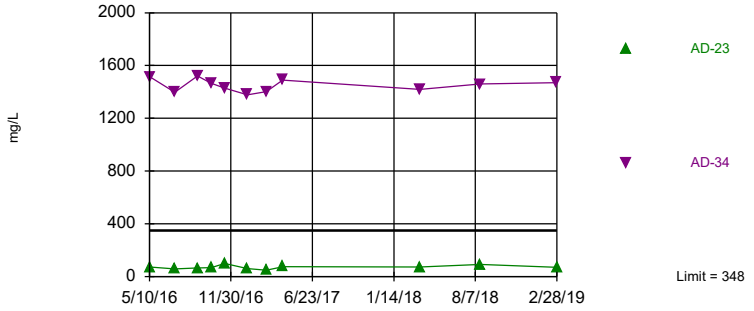
Constituent: Sulfate, total Analysis Run 7/11/2019 1:42 PM View: PL's - Interwell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Exceeds Limit: AD-34

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=169.4, Std. Dev.=102.7, n=44, 2.273% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9299, critical = 0.924. Kappa = 1.739 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 2 points to limit. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:42 PM View: PL's - Interwell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Intrawell Prediction Limit Summary - Significant Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/11/2019, 1:41 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Chloride, total (mg/L)	**AD-16**	**11.43**	**n/a**	**2/27/2019**	**20.3**	**Yes**	**8**	**9.25**	**0.8864**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Chloride, total (mg/L)	**AD-27**	**9**	**n/a**	**2/28/2019**	**11.7**	**Yes**	**8**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.02144**	**NP Intra (normality) 1 of 2**

Intrawell Prediction Limit Summary - All Results

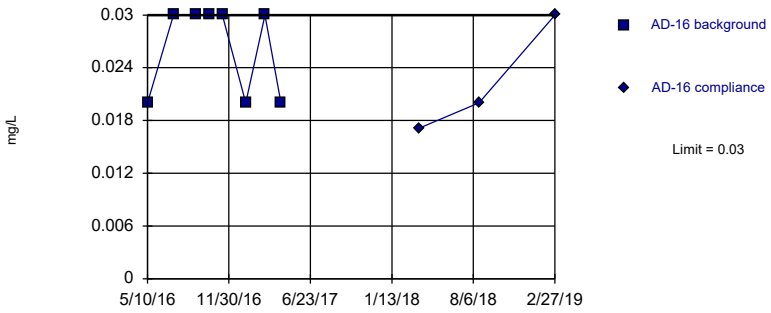
Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/11/2019, 1:41 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-16	0.03	n/a	2/27/2019	0.03	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Boron, total (mg/L)	AD-27	0.03	n/a	2/28/2019	0.07	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Boron, total (mg/L)	AD-8	1.58	n/a	2/28/2019	1.05	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Boron, total (mg/L)	AD-23	0.03	n/a	2/28/2019	0.02	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Boron, total (mg/L)	AD-34	0.1201	n/a	2/27/2019	0.08	No	8	0.08888	0.01271	0	None	No	0.002505	Param Intra 1 of 2
Boron, total (mg/L)	AD-12	0.05454	n/a	2/27/2019	0.03	No	8	0.03625	0.00744	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-16	2.318	n/a	2/27/2019	0.704	No	8	1.504	0.3311	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-27	4.848	n/a	2/28/2019	4.02	No	8	4.21	0.2595	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-8	109	n/a	2/28/2019	103	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Calcium, total (mg/L)	AD-23	0.6535	n/a	2/28/2019	0.3	No	8	0.3451	0.1255	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-34	42.53	n/a	2/27/2019	39.9	No	8	37.21	2.163	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-12	0.4631	n/a	2/27/2019	0.4	No	8	0.3269	0.05542	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	**AD-16**	**11.43**	**n/a**	**2/27/2019**	**20.3**	**Yes**	**8**	**9.25**	**0.8864**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Chloride, total (mg/L)	**AD-27**	**9**	**n/a**	**2/28/2019**	**11.7**	**Yes**	**8**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.02144**	**NP Intra (normality) 1 of 2**
Chloride, total (mg/L)	AD-8	15.69	n/a	2/28/2019	6.83	No	8	11.88	1.553	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-23	7.893	n/a	2/28/2019	6.94	No	8	5.125	1.126	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-34	9.204	n/a	2/27/2019	7.64	No	8	7.375	0.744	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-12	8.794	n/a	2/27/2019	6.08	No	8	6.25	1.035	0	None	No	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-16	1	n/a	2/27/2019	0.07	No	8	n/a	n/a	100	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-27	1	n/a	2/28/2019	0.2	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-8	3.988	n/a	2/28/2019	0.4	No	8	2.25	0.7071	12.5	None	No	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-23	1	n/a	2/28/2019	0.04	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-34	1	n/a	2/27/2019	0.86	No	8	n/a	n/a	62.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-12	1	n/a	2/27/2019	0.09	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

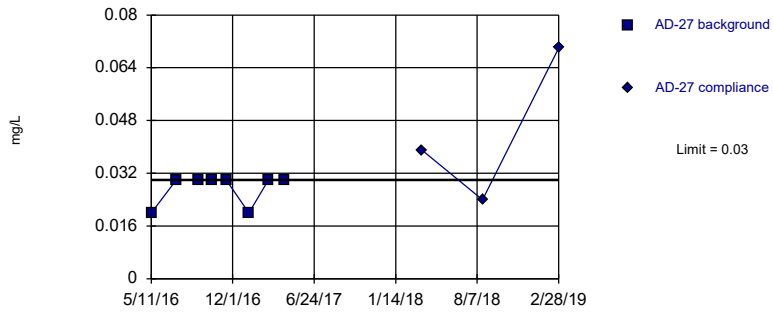
Constituent: Boron, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

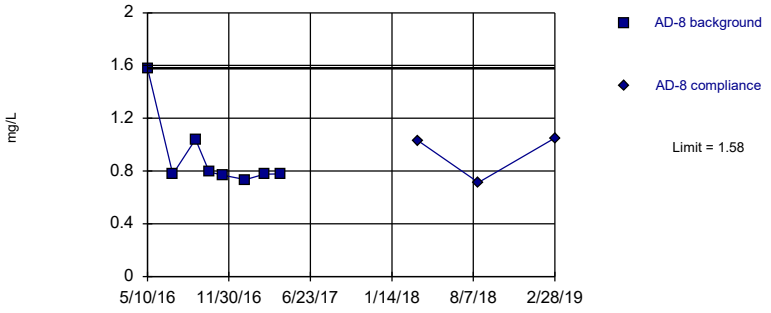
Constituent: Boron, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

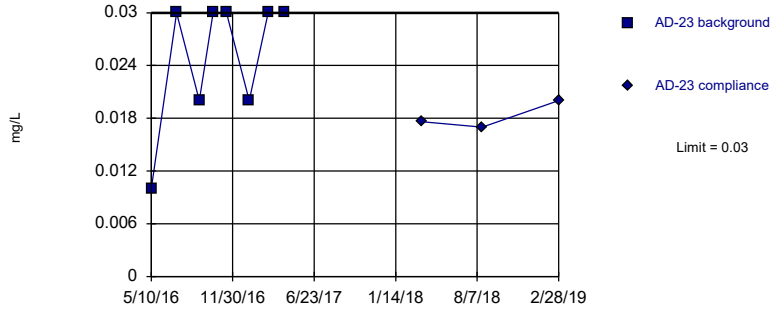
Constituent: Boron, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



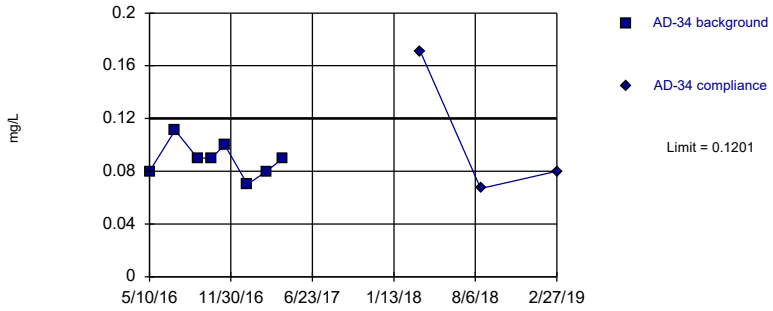
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Boron, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.08888, Std. Dev.=0.01271, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9562, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Boron, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell

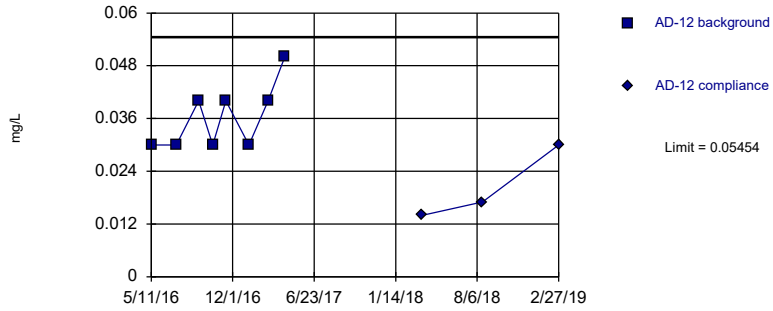
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.03625, Std. Dev.=0.00744, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7968, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Boron, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell

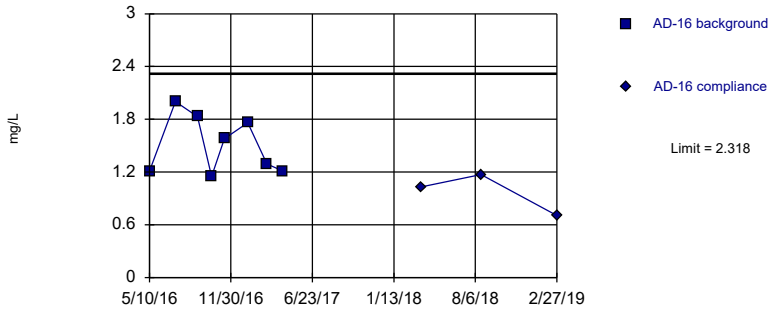
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1.504, Std. Dev.=0.3311, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8818, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell

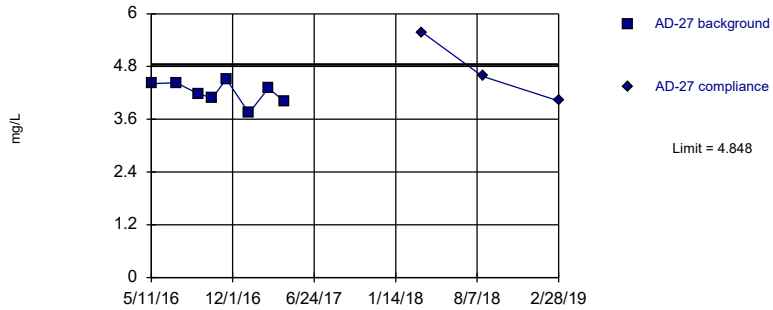
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.21, Std. Dev.=0.2595, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9482, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

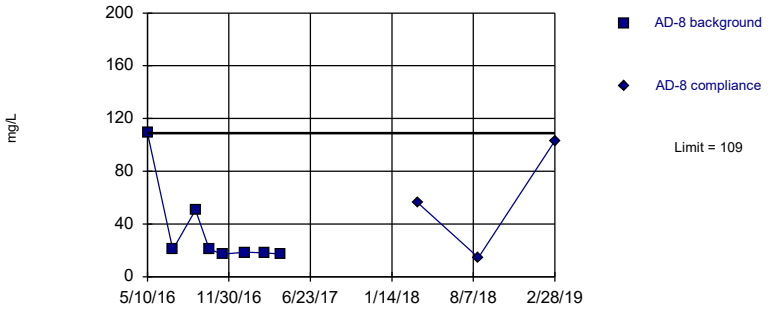
Constituent: Calcium, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

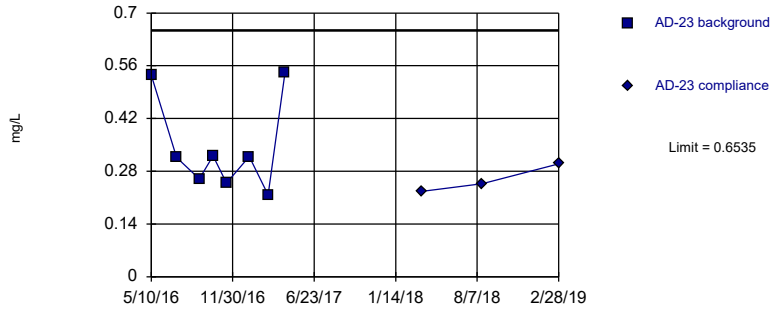
Constituent: Calcium, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.3451, Std. Dev.=0.1255, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.809, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

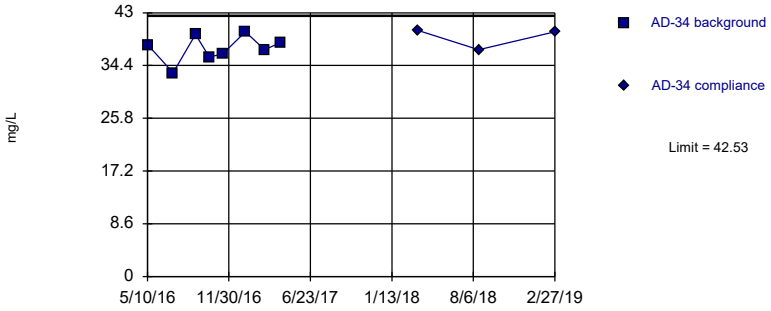
Constituent: Calcium, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=37.21, Std. Dev.=2.163, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9581, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

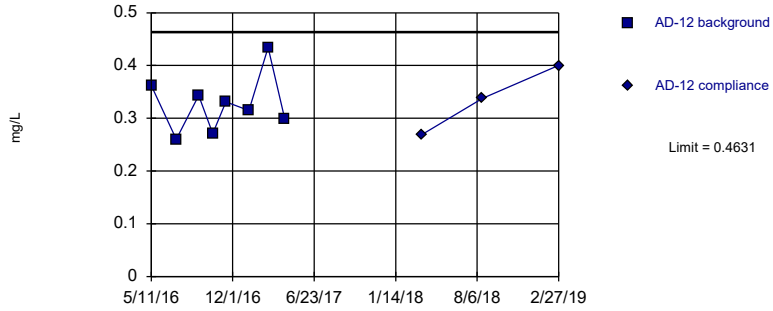
Constituent: Calcium, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



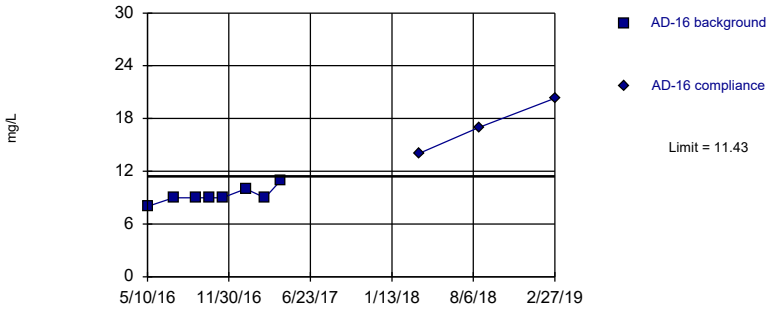
Background Data Summary: Mean=0.3269, Std. Dev.=0.05542, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9467, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=9.25, Std. Dev.=0.8864, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8264, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

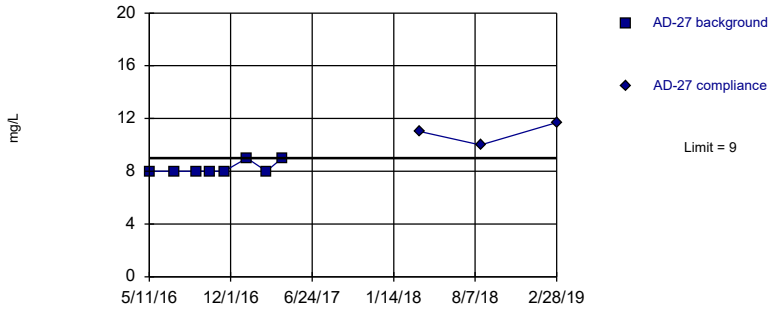
Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

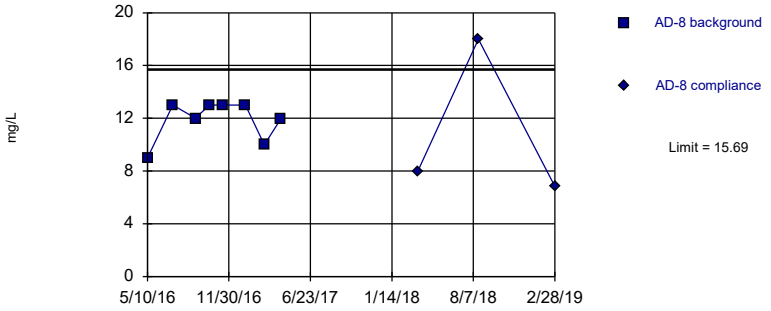
Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=11.88, Std. Dev.=1.553, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7682, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

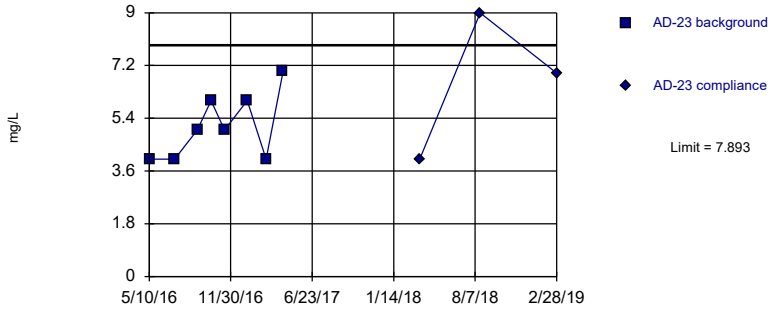
Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



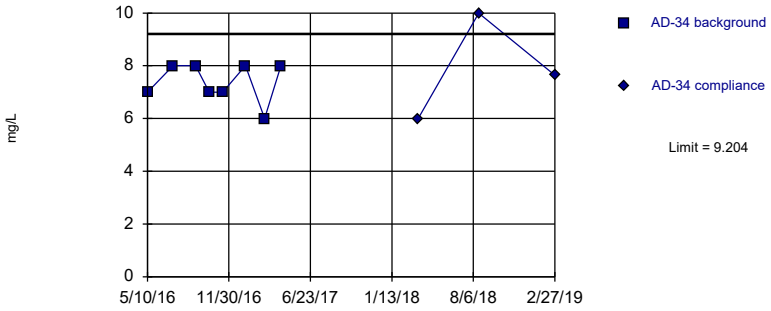
Background Data Summary: Mean=5.125, Std. Dev.=1.126, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8815, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=7.375, Std. Dev.=0.744, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7968, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell

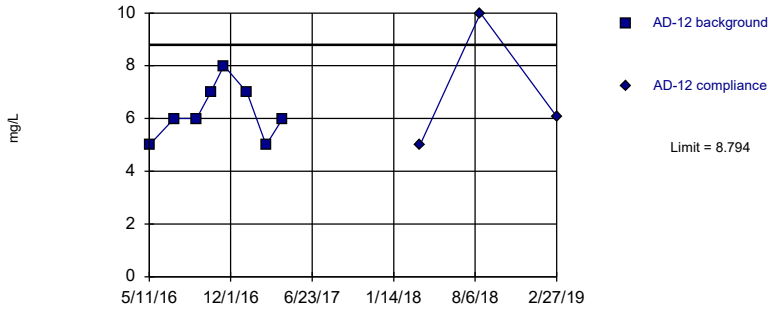
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=6.25, Std. Dev.=1.035, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9171, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

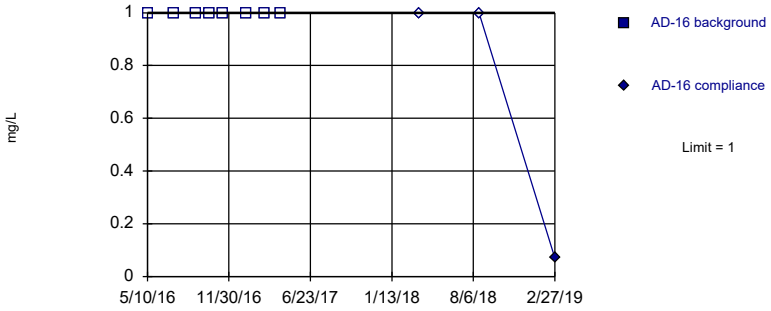
Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 8) were censored; limit is most recent reporting limit. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

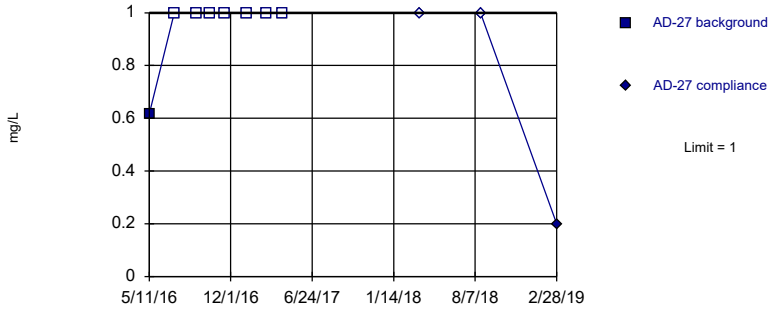
Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell

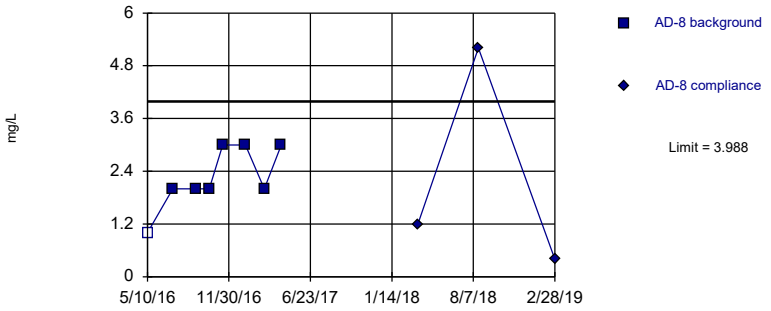
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=2.25, Std. Dev.=0.7071, n=8, 12.5% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8268, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

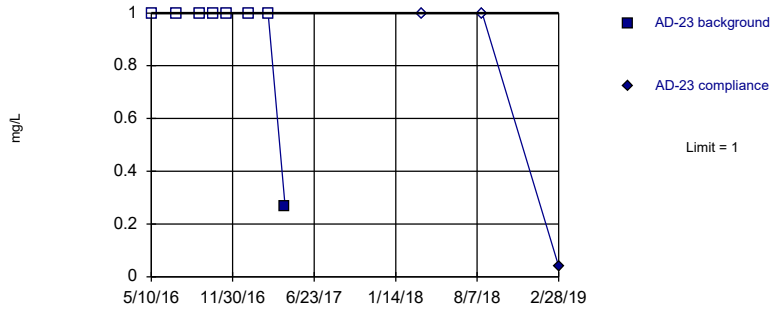
Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

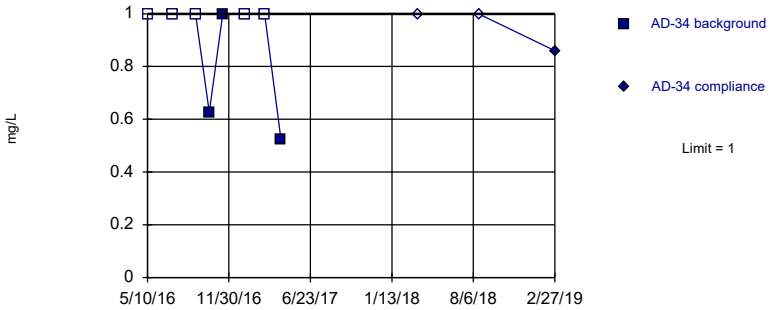
Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 62.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

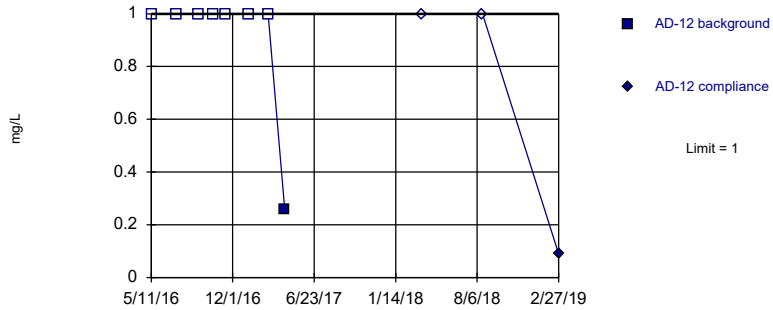
Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

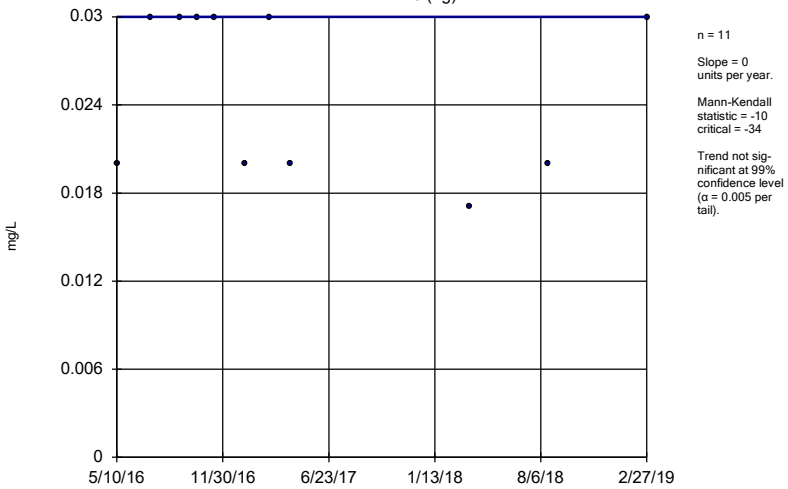
Trend Test Summary Table - All Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/11/2019, 1:55 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-16 (bg)	0	-10	-34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-27 (bg)	0.001755	17	34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-8 (bg)	-0.02823	-7	-34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0	-4	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	**AD-16 (bg)**	**3.702**	**43**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride, total (mg/L)	**AD-27 (bg)**	**1.267**	**35**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride, total (mg/L)	AD-8 (bg)	-0.5368	-8	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.03234	10	34	No	11	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-16 (bg)	0	-10	-34	No	11	90.91	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-27 (bg)	0	-1	-34	No	11	81.82	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-8 (bg)	0	8	34	No	11	9.091	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-12 (bg)	0	-15	-34	No	11	81.82	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-16 (bg)	-3.411	-16	-34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-27 (bg)	3.411	13	34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-8 (bg)	5.333	4	34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-34	32.31	9	34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.5376	-15	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-16 (bg)	-20.21	-32	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-27 (bg)	-10.77	-15	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-8 (bg)	2.271	4	34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-34	-5.947	-3	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-19.73	-20	-34	No	11	9.091	n/a	n/a	0.01	NP

Sen's Slope Estimator

AD-16 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -10 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

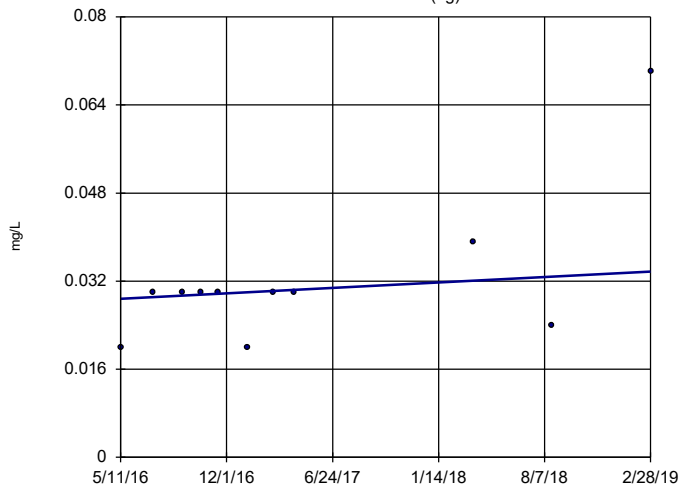
Constituent: Boron, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 11

Slope = 0.001755 units per year.

Mann-Kendall statistic = 17 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

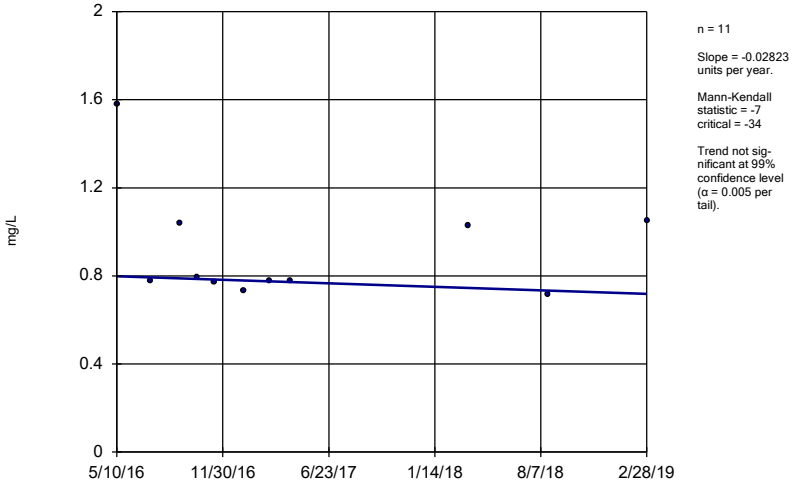
Constituent: Boron, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 11

Slope = -0.02823 units per year.

Mann-Kendall statistic = -7 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

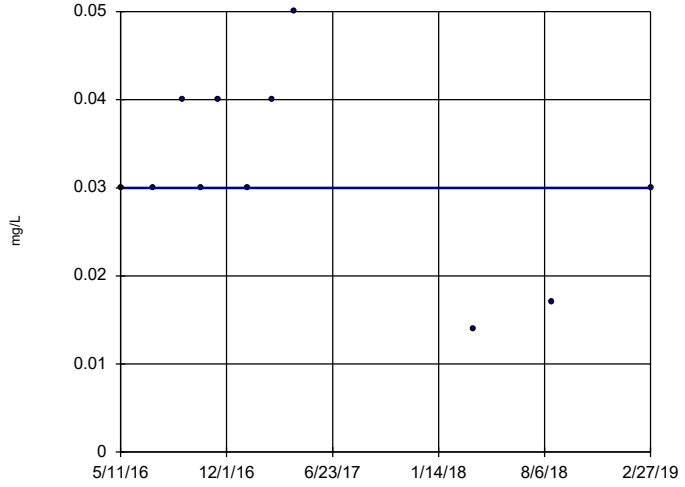
Constituent: Boron, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -4 critical = -34

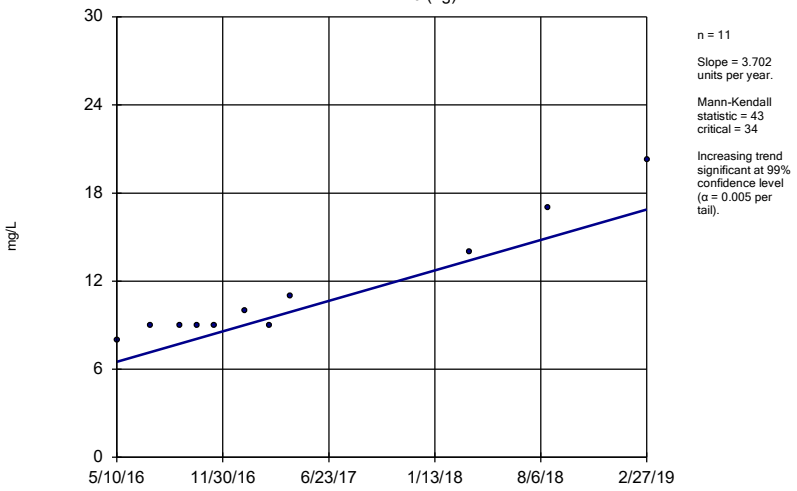
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-16 (bg)



n = 11

Slope = 3.702 units per year.

Mann-Kendall statistic = 43 critical = 34

Increasing trend significant at 99% confidence level (α = 0.005 per tail).

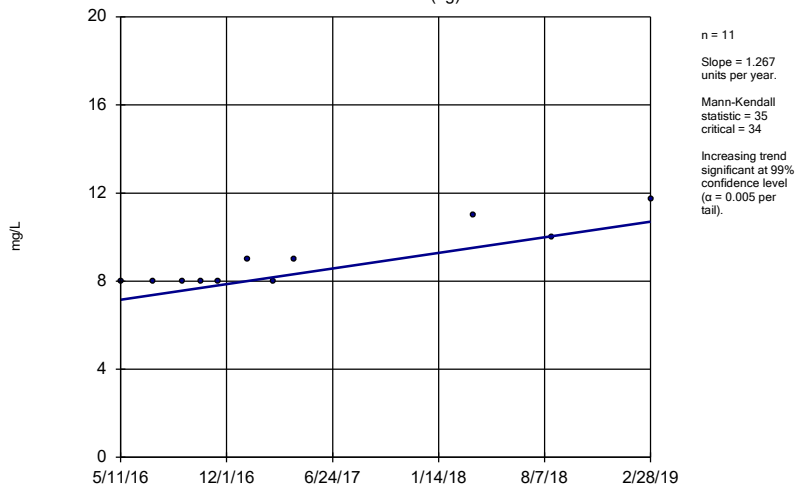
Constituent: Chloride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 11

Slope = 1.267 units per year.

Mann-Kendall statistic = 35 critical = 34

Increasing trend significant at 99% confidence level (α = 0.005 per tail).

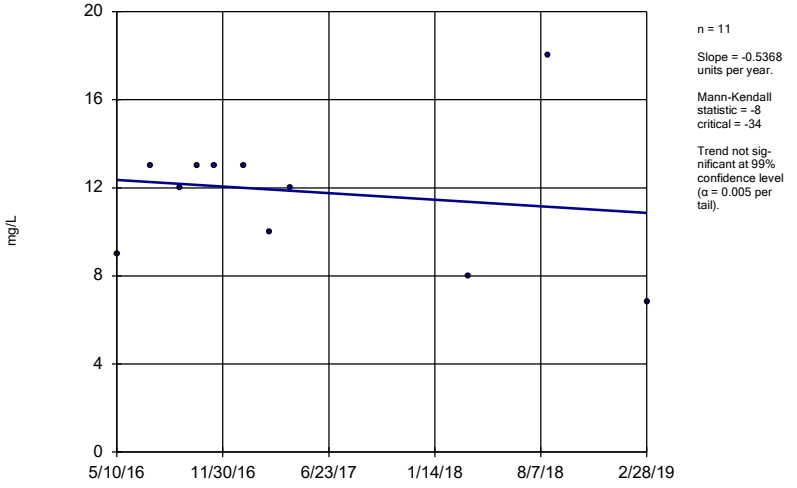
Constituent: Chloride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 11

Slope = -0.5368 units per year.

Mann-Kendall statistic = -8 critical = -34

Trend not sig-nificant at 99% confidence level (α = 0.005 per tail).

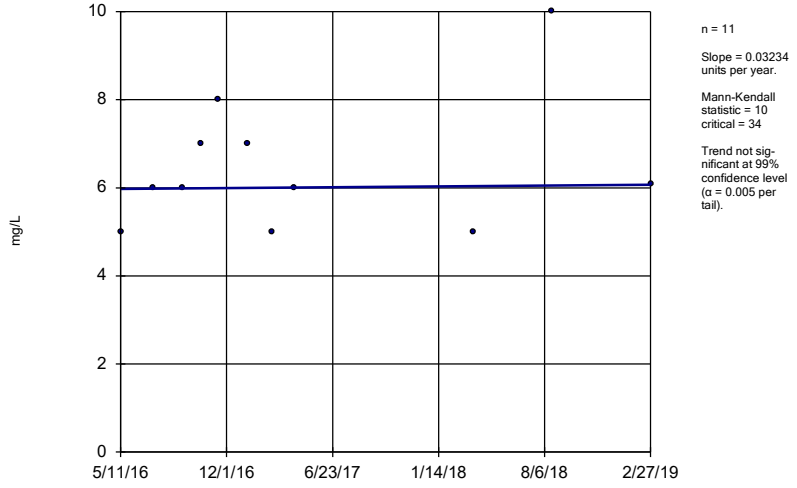
Constituent: Chloride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.03234 units per year.

Mann-Kendall statistic = 10 critical = 34

Trend not sig-nificant at 99% confidence level (α = 0.005 per tail).

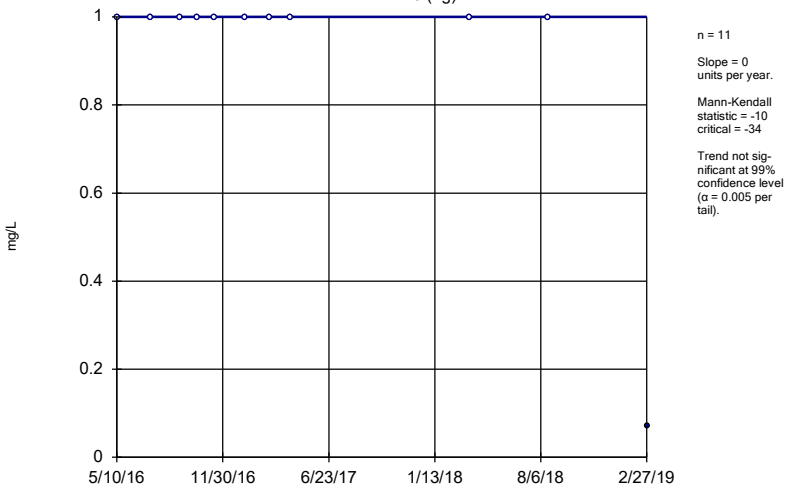
Constituent: Chloride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-16 (bg)



n = 11

Slope = 0
units per year.

Mann-Kendall
statistic = -10
critical = -34

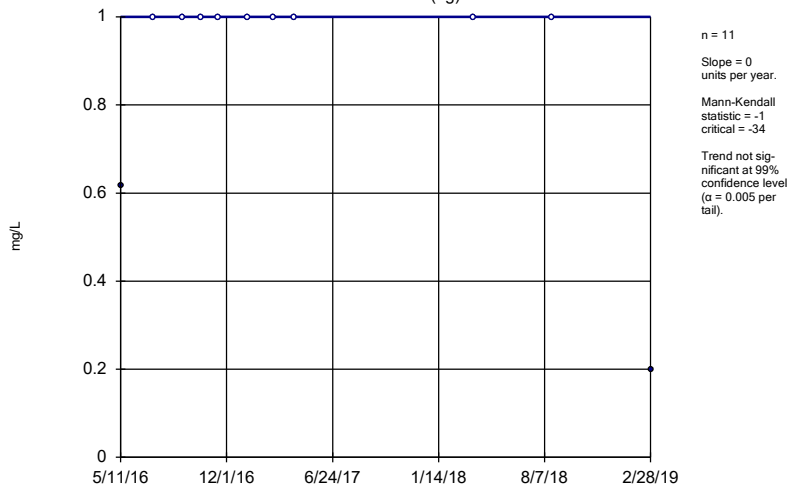
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Fluoride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-27 (bg)



n = 11

Slope = 0
units per year.

Mann-Kendall
statistic = -1
critical = -34

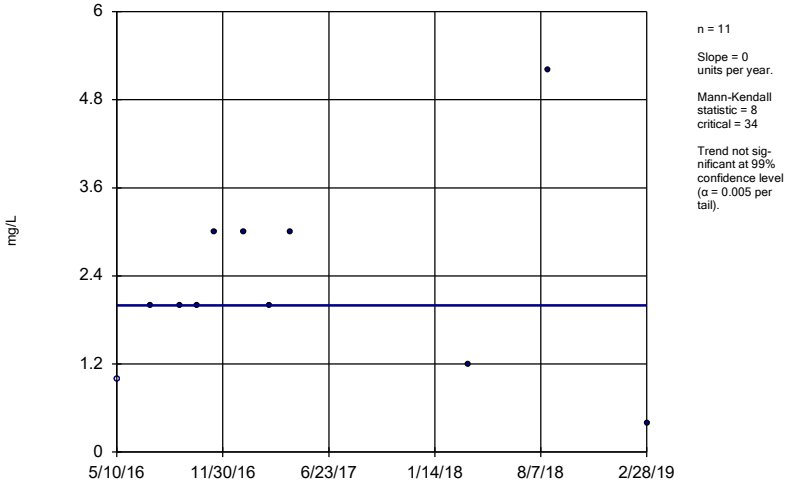
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Fluoride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-8 (bg)



n = 11

Slope = 0
units per year.

Mann-Kendall
statistic = 8
critical = 34

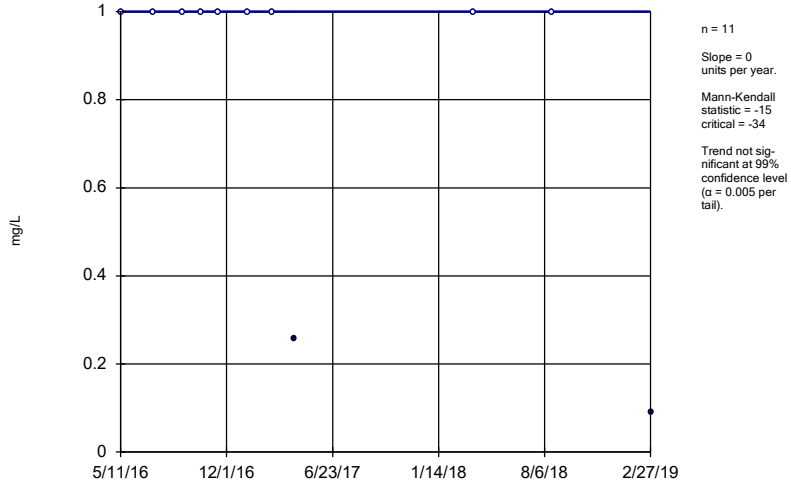
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Fluoride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0
units per year.

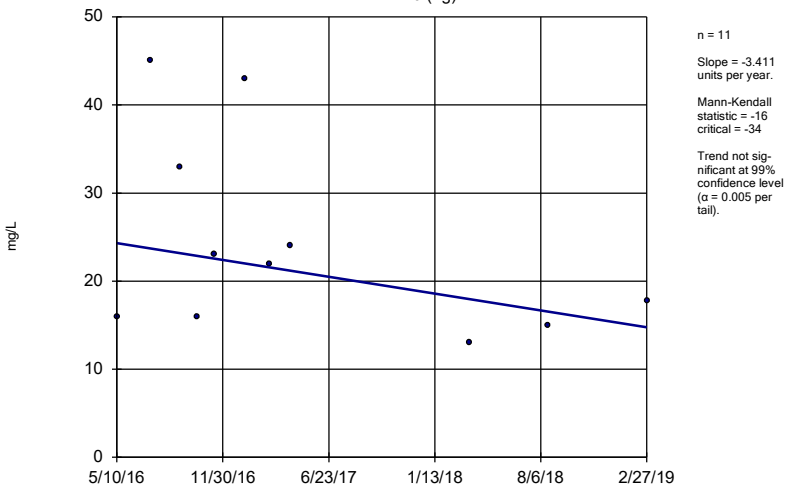
Mann-Kendall
statistic = -15
critical = -34

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Fluoride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-16 (bg)



n = 11

Slope = -3.411 units per year.

Mann-Kendall statistic = -16
critical = -34

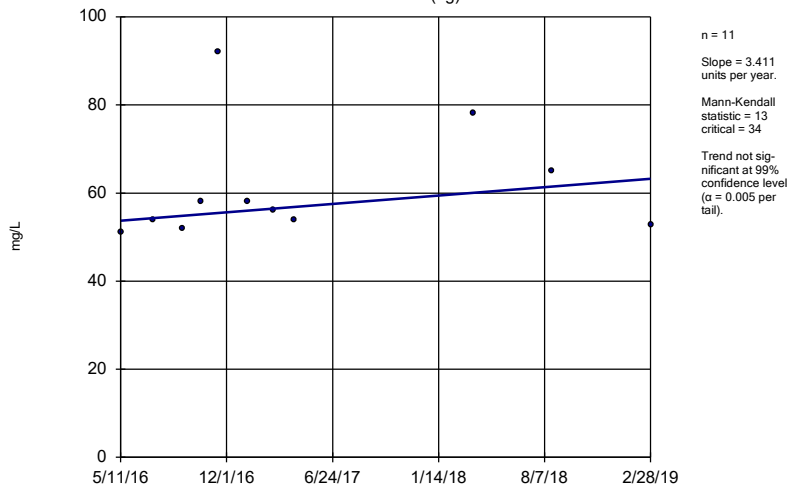
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 11

Slope = 3.411 units per year.

Mann-Kendall statistic = 13
critical = 34

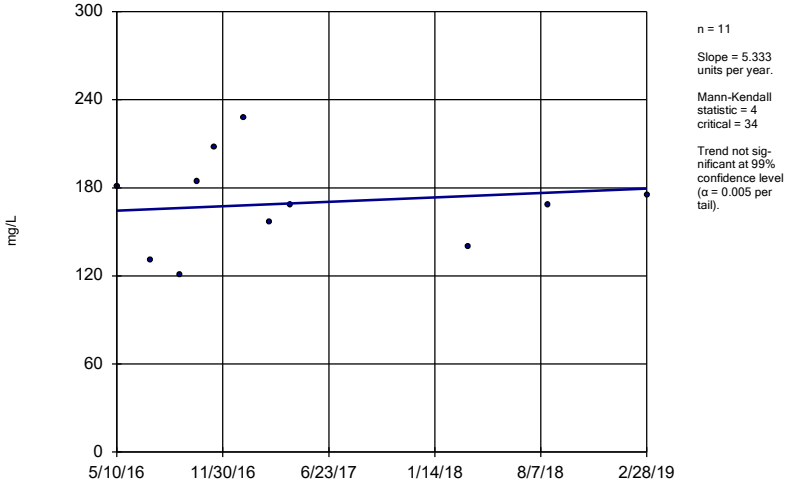
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 11

Slope = 5.333 units per year.

Mann-Kendall statistic = 4
critical = 34

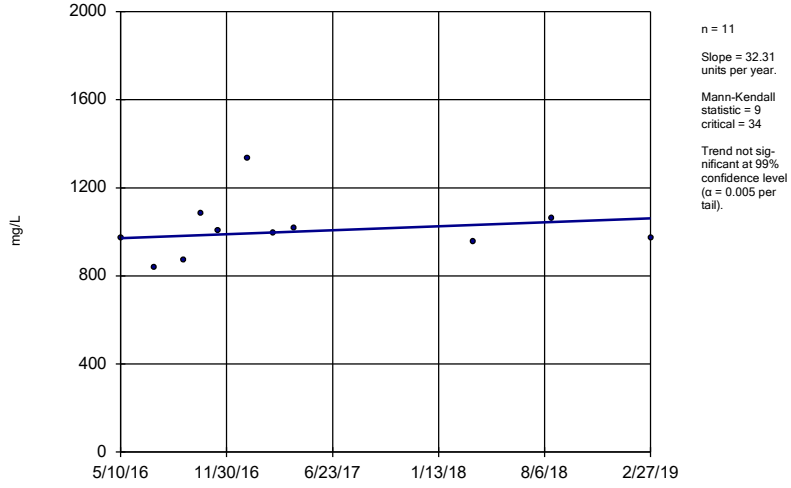
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-34



n = 11

Slope = 32.31 units per year.

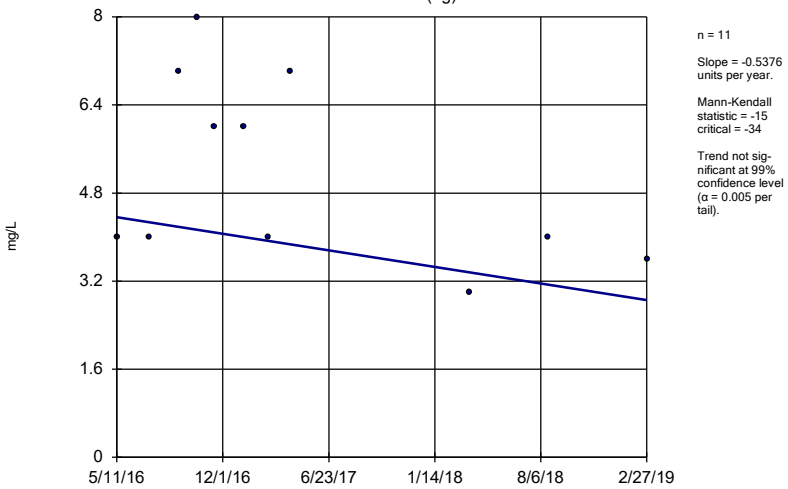
Mann-Kendall statistic = 9
critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = -0.5376 units per year.

Mann-Kendall statistic = -15
critical = -34

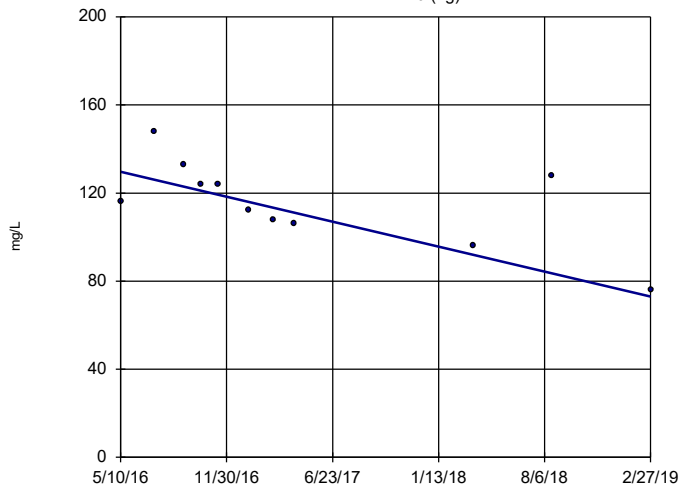
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-16 (bg)



n = 11

Slope = -20.21 units per year.

Mann-Kendall statistic = -32
critical = -34

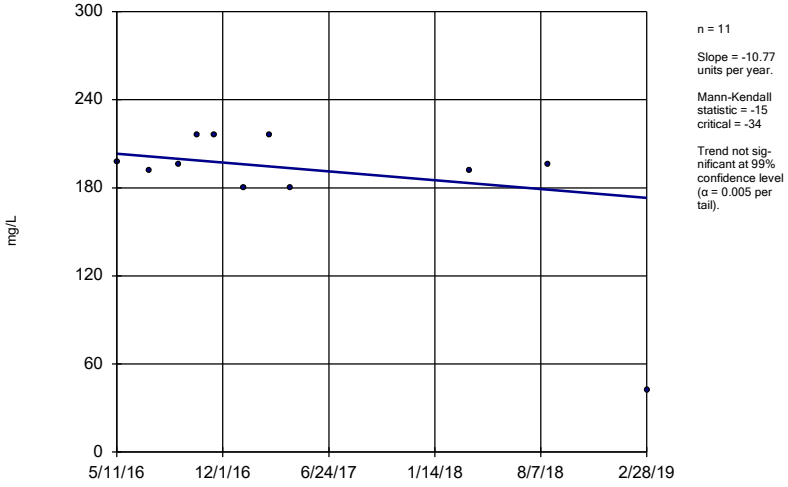
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 11

Slope = -10.77 units per year.

Mann-Kendall statistic = -15
critical = -34

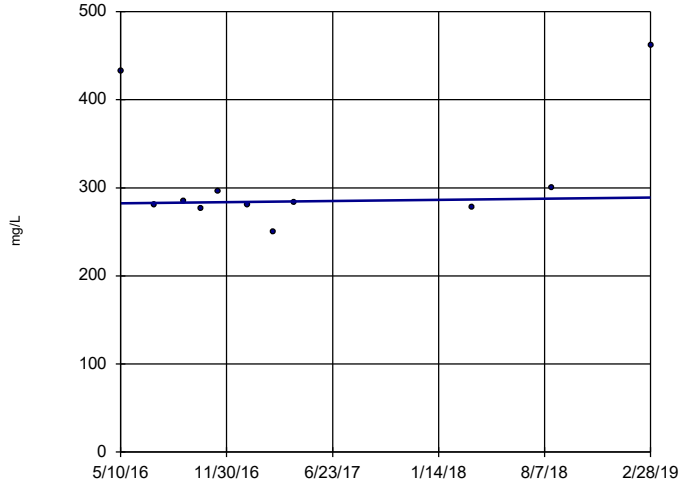
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 11

Slope = 2.271 units per year.

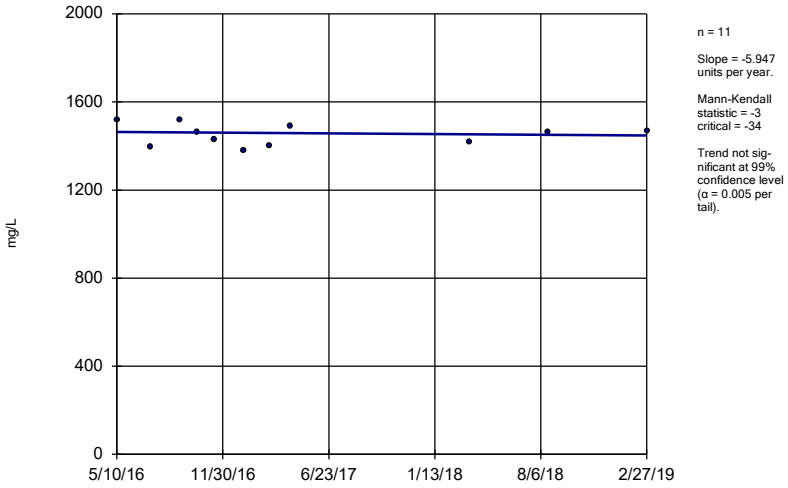
Mann-Kendall statistic = 4
critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-34



n = 11

Slope = -5.947 units per year.

Mann-Kendall statistic = -3
critical = -34

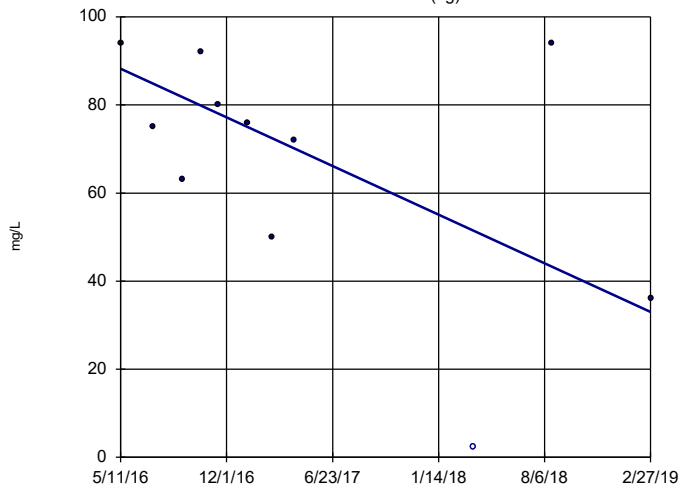
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = -19.73 units per year.

Mann-Kendall statistic = -20
critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Tolerance Limit Summary Table

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/1/2019, 9:49 AM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.008	44	n/a	n/a	86.36	n/a	n/a	0.1047	NP Inter(NDs)
Arsenic, total (mg/L)	n/a	0.00774	44	n/a	n/a	61.36	n/a	n/a	0.1047	NP Inter(normality)
Barium, total (mg/L)	n/a	0.07981	44	0.04604	0.01609	0	None	No	0.05	Inter
Beryllium, total (mg/L)	n/a	0.007	44	n/a	n/a	6.818	n/a	n/a	0.1047	NP Inter(normality)
Cadmium, total (mg/L)	n/a	0.001	44	n/a	n/a	52.27	n/a	n/a	0.1047	NP Inter(normality)
Chromium, total (mg/L)	n/a	0.005116	44	-6.886	0.7673	11.36	None	ln(x)	0.05	Inter
Cobalt, total (mg/L)	n/a	0.0256	44	n/a	n/a	0	n/a	n/a	0.1047	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	n/a	7.355	44	1.427	0.6124	0	None	sqrt(x)	0.05	Inter
Fluoride, total (mg/L)	n/a	5.2	44	n/a	n/a	65.91	n/a	n/a	0.1047	NP Inter(normality)
Lead, total (mg/L)	n/a	0.00446	44	n/a	n/a	72.73	n/a	n/a	0.1047	NP Inter(normality)
Lithium, total (mg/L)	n/a	0.108	44	n/a	n/a	4.545	n/a	n/a	0.1047	NP Inter(normality)
Mercury, total (mg/L)	n/a	0.000211	44	n/a	n/a	47.73	n/a	n/a	0.1047	NP Inter(normality)
Molybdenum, total (mg/L)	n/a	0.005	44	n/a	n/a	88.64	n/a	n/a	0.1047	NP Inter(NDs)
Selenium, total (mg/L)	n/a	0.0308	44	n/a	n/a	61.36	n/a	n/a	0.1047	NP Inter(normality)
Thallium, total (mg/L)	n/a	0.002	44	n/a	n/a	81.82	n/a	n/a	0.1047	NP Inter(NDs)

Confidence Interval Summary Table - Significant Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/11/2019, 1:58 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-34**	**0.3019**	**0.2721**	**0.026**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Lithium, total (mg/L)	**AD-34**	**0.1748**	**0.1447**	**0.11**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**

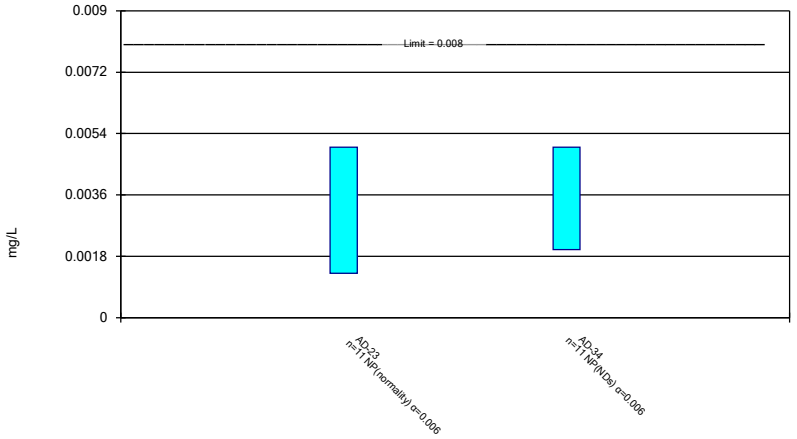
Confidence Interval Summary Table - All Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/11/2019, 1:58 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-23	0.005	0.001298	0.008	n/a	No	11	54.55	No	0.006	NP (normality)
Antimony, total (mg/L)	AD-34	0.005	0.002	0.008	n/a	No	11	90.91	No	0.006	NP (NDs)
Arsenic, total (mg/L)	AD-23	0.007638	0.002243	0.01	n/a	No	11	45.45	No	0.01	Param.
Arsenic, total (mg/L)	AD-34	0.01563	0.005694	0.01	n/a	No	11	0	No	0.01	Param.
Barium, total (mg/L)	AD-23	0.086	0.0469	2	n/a	No	11	0	No	0.006	NP (normality)
Barium, total (mg/L)	AD-34	0.06141	0.01018	2	n/a	No	11	0	x^(1/3)	0.01	Param.
Beryllium, total (mg/L)	AD-23	0.0004637	0.0001293	0.007	n/a	No	11	9.091	No	0.006	NP (normality)
Beryllium, total (mg/L)	AD-34	0.003022	0.001947	0.007	n/a	No	11	0	sqrt(x)	0.01	Param.
Cadmium, total (mg/L)	AD-23	0.001	0.000074	0.005	n/a	No	11	54.55	No	0.006	NP (normality)
Cadmium, total (mg/L)	AD-34	0.009173	0.004993	0.005	n/a	No	11	0	No	0.01	Param.
Chromium, total (mg/L)	AD-23	0.01641	0.001398	0.1	n/a	No	11	0	sqrt(x)	0.01	Param.
Chromium, total (mg/L)	AD-34	0.034	0.0005	0.1	n/a	No	11	18.18	No	0.006	NP (Cohens/xfrm)
Cobalt, total (mg/L)	AD-23	0.002737	0.00116	0.026	n/a	No	11	0	No	0.01	Param.
Cobalt, total (mg/L)	**AD-34**	**0.3019**	**0.2721**	**0.026**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Combined Radium 226 + 228 (pCi/L)	AD-23	10.01	6.077	7.36	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-34	11.43	6.828	7.36	n/a	No	11	0	No	0.01	Param.
Fluoride, total (mg/L)	AD-23	1	0.2688	5.2	n/a	No	11	81.82	No	0.006	NP (NDs)
Fluoride, total (mg/L)	AD-34	1	0.6272	5.2	n/a	No	11	63.64	No	0.006	NP (normality)
Lead, total (mg/L)	AD-23	0.015	0.003213	0.015	n/a	No	11	27.27	No	0.006	NP (Cohens/xfrm)
Lead, total (mg/L)	AD-34	0.012	0.001017	0.015	n/a	No	11	45.45	No	0.006	NP (Cohens/xfrm)
Lithium, total (mg/L)	AD-23	0.008535	0.00387	0.11	n/a	No	10	0	No	0.01	Param.
Lithium, total (mg/L)	**AD-34**	**0.1748**	**0.1447**	**0.11**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Mercury, total (mg/L)	AD-23	0.000095	0.00001721	0.002	n/a	No	11	18.18	No	0.006	NP (Cohens/xfrm)
Mercury, total (mg/L)	AD-34	0.000105	0.000015	0.002	n/a	No	11	18.18	No	0.006	NP (Cohens/xfrm)
Molybdenum, total (mg/L)	AD-23	0.005	0.0003152	0.1	n/a	No	11	54.55	No	0.006	NP (normality)
Molybdenum, total (mg/L)	AD-34	0.005	0.0006882	0.1	n/a	No	11	72.73	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-23	0.005	0.001	0.05	n/a	No	11	36.36	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-34	0.013	0.004508	0.05	n/a	No	11	54.55	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-23	0.001	0.001	0.002	n/a	No	11	90.91	No	0.006	NP (NDs)
Thallium, total (mg/L)	AD-34	0.001	0.001	0.002	n/a	No	11	90.91	No	0.006	NP (NDs)

Non-Parametric Confidence Interval

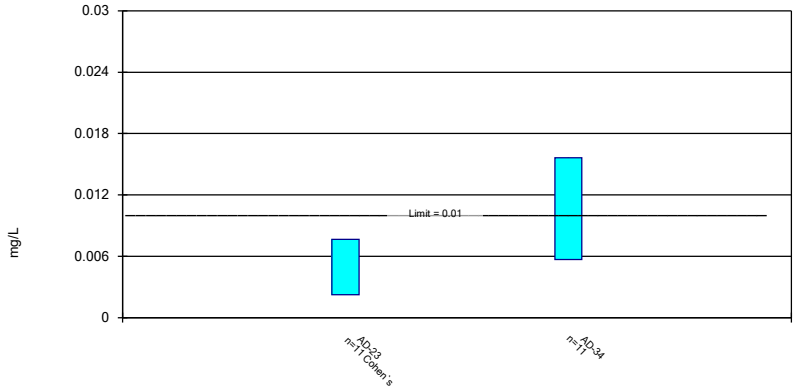
Compliance Limit is not exceeded.



Constituent: Antimony, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Parametric Confidence Interval

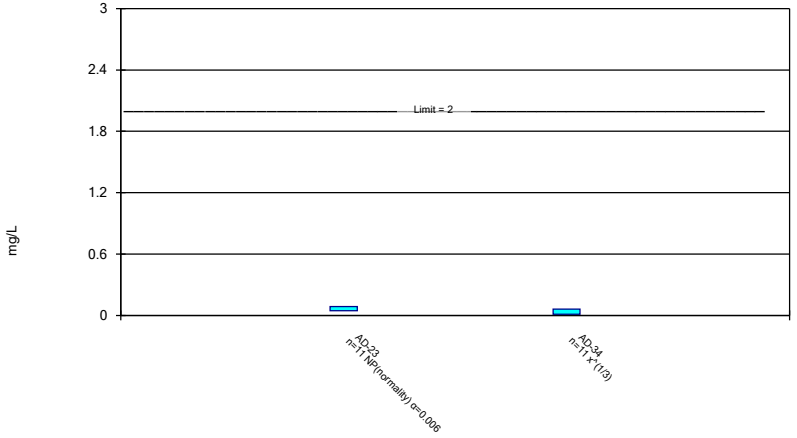
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Arsenic, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Parametric and Non-Parametric (NP) Confidence Interval

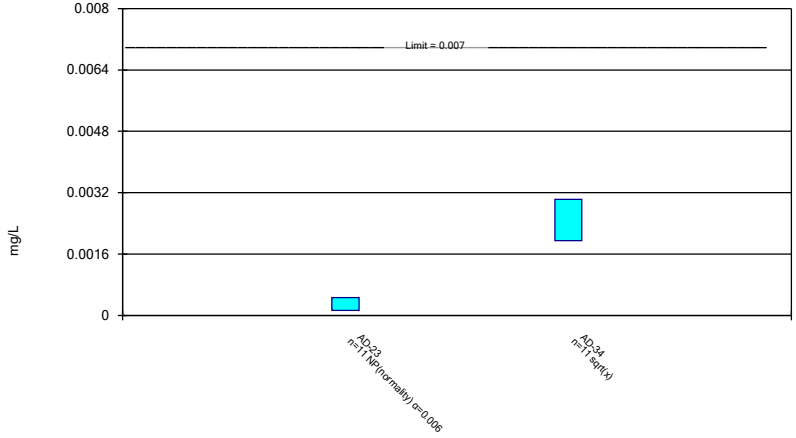
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Barium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Parametric and Non-Parametric (NP) Confidence Interval

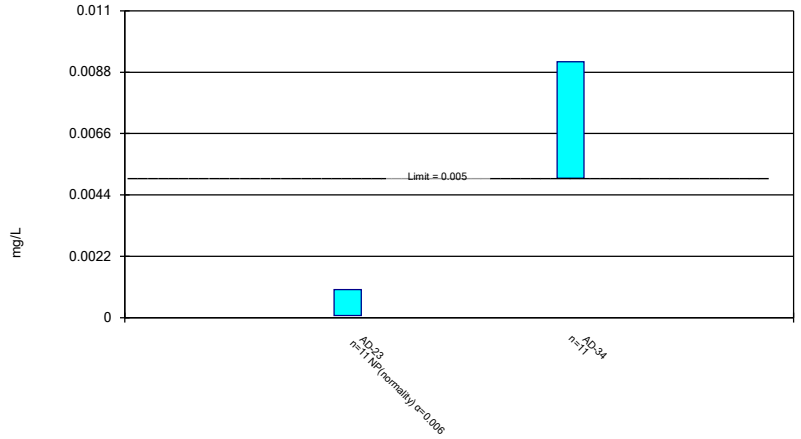
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Beryllium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

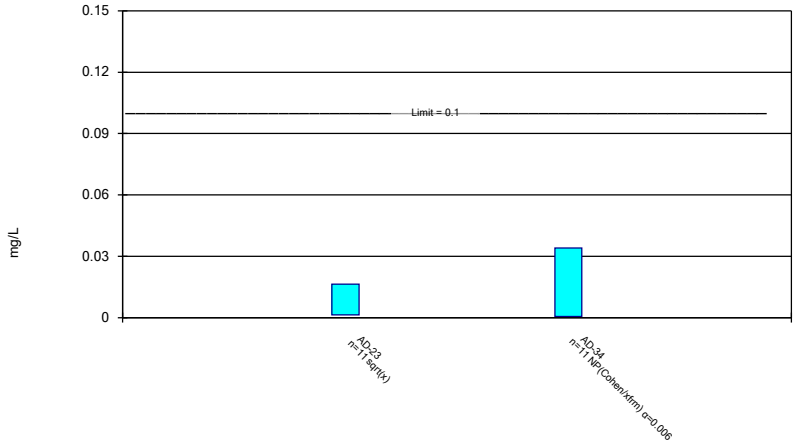


Constituent: Cadmium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

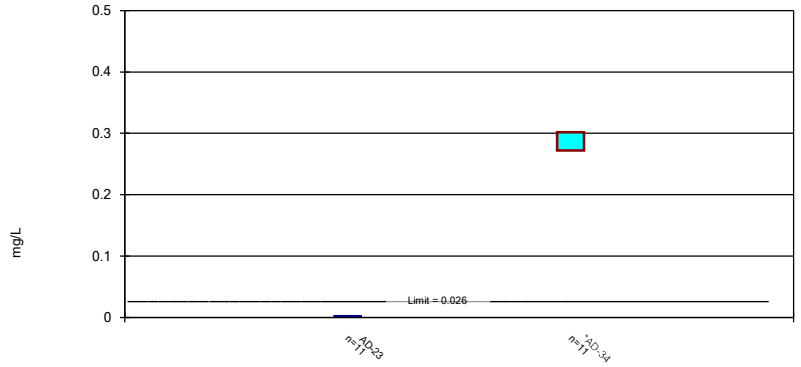


Constituent: Chromium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

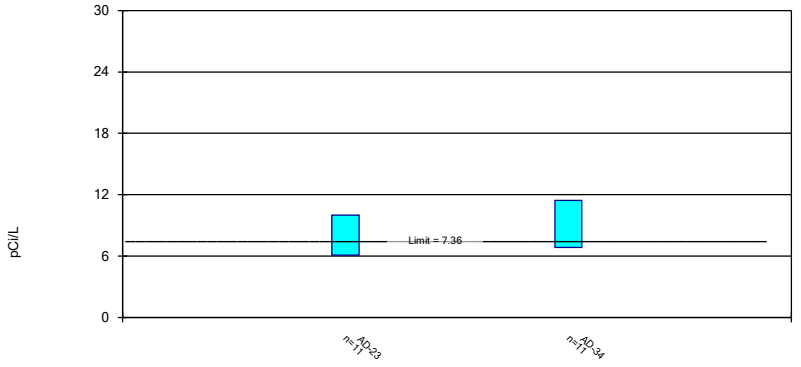


Constituent: Cobalt, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

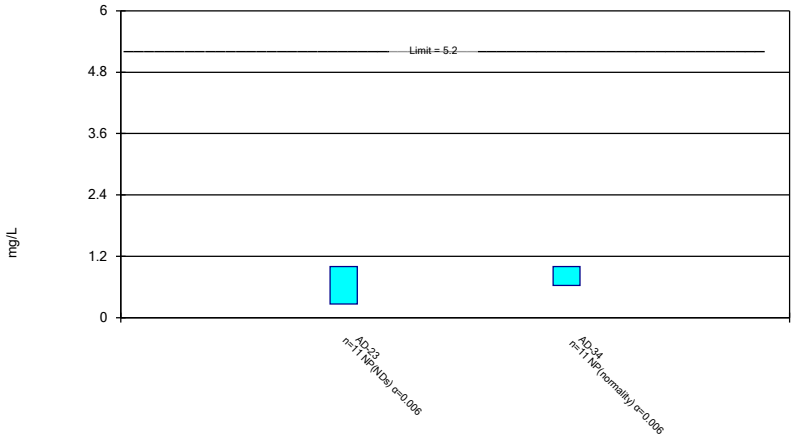
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals -
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

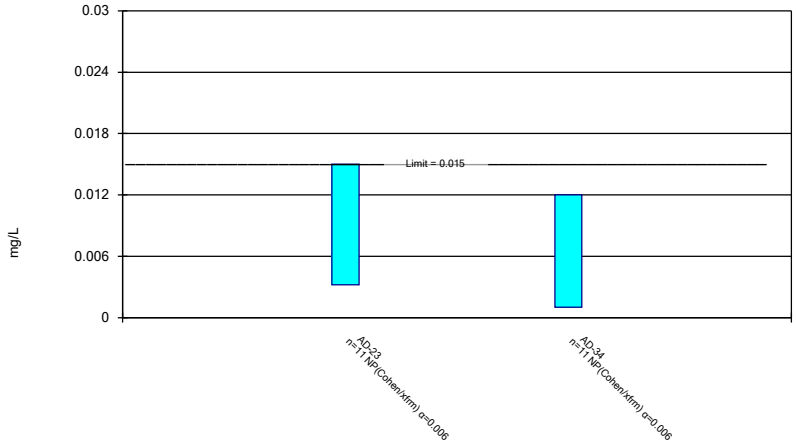


Constituent: Fluoride, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

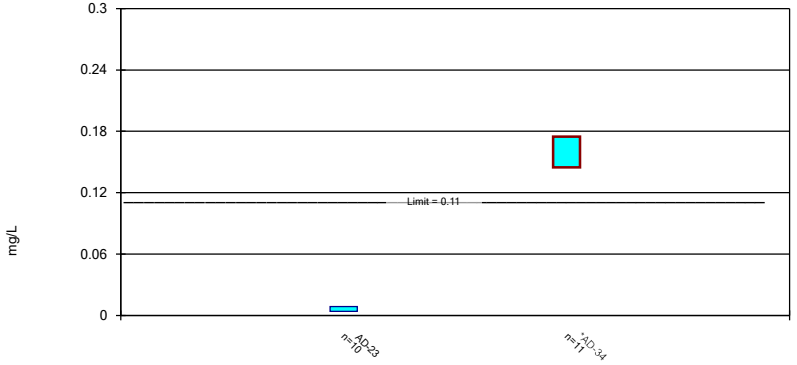


Constituent: Lead, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

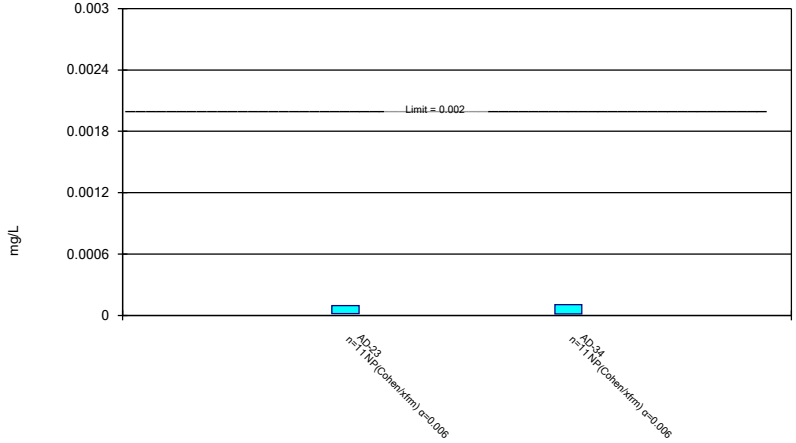


Constituent: Lithium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

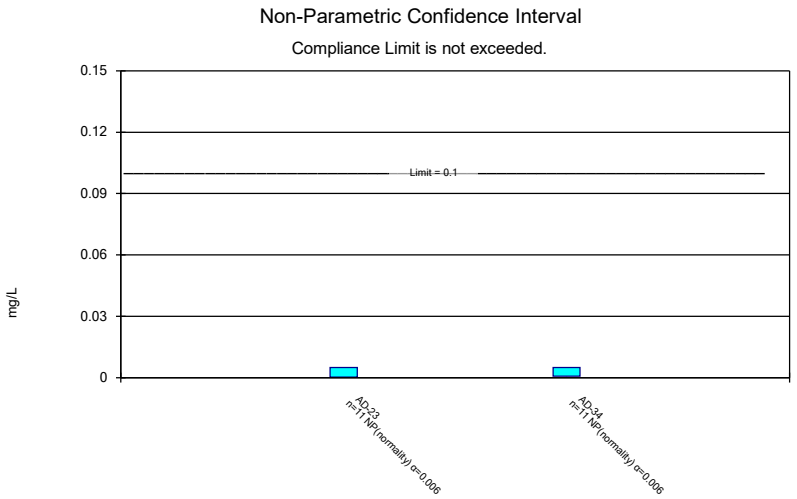
Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

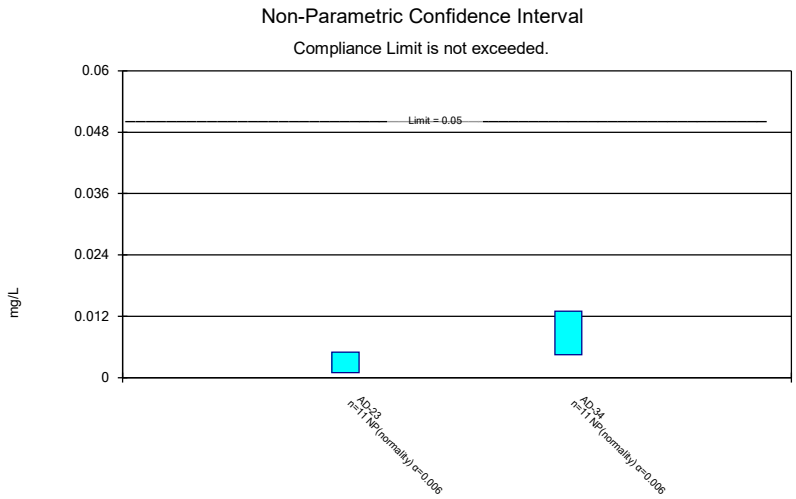


Constituent: Mercury, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill



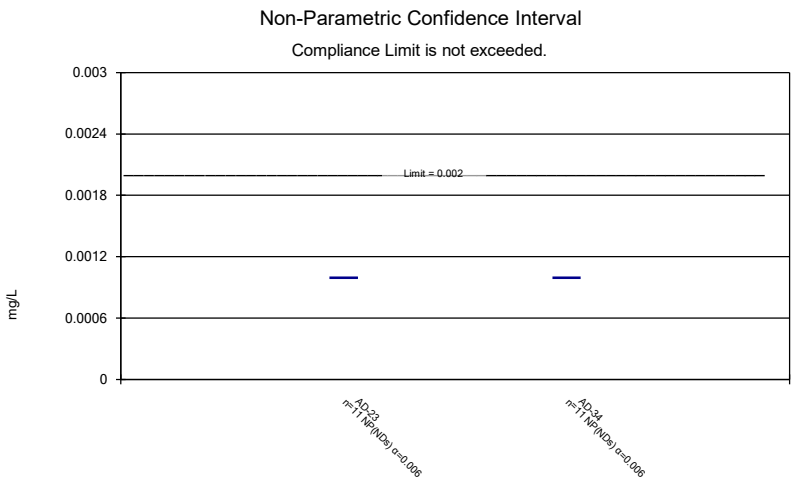
Constituent: Molybdenum, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Selenium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Thallium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

Alternate Source Demonstration Evaluation Report

American Electric Power

Henry W. Pirkey Power Plant
Landfill CCR Management Unit
Project No. 112112

Revision 1
4/22/2019
(Original Report date 3/26/2019)

Alternate Source Demonstration Evaluation Report

prepared for

American Electric Power
Henry W. Pirkey Power Plant
Landfill CCR Management Unit
Hallsville, Texas

Project No. 112112

Revision 1
4/22/2019
(Original Report date 3/26/2019)

prepared by

Burns & McDonnell Engineering Company, Inc.
St. Louis, Missouri

INDEX AND CERTIFICATION

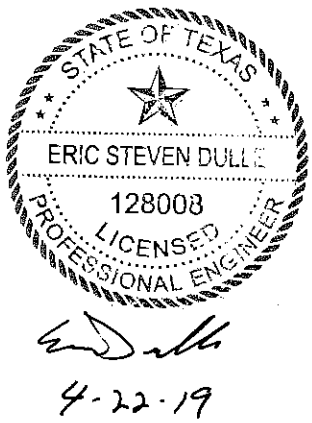
American Electric Power
Alternate Source Demonstration Evaluation Report
Project No. 112112

Report Index

Chapter Number	Chapter Title	Number of Pages
1	Introduction	3
2	Supplemental Data Collection	4
3	Alternate Source Evaluation Summary	7
4	Summary and Conclusions	3
5	References	1
Appendix A	Data Summary Tables	6

Certification

I hereby certify, as a Professional Engineer in the state of Texas, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the American Electric Power or others without specific verification or adaptation by the Engineer.



4-22-19

Eric Dulle, P.E. (Texas 128008)

Date: 4/22/2019

TABLE OF CONTENTS

LIST OF TABLES

Page No.

LIST OF FIGURES

Page No.

LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
AEP	American Electric Power
amsl	Above Mean Sea Level
ASD	Alternate Source Demonstration
Burns & McDonnell	Burns & McDonnell Engineering Company, Inc.
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPA	U. S. Environmental Protection Agency
ft	Feet
GWPS	Groundwater Protection Standard
LCL	Lower confidence limit
MCL	Maximum contaminant level
MDL	Method detection limit
mg/L	Milligram per Liter
MS	Matrix spike
MSD	Matrix spike duplicate
SWEPCO	Southwestern Electric Power Company
SSL	Statistically Significant Level
UTL	Upper tolerance limit

1.0 INTRODUCTION

Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) has prepared on behalf of AEP this Alternate Source Demonstration (ASD) Evaluation Report (ASD Evaluation Report) for the existing coal combustion residuals (CCR) landfill (Landfill) located at the American Electric Power (AEP) Southwestern Electric Power Company (SWEPCO) Henry W. Pirkey Power Plant (Pirkey Plant or Site) in Hallsville, Texas.

In 2018, two assessment monitoring events were conducted at the Pirkey Plant Landfill in accordance with 40 Code of Federal Regulations (CFR) 257.95. The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and U. S. Environmental Protection Agency's (EPA) Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance (Unified Guidance; EPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or GWPSs established under 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). An SSL was identified for cadmium and cobalt at AD-34 at the Landfill (Geosyntec, 2018).

This ASD is produced in conformance with requirements in the "Standards for the Disposal of Coal Combustion Residuals (CCR) in Landfills and Surface Impoundments" in 40 CFR 257.95(g)(3)(ii).

1.1 Purpose and Scope of Evaluation

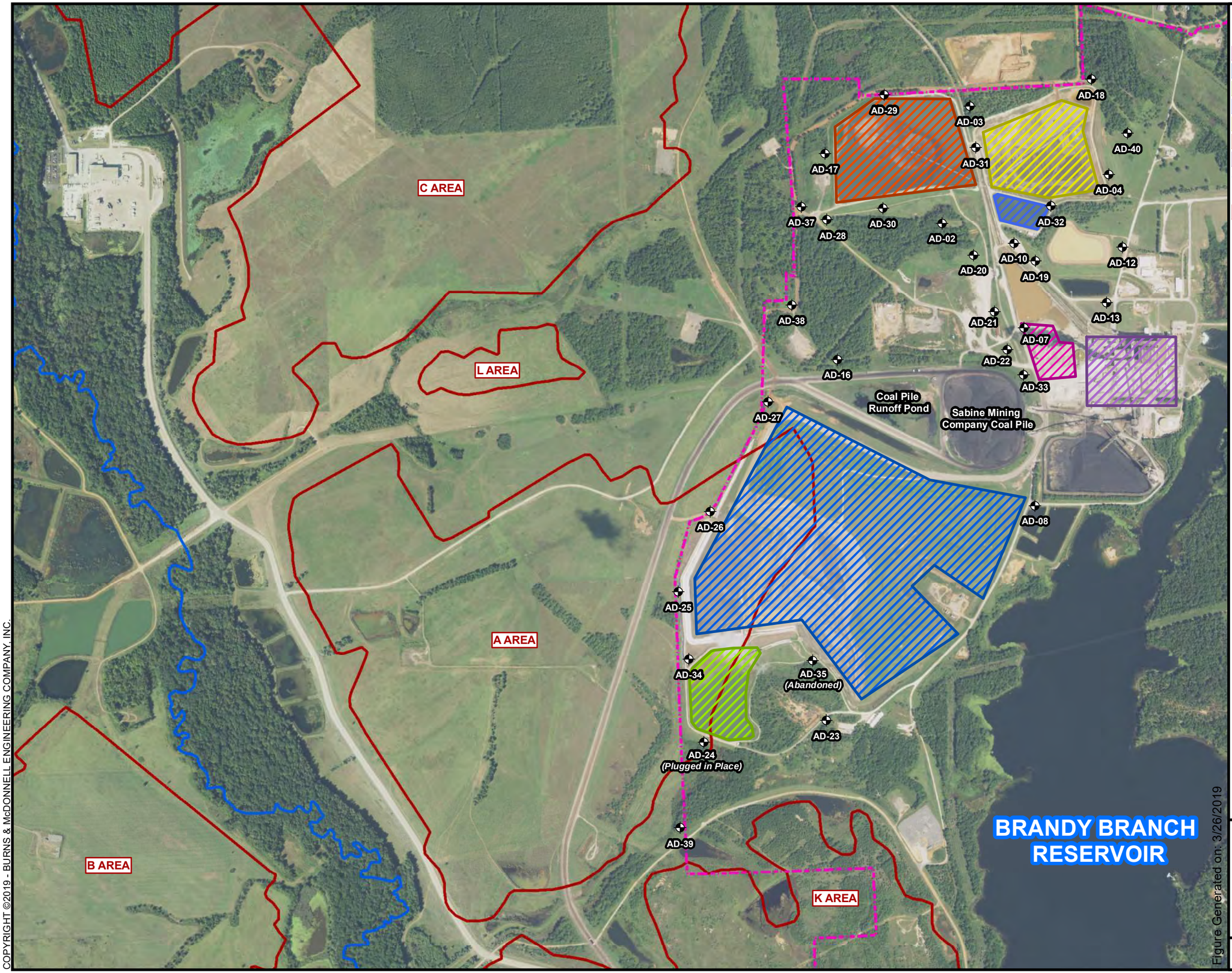
The purpose of this evaluation is to determine if concentrations of certain CCR constituents measured in groundwater samples collected from Site groundwater monitoring wells at SSLs above GWPSs established for the Landfill in accordance with 40 CFR 257.95(h) resulted from a source other than the Landfill or from natural variation in groundwater quality. Specifically, the LCL for cadmium (0.00511 milligram per liter [mg/L]) at AD-34 was above the Landfill GWPS of 0.005 mg/L and the LCL for cobalt (0.277 mg/L) at AD-34 was above the Landfill GWPS of 0.026 mg/L. The scope of the evaluation

included reviews of historical site records, existing groundwater monitoring system well data, and supplemental data collected from December 2018 through March 2019 to support this evaluation.

1.2 Site Setting

As shown on Figure 1-1, the Landfill is bound by an access road followed by Brandy Branch Reservoir to the east, the Stormwater Runoff Pond followed by former lignite mining areas to the south, former lignite mining areas to the west, and a coal pile and coal pile runoff pond to the north. Western portions of the Landfill are underlain by former lignite mining (reclaimed) land. The local surface topography slopes downward to the southwest towards Hatley Creek, located approximately 0.7 miles west of the Landfill. An unnamed tributary of Hatley Creek originates south of the Stormwater Runoff Pond and flows to the southwest towards Hatley Creek.

The Landfill, including closed, active, and under construction areas, occupies approximately 137 acres. The landfill consists of 10 cells identified by their date of construction (1984, 1987, 1993, 1995, 1997, 1999, 2005E, 2005W, 2012 and 2015) and there are three (3) leachate collection outlets along the southern edge of the active cell and the areas under construction. According to the Arcadis 2018 Landfill Lateral Expansion – CCR Location Restriction Evaluation (Arcadis 2018), AEP initiated an evaluation for the lateral expansion of the landfill. The expansion will cover approximately 15 acres and will be located directly southeast of the current landfill.



LEGEND

- AEP CCR WELL
- FGD STACKOUT AREA
- LANDFILL
- STORMWATER RUNOFF POND
- CLEARWATER POND
- EAST BOTTOM ASH POND
- WEST BOTTOM ASH POND
- AEP PIRKEY PLANT
- HATLEY CREEK
- PROPERTY BOUNDARY
- MINE AREAS

NOTES

1) PROPERTY BOUNDARY PROVIDED BY AKRON CONSULTING, LLC.
2) MOST RECENT SAMPLE AND BORING LOCATIONS - 3/20/19.

N

0 625 1,250 2,500 Feet

FIGURE 1-1
SITE LAYOUT MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

BURNS McDONNELL

Figure Generated on: 3/26/2019

2.0 SUPPLEMENTAL DATA COLLECTION

This section of the ASD Evaluation Report describes sampling and analysis conducted during supplemental data collection activities to support the Landfill ASD evaluation at the Site in February and March 2019.

2.1 Overview

Supplemental data collection activities included the collection and analysis of groundwater samples from existing Landfill sentinel wells AD-25 and AD-26 and newly installed sentinel well (SB-10/AD-39) and nature and extent wells located west and southwest of the Landfill (SB-07, SB-08, SB-09, SB-10, and SB-11). In addition, these activities included the collection and analysis of a Landfill leachate sample and surface water sample of the water impounded in the Landfill Stormwater Runoff Pond located southwest of the Landfill. A summary of sample locations is provided in Table 2-1 below and sample locations are shown on Figure 2-1.

Table 2-1: Supplemental Data Collection Summary

Sample Media	Location (Designation)	Purpose/Notes
Landfill Leachate	Landfill	Characterize leachate from Landfill
Surface Water	Landfill Stormwater Runoff Pond	Characterize water quality for runoff collected in Landfill Stormwater Runoff Pond
Groundwater	AD-25 (sentinel well), AD-26 (sentinel well), SB-07 (nature and extent well), SB-08 (nature and extent well), SB-09 (nature and extent well), SB-10 (nature and extent well), SB-11 (nature and extent well), and AD-39 (sentinel well)	Characterize groundwater quality in former lignite mining (reclaimed) areas and areas to the southwest of the Landfill
Soil	SB-6, SB-7, SB-8, SB-9, SB-10 and SB-11	Characterize soil conditions in former lignite mining (reclaimed) areas and background (SB-6)

A summary of the Landfill leachate and stormwater runoff pond results is provided in Appendix A, Table A-1, a summary of groundwater sampling results is provided in Appendix A, Table A-2, and a summary of soil sampling results are summarized in Appendix A, Table A-3. A synoptic round of water level measurements was collected on March 13, 2019 at existing monitoring and sentinel wells and at newly installed nature and extent and sentinel monitoring wells. These measurements are summarized in

Appendix A, Table A-4. Figure 2-2 presents the potentiometric surface map prepared using the March 13, 2019 synoptic round of water level measurements.

LEGEND

- AEP CCR WELL
- LEACHATE SAMPLE
- SOIL BORING
- SURFACE WATER
- HATLEY CREEK
- PROPERTY BOUNDARY
- MINE AREAS

NOTES

1) PROPERTY BOUNDARY PROVIDED BY AKRON CONSULTING, LLC.
2) MOST RECENT SAMPLE AND BORING LOCATIONS - 3/20/19.

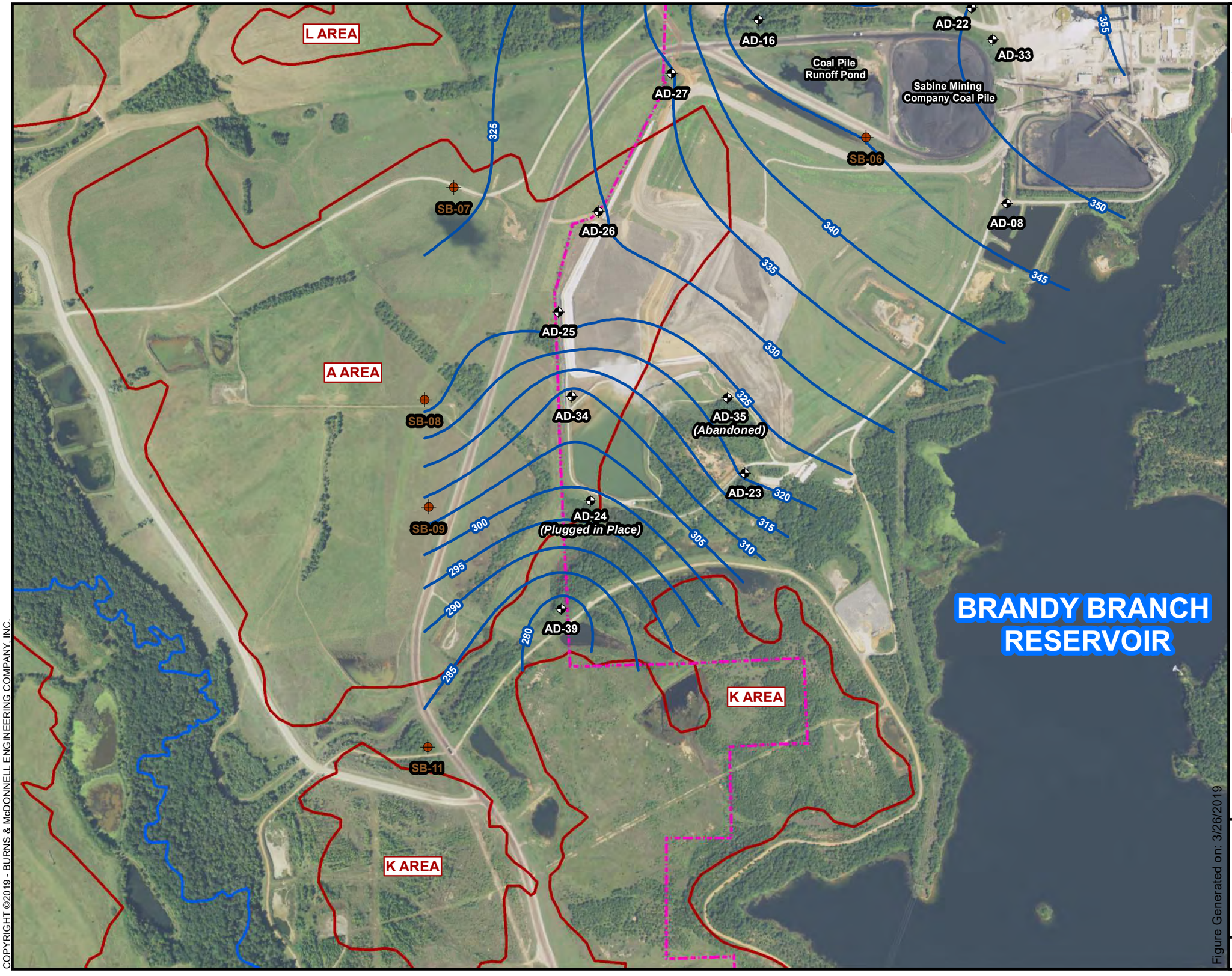
N

0 500 1,000 2,000 Feet

Figure Generated on: 3/26/2019

FIGURE 2-1
SAMPLE LOCATION MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

BURNS McDONNELL



LEGEND

- AEP CCR WELL
- SOIL BORING
- GROUNDWATER CONTOURS 3/12/19
- HATLEY CREEK
- PROPERTY BOUNDARY
- MINE AREAS

NOTES

1) PROPERTY BOUNDARY PROVIDED BY AKRON CONSULTING, LLC.
2) GROUNDWATER CONTOURS PLOTTED AT 5'/CONTOUR.
3) GROUNDWATER CONTOURS DRAFTED BASED ON ELEVATIONS COLLECTED ON 3/12/19

N

0 500 1,000 2,000 Feet

FIGURE 2-2
POTENTIOMETRIC SURFACE MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

BURNS McDONNELL

Figure Generated on: 3/26/2019

3.0 ALTERNATE SOURCE EVALUATION SUMMARY

This section of the ASD Evaluation Report presents lines of evidence that CCR constituents, at concentrations above GWPSs at the Landfill, resulted from sources other than the Landfill.

3.1 Coal Mine Drainage

Water levels at monitoring well AD-34 are consistently above the ground surface and represent artesian conditions. Prior to the installation of AD-34 and landfill cell and stormwater runoff pond expansion in 2015, groundwater from the former lignite (reclaimed) mine discharged to the ground surface in the area of AD-34. Figure 3-1 shows two aerial photographs in the area of AD-34. The December 2009 photo depicts surface flow from the mine drainage with the future location of monitoring well AD-34 located adjacent to the historical surface discharge of mine drainage (AD-34 was installed in December 2015). The August 2018 photo shows the current well location relative to the Landfill Pond Road and the 2015 Cell.

Studies of coal mine draining have identified the presence of cadmium and cobalt in coal mine drainage water. One such study summarizes analytical results for water samples from 128 untreated coal mine drainage discharges (Hyman and Watzlaf, 1997). For samples included in this study, 119 of 128 were analyzed for cadmium and 110 of 128 were analyzed for cobalt. The average of the detected cadmium concentrations was 0.014 mg/L and average of the detected cobalt concentrations 0.794 mg/L. In another EPA study, 15 samples of runoff water from coal mine reclamation areas were analyzed for cadmium and the average of the detected cadmium concentrations was 0.019 mg/L (USEPA, 1982). The runoff water samples for this study were not analyzed for cobalt. A study published in 2008 included analysis of cadmium results for 140 abandoned coal mines in Pennsylvania. For the 99 abandoned bituminous coal sites included in the study the median cadmium concentration was 0.023 mg/L (Cravotta III, 2008). The data from these studies indicates that untreated coal mine drainage similar to conditions at the Landfill affect groundwater conditions. Therefore, impacts from coal mine drainage in the area of AD-34 and coal mine drainage is a source of cadmium and cobalt.

LEGEND

- AEP CCR WELL
- PROPERTY_BOUNDARY
- RUNOFF FROM MINE DRAINAGE

NOTE

1) 2009 AND 2017 AERIAL PHOTO SOURCE: GOOGLE EARTH
2) MONITORING WELL AD-34 WAS INSTALLED ON: DECEMBER 11TH, 2015

N

0 30 60 120 Feet

Figure Generated On: 4/19/2019

FIGURE 3-1
HISTORICAL COAL MINE
DRAINAGE MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

BURNS McDONNELL

3.2 Historical Cadmium Concentrations

Table 3-1 presents historical concentrations of cadmium in samples from sentinel wells AD-25 and AD-26 and Table 3-2 presents historical concentrations of cadmium in samples from monitoring well AD-34.

Table 3-1: Historical Cadmium Concentrations for AD-25 and AD-26

Well Location	Sample Date	Cadmium (mg/L)
AD-25	4/12/2011	0.008
	12/14/2011	0.004
	6/19/2012	0.003
	1/22/2013	0.001
	7/17/2013	0.002
	1/21/2014	0.009
	7/8/2014	0.013
AD-26	4/12/2011	0.004
	12/14/2011	0.005
	6/19/2012	0.003
	1/22/2013	0.005
	7/17/2013	0.004
	1/21/2014	0.003
	7/8/2014	0.012

Notes: mg/L = milligram per liter

Table 3-2: Historical Cadmium Concentrations for AD-34

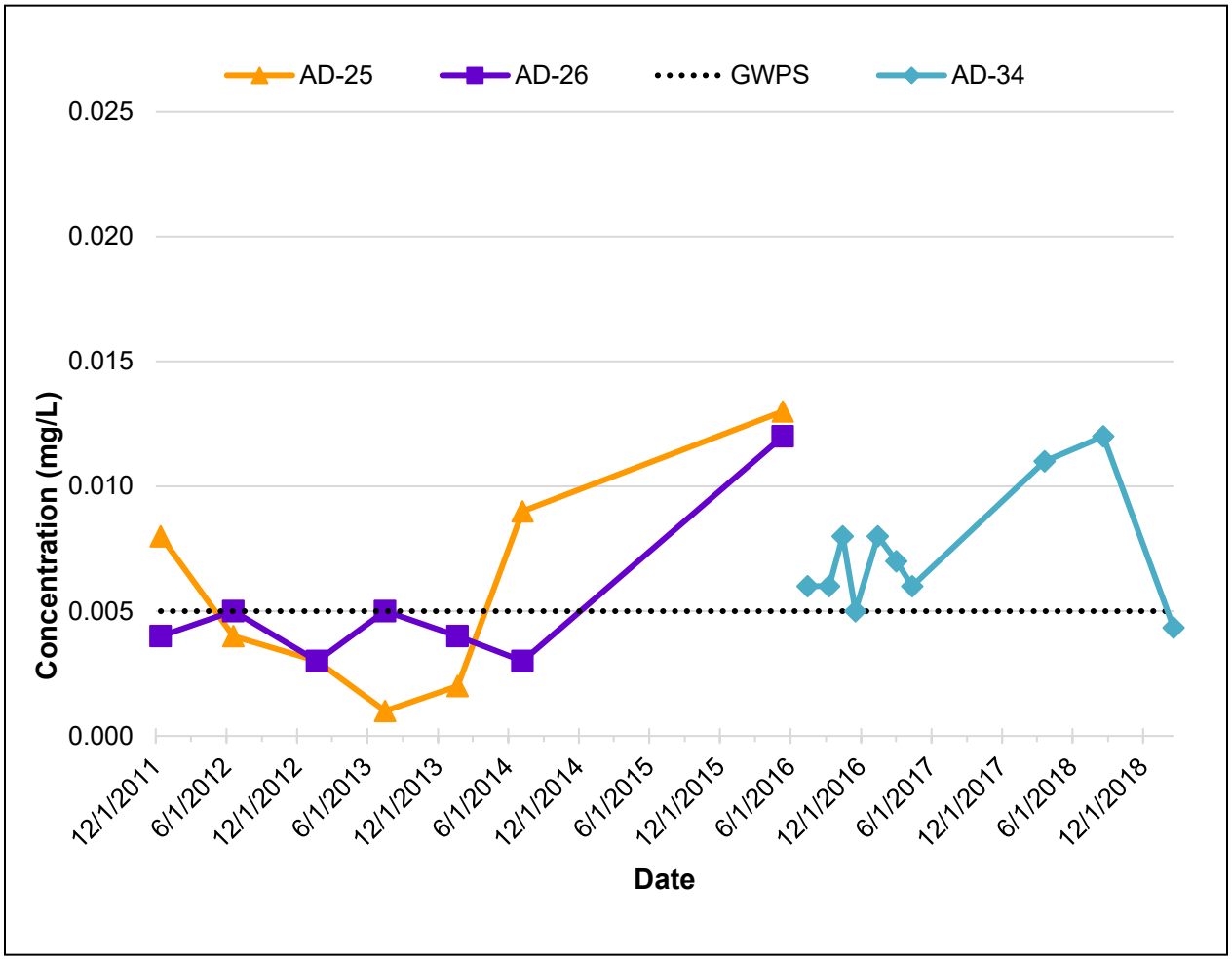
Well Location	Sample Date	Cadmium (mg/L)
AD-34	5/10/2016	0.006
	7/13/2016	0.006
	9/8/2016	0.008
	10/12/2016	0.005
	11/15/2016	0.008
	1/11/2017	0.007
	2/28/2017	0.006
	4/10/2017	0.011
	3/21/2018	0.012
	8/20/2018	0.00434

Notes: mg/L = milligram per liter

Figure 3-2 shows concentrations of cadmium over time in sentinel wells AD-25 and AD-26 along with concentrations of cadmium over time in samples from monitoring well AD-34. A comparison of these historical results indicates that recent cadmium concentrations in samples from AD-34 are within the range of historical cadmium concentrations in samples from sentinel wells located immediately

hydraulically upgradient of AD-34. These cadmium concentrations are also at levels consistent with the average and median concentrations for water affected by former coal mining activities discussed in Section 3.1. It should also be noted that the cadmium concentrations in the sentinel and monitoring wells exhibit natural variability over time. This data indicates former lignite coal mining is a source cadmium at AD-34.

Figure 3-2: Cadmium Concentrations at AD-25, AD-26 and AD-34



3.3 Historical Cobalt Concentrations

Table 3-3 presents historical concentrations of cobalt in samples from monitoring well AD-34. Historical samples from AD-25 and AD-26 were not analyzed for cobalt. A comparison between AD-34 historical and recent results indicate that recent cobalt concentrations are generally consistent over time and have been within a relatively narrow range. The February 2019 concentration of cobalt at sentinel well AD-25, located immediately hydraulically upgradient of AD-34, is approximately two times higher than the average concentration at AD-34 and is slightly lower than the average concentration for coal mine

drainage water discussed in Section 3.1. This data indicates former lignite coal mining is a source of cobalt at AD-34.

Table 3-3: Cobalt Concentrations for AD-25, AD-26, and AD-34

Well Location	Sample Date	Cobalt (mg/L)
AD-25	2/18/2019	0.63
AD-26	2/18/2019	0.19 F
AD-34	5/10/2016	0.301
	7/13/2016	0.296
	9/8/2016	0.306
	10/12/2016	0.297
	11/15/2016	0.292
	1/11/2017	0.284
	2/28/2017	0.294
	4/10/2017	0.299
	3/21/2018	0.279
	8/20/2018	0.249

Notes: mg/L = milligram per liter, F = Matrix Spike (MS) and/or MS Duplicate (MSD) Recovery is outside acceptable limits

3.4 Comparison of Groundwater and Landfill Sample Results

This section presents a comparison of concentrations of leachate from the Landfill and the adjacent stormwater runoff pond to evaluate if they are a potential source of cadmium and cobalt in AD-34. Table 3-4 shows the most recent analytical sampling results for monitoring wells and sentinel wells in the area of the Landfill. This table also notes if the monitoring or sentinel well is considered hydraulically upgradient, downgradient, or cross-gradient of the Landfill and if the monitoring or sentinel well is in a former lignite mining area. As presented in Table 3-4, cadmium and cobalt were detected at very low concentrations in the Landfill leachate and stormwater runoff pond samples. Cadmium concentrations from both potential sources (i.e., Landfill leachate and stormwater runoff pond samples) are an order of magnitude (i.e., ten times) lower than concentrations at AD-34, AD-25, and AD-26 in the former lignite mining area. Cobalt concentrations in the Landfill leachate and stormwater runoff pond samples are three orders of magnitude (i.e., 1,000 times) lower than concentrations at AD-34, AD-25, and AD-26 in the former lignite mining area. Cadmium and cobalt concentrations were highest in samples from nature and extent wells and sentinel wells in former lignite mining area.

Two CCR constituents detected at relatively high levels in the Landfill leachate and stormwater runoff ponds were chloride and molybdenum. Chloride is a conservative (non-reactive) ion and can be used to evaluate the potential influence of leachate on groundwater quality and molybdenum metal transport can

be similar to other metals associated with CCR. The highest concentrations of chloride and molybdenum were detected in the Landfill leachate and stormwater runoff pond samples. Molybdenum was not detected above the laboratory reporting limit in the most recent samples collected from monitoring and sentinel wells and the concentration of molybdenum in the Landfill leachate and stormwater runoff pond water samples was four to five orders of magnitude (i.e., 10,000 to 100,000 times) higher than the detected levels at upgradient and downgradient sentinel wells. Chloride concentrations at nature and extent wells, sentinel wells and monitoring wells ranged from 2.5 mg/L to 38 mg/L, were variable among the well groupings, and were an order of magnitude (i.e., ten times) lower than chloride concentrations in the Landfill leachate and stormwater runoff pond. The comparison of the results demonstrates little correlation between the concentration of key constituents in groundwater and leachate samples indicating that the Landfill and the stormwater runoff pond are not a source of cadmium and cobalt in AD-34.

Additionally, concentrations in downgradient wells AD-23, AD-35, and AD-39 are similar to concentrations in upgradient wells, indicating that the Landfill is not affecting groundwater conditions in these downgradient wells. Also, AD-34 concentrations are more similar to concentrations in nature and extent wells and sentinel wells (also installed within the former lignite mine area), further indicating that former lignite mining area is a source of cadmium and cobalt in AD-34.

The highest concentrations of cobalt in recent groundwater samples from the area of the Landfill were from wells installed within the former lignite mining area and the highest cobalt concentration was detected at AD-25 located immediately upgradient of AD-34. Similarly, the highest concentrations of cadmium were detected in wells installed within the former lignite mining area. Lower cadmium concentrations further to the west of the Landfill may be the result of increased pH in these areas reducing the solubility and mobility of cadmium in groundwater. This pattern of high cadmium and cobalt groundwater concentrations indicate that the former lignite mining area is a source of cadmium and cobalt in AD-34.

Table 3-4: Other Notable Constituents

Sample Location/Type	Former Lignite Mine (Reclaimed) Area	Sample Date	Cadmium (mg/L)	Chloride (mg/L)	Cobalt (mg/L)	Molybdenum (mg/L)
Upgradient Monitoring Wells						
AD-8	No	8/20/2018	0.00018	18	0.0159	0.00002
AD-12	No	8/20/2018	0.00001	10	0.00172	0.00004
AD-27	No	8/21/2018	0.00046	10	0.0246	0.00007
Landfill						
Leachate	--	3/6/2019	0.0003 J	640	0.00043 J	3.7

Sample Location/Type	Former Lignite Mine (Reclaimed) Area	Sample Date	Cadmium (mg/L)	Chloride (mg/L)	Cobalt (mg/L)	Molybdenum (mg/L)
Stormwater Runoff Pond	--	3/6/2019	0.0001 J	110	0.00091 JF	0.52
Downgradient Monitoring Wells						
AD-23	No	8/20/2018	0.00001 J	9	0.000803	0.00007 J
AD-34	Yes	8/20/2018	0.00434	10	0.249	0.00003 J
AD-35	No	8/20/2018	0.00012	38	0.0119	0.00004 J
AD-39	No	3/7/2019	0.005 U	2.5 JB	0.0036 J	0.01 U
Cross-gradient and Downgradient Sentinel and Nature and Extent Wells (former lignite mining area)						
AD-25	Yes	2/18/2019	0.0029	6.2 B	0.63	0.01 U
AD-26	Yes	2/18/2019	0.0035	34	0.19 F	0.01 U
SB-07	Yes	3/6/2019	0.0005 U	18.3	0.0235	0.001 U
SB-08	Yes	2/28/2019	0.0002 J	22 B	0.037	0.01 U
SB-09	Yes	3/6/2019	0.0008	32.7	0.0878	0.001 U
SB-11	No	3/11/2019	0.0005 U	14.5	0.0228	0.001 U

Notes: mg/L = milligram per liter; B = Compound was found in the blank and sample; F = Matrix Spike (MS) and/or MS Duplicate (MSD) Recovery is outside acceptable limits; J = Result is less than the reporting limit but greater than or equal to the Method Detection Limit (MDL) and the concentration is an approximate value; U = Indicates the analyte was analyzed for but not detected above the MDL.

3.5 Soil Sampling Results

Soil sample analytical results are summarized in Appendix A, Table A-3. Concentrations of cobalt were generally an order of magnitude (i.e., ten times) higher than the concentrations of cadmium detected in the soil samples in the area of the Landfill. Groundwater concentrations exhibit a similar pattern with cobalt concentrations and are generally at least an order of magnitude higher than the cadmium concentrations in groundwater. The highest concentrations of both cadmium and cobalt were detected in soil samples collected in former lignite mining area (four of the five soil sampling locations were in former lignite mining (reclaimed) area). The pattern for groundwater concentrations is also similar with the highest cobalt and cadmium concentrations found in the former lignite mining area. This pattern of high cadmium and cobalt groundwater concentrations indicate that the former lignite mining area is a source of cadmium and cobalt in AD-34.

4.0 SUMMARY AND CONCLUSIONS

This section of the ASD Evaluation Report provides a summary of the notable observations and conclusions resulting from a review of the groundwater, leachate, stormwater runoff pond water sample, and soil sample results for the Site. The following observations and conclusions provide multiple lines of evidence that the source of cadmium and cobalt concentration above the GWPS at AD-34 is the former lignite mining area.

- Monitoring well AD-34 is located in reclaimed mine spoils from former lignite mining operations and is in an area where historical coal mine drainage discharged to the ground surface. AD-34 is located hydraulically downgradient of portions of former lignite mining area and portions of the landfill.

- Recent cadmium concentrations in groundwater samples from AD-34 are similar to historical cadmium concentrations in groundwater samples from nature and extent wells in reclaimed mine spoils located immediately hydraulically upgradient of AD-34 (AD-25 and AD-26) and are similar to concentrations found in coal mine drainage impacted water. This data is evidence that former lignite coal mining is a source of cadmium at AD-34.

- The February 2019 concentration of cobalt at sentinel well AD-25 located immediately hydraulically upgradient of AD-34 is approximately two times higher than the average concentration at AD-34 and is slightly lower than the average concentration found in coal mine drainage impacted water. This data is evidence that former lignite coal mining is a source of cobalt at AD-34.

- Cadmium and cobalt were detected at very low concentrations in the Landfill leachate and stormwater runoff pond samples as well as upgradient monitoring wells. Cadmium and cobalt concentrations were highest in samples from monitoring wells, sentinel well, and nature and extent well in former lignite mining (reclaimed) areas. Conversely, the highest concentrations of chloride and molybdenum were detected in the Landfill leachate and stormwater runoff pond samples. The lack of correlation between key constituents in groundwater and leachate samples and lack of correlation among wells is evidence that the Landfill and stormwater runoff pond are not the source of cadmium and cobalt at AD-34.

- The highest concentrations of cadmium and cobalt were consistently detected in wells in the former lignite mining area. This pattern of high cadmium and cobalt groundwater concentrations is evidence that the former lignite mining area is the source of cadmium and cobalt in AD-34.

- The pattern for the highest soil sample concentrations was similar to the groundwater pattern with the highest concentrations of both cadmium and cobalt detected in soil samples from the former lignite mining area (four of the five soil sampling locations were in former lignite mining area). This pattern of high cadmium and cobalt soil concentrations is evidence that the former lignite mining area is a source of cadmium and cobalt at AD-34.

Per EPA's Solid Waste Disposal Facility Criteria Technical Manual, Subpart E (EPA530-R-93-017, November 1993), this ASD has documented that:

- An alternative source exists. The highest concentrations of cadmium and cobalt in groundwater and soil samples were consistently detected in wells in the former lignite mining area. Literature documents coal mine impacted sites have high concentration of cadmium and cobalt. Previous studies of coal mine discharges have identified similar elevated concentrations of cadmium and cobalt.

- Hydraulic connection exists between the alternative source and the groundwater monitoring well(s) with the significant increase. The established Landfill monitoring well network and newly installed shallow sentinel wells in the area of the Landfill are all screened within the same hydrostratigraphic zone of the uppermost aquifer and former lignite mining area and non-mined area are hydraulically connected.

- Constituent(s) are present at the alternative source or along the flow path from the alternative source prior to possible release from the [CCR] unit. The highest concentrations of cadmium and cobalt were consistently detected in wells in the former lignite mining area and as shown on Figure 2-2 former lignite mining areas are located hydraulically upgradient from AD-34.

- The relative concentration and distribution of constituents in the zone of contamination are more strongly linked to the alternative source than to the [CCR] unit when the fate and transport characteristics of the constituents are considered. The highest concentrations of cadmium and cobalt were consistently detected in wells in the former lignite mining area. Cadmium concentrations in Landfill leachate was an order of magnitude (i.e., ten times) lower than concentrations at AD-34, AD-25, and AD-26 in the former lignite mining area. Cobalt

concentrations in Landfill leachate are three orders of magnitude (i.e. 1,000 times) lower than concentrations at AD-34, AD-25, and AD-26 in the former lignite mining area.

- The concentration observed in groundwater could not have resulted from the [CCR] unit given the waste constituents and concentrations in the [CCR] unit leachate and wastes, and site hydrogeologic conditions. Cadmium concentration in the Landfill leachate was an order of magnitude (i.e., ten times) lower than concentrations detected at AD-34, AD-25, and AD-26 located in the former lignite mining area. Cobalt concentrations in Landfill leachate are three orders of magnitude (i.e. 1,000 times) lower than concentrations at AD-34, AD-25, and AD-26 located in the former lignite mining area.

- The data supporting conclusions regarding the alternative source are historically consistent with hydrogeologic conditions and findings of the monitoring program. As discussed in Sections 3.2 and 3.3 cadmium and cobalt concentrations have shown some natural variability but are generally consistent over time.

As summarized above, there are multiple lines of evidence demonstrating that the source of cadmium and cobalt concentrations in samples from monitoring well AD-34 resulting in an SSL above the GWPS is the former lignite mining spoils located beneath portions of the Landfill and to the west of the Landfill.

5.0 REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

Arcadis, 2016. Landfill – CCR Groundwater Monitoring Well Network Evaluation. Prepared for American Electric Power Service Corporation. May.

Arcadis, 2018. 2018 Landfill Lateral Expansion – CCR Location Restriction Evaluation, October.

Cravotta III, C.A. 2008. *Dissolved metals and associated constituents in abandoned coal-mine discharges, Pennsylvania, USA. Part 2: Geochemical controls on constituent concentrations*, Applied Geochemistry 23 (2008), pp 203–226

Flawn, P.T., 1965. Geologic Atlas of Texas, Tyler Sheet. University of Texas at Austin, Bureau of Economic Geology. March.

Hyman, D.M. and Watzlaf, G.R., 1997. *Metals and Other Components of Coal Mine Drainage as Related to Aquatic Life Standards*, Proceedings America Society of Mining and Reclamation, 1997 pp 531-545.

Geosyntec Consultants, 2018. Statistical Analysis Summary – H.W. Pirkey Power Plant. Hallsville, Texas. January 3.

U. S. Environmental Protection Agency (USEPA), 1982. Development Document for Effluent Limitations Guidelines and Standards for the Coal Mining. EPA 440/1-82/057.

U. S. Environmental Protection Agency (USEPA), 1993. Solid Waste Disposal Facility Criteria Technical Manual, Subpart E. EPA530-R-93-017.

U. S. Environmental Protection Agency (USEPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007.

APPENDIX A - DATA SUMMARY TABLES

Sample Area:		Landfill	Landfill
Sample ID:		**LANDFILL LEACHATE-1**	**LANDFILL STORMWATER RUNOFF POND-1**
Sample Type:		Water	Water
Screened Interval (ft bgs):		Surface	Surface
Date Sampled:		2/11/2019	2/11/2019
Appendix III			
Boron	mg/L	5000.0 U	1000.0 U
Calcium	mg/L	590.0	290.0
Chloride	mg/L	640.0	110.0
Fluoride	mg/L	0.5 J	0.75 J
pH	-	9.6	8.85
Sulfate	mg/L	2200.0 B	1100.0 B
Total Dissolved Solids	mg/L	5100.0	2000.0
Appendix IV			
Antimony	mg/L	0.0044 B	0.0026 J B
Arsenic	mg/L	0.045	0.0048 J
Barium	mg/L	0.048 J	0.071 J F1
Beryllium	mg/L	0.00011 J	0.004 U
Cadmium	mg/L	0.0003 J	0.00012 J F1
Chromium	mg/L	0.005 U	0.0005 J F1
Cobalt	mg/L	0.00043 J	0.00091 J F1
Fluoride	mg/L	0.5 J	0.75 J
Lead	mg/L	0.00029 J B	0.00014 J B
Lithium	mg/L	0.042	0.014 J
Mercury	mg/L	0.0005	0.0002 U F1
Molybdenum	mg/L	3.7	0.52
Selenium	mg/L	0.13	0.037
Thallium	mg/L	0.002 U	0.002 U
Combined Ra 226/228	pCi/L	0.528 U	0.375 U

NA - Data Not Yet Available from Lab.

B - Compound was found in the blank and sample.

J - Result is less than the Reporting Limit (RL) but greater than or equal to the Method Detection Limit (MDL) and the concentrat

U - Indicates the analyte was analyzed for but not detected.

M1 - Matrix Spike (MS) recovery exceeded Quality Control (QC) limits. Batch accepted based on laboratory control sample (LC

D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

F1 - MS and/or MS Duplicate (MSD) Recovery is outside acceptable limits.

* - LCS and/or LCSD is outside acceptable limits.

^ - Instrument related QC outside acceptable limits.

Sample Area:		Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill
Sample ID:		**SB-7 / 35-45**	**SB-7 / 60-70**	**SB-8 / 25-35**	**SB-8/55-65**	**SB-8/80-90**	**SB-9 / 20-30**	**SB-9 / 50-60**	**SB-10 / 40-50**
Sample Type:		Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Screened Interval (ft bgs):		35-45	60-70	25-35	55-65	80-90	20-30	50-60	40-50
Date Sampled:		3/4/2019	3/4/2019	2/28/2019	3/1/2019	3/1/2019	3/1/2019	2/23/2019	2/23/2019
Appendix III									
Boron	mg/L	0.174	0.186	0.2 J	0.16 J	0.19 J	0.203	0.204	0.23 J
Calcium	mg/L	18.6	37.3	38.0	53.0	71.0	54.7	170.0	5.7
Chloride	mg/L	18.3	18.2	22 B	12 B	30 B ^	32.7	6.8	20.0 B F1
Fluoride	mg/L	0.21	0.29	0.32 J	0.12 J	0.084 J	1.6	0.48	0.23 J
pH	-	5.6	6.1	4.7	5.3	6.3	6.1	4.8	7.5
Sulfate	mg/L	131.0	348.0 M1	350 B	1400 B	300 B	747.0	2580.0	48.0 B
Total Dissolved Solids	mg/L	346.0	614.0	690.0	1000.0	650.0	968.0	3830.0	310.0
Appendix IV									
Antimony	mg/L	0.001 U	0.001 U	0.003 U	0.003 U	0.003 U	0.001 U	0.001	0.003 U
Arsenic	mg/L	0.0037	0.0161	0.0012 J	0.0087	0.005 U	0.0038	0.0232 U M1	0.00099 J
Barium	mg/L	0.109	0.0974	0.087 J	0.028 J	0.048 J	0.258	0.0144	0.067 J
Beryllium	mg/L	0.0005 U	0.0005 U	0.0011 J	0.00078 J	0.00088 J	0.0029	0.005	0.00033 J
Cadmium	mg/L	0.0005 U	0.0005 U	0.00024 J	0.005 U	0.005 U	0.00082	0.0005 U	0.005 U
Chromium	mg/L	0.005 U	0.005 U	0.005 U	0.005	0.005 U	0.005 U	0.01 U D3	0.0033 J
Cobalt	mg/L	0.0235	0.0701	0.037	0.029	0.0049 J	0.0878	0.163	0.0015 J
Fluoride	mg/L	0.21	0.29	0.32 J	0.12 J	0.084 J	1.6	0.48	0.23 J
Lead	mg/L	0.001 U	0.001 U	0.005 U	0.0015 J	0.005 U	0.001 U	0.001 U M1	0.0012 J
Lithium	mg/L	0.103	0.2	0.059	0.17	0.16	0.0684	0.3	0.045
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.001 U	0.001 U	0.01 U	0.01 U	0.01 U	0.001 U	0.001 U	0.0013 J
Selenium	mg/L	0.001 U	0.001 U	0.01 U	0.01 U	0.01 U	0.009	0.0166 U M1	0.01 U
Thallium	mg/L	0.001 U	0.001 U	0.002 U	0.002 U	0.002 U	0.001 U	0.001 M1	0.002 U
Combined Ra 226/228	pCi/L	5.38 ± 1.37	5.22 ± 1.39	NA	NA	NA	10.9 ± 2.14	7.53 ± 1.52	NA

NA - Data Not Yet Available from Lab.

B - Compound was found in the blank and sample.

J - Result is less than the Reporting Limit (RL) but greater than or equal to the Method Detction Limite (MDL) and the concentration is an approximate value.

U - Indicates the analyte was analyzed for but not detected.

M1 - Matrix Spike (MS) recovery exceeded Quality Control (QC) limits. Batch accepted based on laboratory control sample (LCS) recovery.

D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

F1 - MS and/or MS Duplicate (MSD) Recovery is outside acceptable limits.

* - LCS and/or LCSD is outside acceptable limits.

^ - Instrument related QC outside acceptable limits.

Sample Area:		Landfill	Landfill	Landfill	Landfill	Landfill
Sample ID:		**SB-11/5-15**	**SB-11/33-43**	**AD-25**	**AD-26**	**AD-39**
Sample Type:		Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Screened Interval (ft bgs):		5-15	33-43	MW	MW	MW
Date Sampled:		3/11/2019	3/11/2019	2/18/2019	2/18/2019	2/22/2019
Appendix III						
Boron	mg/L	0.1 U	0.276	0.055 J *	0.12 J	1.1 J
Calcium	mg/L	10.2	17.3	83.0	95.0	44
Chloride	mg/L	14.5	26.1	6.2 B	34.0	2.5 J B
Fluoride	mg/L	0.82	0.2 U	2.8	3.6	0.059 J
pH	-	5.1	6.9	3.51	3.37	5.89
Sulfate	mg/L	159.0	97.4	1500.0 B	1500.0 B	120.0 B
Total Dissolved Solids	mg/L	294.0	314.0	2100.0	2000.0	260.0
Appendix IV						
Antimony	mg/L	0.001 U	0.001 U	0.0011 J B	0.0016 J ^ B	0.0030 U
Arsenic	mg/L	0.001 U	0.001	0.013	0.0037 J	0.0075
Barium	mg/L	0.0914	0.0456	0.0079 J	0.012 J	0.024 J
Beryllium	mg/L	0.0006	0.0005 U	0.0091	0.0084	0.0040 U
Cadmium	mg/L	0.0005 U	0.0005 U	0.0027 J	0.0035 J	0.0050 U
Chromium	mg/L	0.005 U	0.005 U	0.0011 J	0.0022 J	0.0033 J
Cobalt	mg/L	0.0228	0.0023	0.6	0.19 F1	0.0036 J
Fluoride	mg/L	0.82	0.2 U	2.8	3.6	0.059 J
Lead	mg/L	0.001 U	0.001 U	0.00075 J	0.00065 J	0.0050 U
Lithium	mg/L	0.0111	0.0576	0.13	0.16	0.040 U
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.001 U	0.001 U	0.01 U	0.01 U	0.010 U
Selenium	mg/L	0.001 U	0.001 U	0.00062 J	0.01 U	0.010 U
Thallium	mg/L	0.001 U	0.001 U	0.002 U	0.002 U	0.0020 U
Combined Ra 226/228	pCi/L	8.47 ± 1.64	4.59 ± 1.10	NA	NA	NA

NA - Data Not Yet Available from Lab.

B - Compound was found in the blank and sample.

J - Result is less than the Reporting Limit (RL) but greater than or equal to the Method Detction Limite (MDL) and the concentration is an approximate value.

U - Indicates the analyte was analyzed for but not detected.

M1 - Matrix Spike (MS) recovery exceeded Quality Control (QC) limits. Batch accepted based on laboratory control sample (LCS) recovery.

D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

F1 - MS and/or MS Duplicate (MSD) Recovery is outside acceptable limits.

* - LCS and/or LCSD is outside acceptable limits.

^ - Instrument related QC outside acceptable limits.

Sample Area:		Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill
Sample ID:		**SB-6 / 6-7**	**SB-6 / 16-17**	**SB-7 / 7-8**	**SB-7 / 22-23**	**SB-8 / 6-7**	**SB-8 / 25-26**	**SB-9 5-6**	**SB-9 20-21**
Sample Type:		Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sampled Interval (ft bgs):		6-7	16-17	7-8	22-23	6-7	25-26	5-6	20-21
Date Sampled:		2/22/2019	2/22/2019	2/28/2019	2/28/2019	2/27/2019	2/27/2019	3/4/2019	3/4/2019
Isotopic Uranium & Thorium (6020/Alpha Spec)									
Uranium-233/234	pCi/g	0.534	0.355	0.539	0.217	0.604	0.314	NA	NA
Uranium-235/236	pCi/g	0.0459 U	0.0342 U	0.0243 U	-0.00247 U	0.0108 U	0.0380	NA	NA
Uranium-238	pCi/g	0.596	0.325	0.581	0.271	0.564	0.433	NA	NA
Uranium	mg/kg	60.0 U	64.0 U	1.1	0.59 J	0.93	0.71	NA	NA
Thorium-228	pCi/g	0.537	0.839	0.610	0.324	0.584	0.356	NA	NA
Thorium-230	pCi/g	0.477	0.382	0.579	0.357	0.583	0.427	NA	NA
Thorium-232	pCi/g	0.604	0.559	0.464	0.472	0.724	0.382	NA	NA
Thorium	mg/kg	60.0 U	64.0 U	4.4	4.3	4.2	3.7	NA	NA
Appendix IV + Boron									
Antimony	mg/kg	1.2 U	1.3 U	0.40 U	0.42 U	0.38 U	0.40 U		
Arsenic	mg/kg	6.9	6.9	6.9	23	2.7	18		
Barium	mg/kg	51	15 J	66	41	18 J	10 J		
Boron	mg/kg	23 U	25 U	3.4 J	7.1 J	3.7 J	3.4 U		
Beryllium	mg/kg	0.28 J	0.20 J	0.50	0.37 J	0.35 J	0.36 J		
Cadmium	mg/kg	0.067 J	0.094 J	0.095 J	0.12 J	0.085 J	0.12 J		
Chromium	mg/kg	23	21	12	12	4.2	18		
Cobalt	mg/kg	1.5 J	6.4 U	3.1 J	12	5.5 J	2.4 J		
Fluoride	mg/kg	1.1 U	0.95 J	3.1	2.5	0.75 U	0.75 U		
Lead	mg/kg	7.4	4.7	9.3	6.2	9.1	6.1		
Lithium	mg/kg	4.6 J	0.98 J	3.8 J	7.2	2.4 J	2.1 J		
Mercury	mg/kg	0.032 U	0.044 U	0.033 J	0.018 J	0.042	0.017 U		
Molybdenum	mg/kg	0.80 J	0.52 J	0.39 J	0.26 U	0.40 J	0.47 J		
Selenium	mg/kg	1.2 U	0.74 J	0.70 J	0.70 J	0.58 J	0.67 J		
Thallium	mg/kg	2.3 U	2.5 U	0.38 U	0.40 U	0.36 U	0.38 U		
Combined Ra 226/228	pCi/L	NA	NA	NA	NA	NA	NA		

- Analyte Not Requested

NA - Data Not Yet Available from Lab

B - Compound was found in the blank and sample.

J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

U - Indicates the analyte was analyzed for but not detected.

H - Sample was prepped or analyzed beyond the specified holding time.

M1 - Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

F1 - MS and/or MSD Recovery is outside acceptable limits.

F2 - MS/MSD RPD exceeds control limits.

* - LCS and/or LCSD is outside acceptable limits.

^ - Instrument related QC outside acceptable limits.

Sample Area:		Landfill	Landfill	Landfill	Landfill
Sample ID:		**SB-10/6.5-7.5**	**SB-10/10-11**	**SB-11 / 8-9**	**SB-11 / 10-11**
Sample Type:		Soil	Soil	Soil	Soil
Sampled Interval (ft bgs):		6.5-7.5	10-11	8-9	10-11
Date Sampled:		2/19/2019	2/19/2019	3/11/2019	3/7/2019
Isotopic Uranium & Thorium (6020/Alpha Spec)					
Uranium-233/234	pCi/g	0.353	0.319		
Uranium-235/236	pCi/g	0.0535	0.0470 U		
Uranium-238	pCi/g	0.240	0.263		
Uranium	mg/kg	0.47	1.0		
Thorium-228	pCi/g	0.848	0.741		
Thorium-230	pCi/g	0.449	0.396		
Thorium-232	pCi/g	0.831	0.612		
Thorium	mg/kg	4.7	11.0		
Appendix IV + Boron					
Antimony	mg/kg	1.1 U	1.2 U	1.1 U M1	1.1 U
Arsenic	mg/kg	23	18	2.0	1.7
Barium	mg/kg	6.4 J	7.6 J	14.5	9.8
Boron	mg/kg	23 U	24 U	11.4 U	11.1 U
Beryllium	mg/kg	0.044 J	0.082 J	0.57 U	0.55 U
Cadmium	mg/kg	0.13 J	0.11 J	0.57 U	0.55 U
Chromium	mg/kg	15	21	10.9	9.0
Cobalt	mg/kg	5.7 U	5.9 U	1.1 U	1.1 U
Fluoride	mg/kg	1.2 U	1.2 U	24.0 U M1	25.4 U
Lead	mg/kg	5.3	5.6	4.8	3.7
Lithium	mg/kg	5.7 U	1.1 J	5.2	2.0
Mercury	mg/kg	0.025 J	0.020 J	0.048 U	0.054 U
Molybdenum	mg/kg	0.77 J	1.1 J	5.7 U	5.5 U
Selenium	mg/kg	1.1 U	1.5	1.1 U	1.1 U
Thallium	mg/kg	2.3 U	2.4 U	1.1 U	1.1 U
Combined Ra 226/228	pCi/L	NA	NA	NA	NA

- Analyte Not Requested

NA - Data Not Yet Available from Lab

B - Compound was found in the blank and sample.

J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

U - Indicates the analyte was analyzed for but not detected.

H - Sample was prepped or analyzed beyond the specified holding time.

M1 - Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

F1 - MS and/or MSD Recovery is outside acceptable limits.

F2 - MS/MSD RPD exceeds control limits.

* - LCS and/or LCSD is outside acceptable limits.

^ - Instrument related QC outside acceptable limits.

BURNS McDONNELL

CREATE AMAZING.

Burns & McDonnell World Headquarters
9400 Ward Parkway
Kansas City, MO 64114
O 816-333-9400
F 816-333-3690
www.burnsmcd.com

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant Landfill Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

September 24, 2019

CHA8462

TABLE OF CONTENTS

FIGURES

TABLES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LF	Landfill
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the Landfill (LF, Figure 1). In February 2019, a semi-annual assessment monitoring event was conducted at the LF in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey LF:

- The LCL for cobalt at AD-34 was 0.272 milligrams per liter (mg/L), which exceeded the GWPS of 0.026 mg/L.

- The LCL for lithium at AD-34 was 0.145 mg/L, which exceeded the GWPS of 0.110 mg/L.

No other SSLs were identified (Geosyntec, 2019a).

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State*

> *Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSLs identified for cobalt and lithium at AD-34 should not be attributed to the Pirkey LF.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for cobalt and lithium at AD-34 were based on a Type V cause and not by a release from the Pirkey LF.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for cobalt and lithium and the proposed alternative source are described below.

2.1 Proposed Alternative Sources

Initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to a Type I (sampling causes), Type II (laboratory causes), or Type III (statistical causes) issue. As described below, the SSLs were attributed to impacts from a former lignite mining area, which is a Type V issue.

During the previous assessment monitoring event, SSLs for cadmium and cobalt were identified at AD-34 (Geosyntec, 2018). An ASD was generated which identified impacts from a former lignite mining area as the source for the elevated cadmium and cobalt concentrations (Burns and McDonnell, 2019). As shown in Figure 1, AD-34 is the only downgradient well in the LF monitoring network which is set within mine spoil in the former mining area (identified as Area A in the figure). Other nearby monitoring wells in the mine spoil include AD-25 and AD-26; however, neither is in the LF network.

Additionally, the previous ASD noted that the cobalt and cadmium concentrations in the leachate from the LF and from the LF stormwater runoff pond are several orders of magnitude lower than concentrations observed at AD-34. A comparison of the LF leachate and runoff values to the LCLs and the most recent sampling results finds that the LF liquids have significantly lower concentrations of both lithium and cobalt (Table 1), indicating that the LF is not a likely source for these constituents.

The previous ASD found that cadmium and cobalt concentrations at AD-25, AD-26, and AD-34 were comparable to each other but different from other network wells. A Piper diagram was generated to assess whether major ion concentrations are affected by screen placement in the mine spoil area (Figure 2). The Piper diagram shows that AD-34 groundwater appears more similar to AD-25 and AD-26 groundwater based on the distribution of major ions. Groundwater in the mine spoil area is dominated by sulfate and magnesium, whereas wells in the LF network have higher proportions of chloride, sodium, and potassium.

Monitoring wells AD-48, AD-49 and AD-52 through AD-55 were installed in the former mining area in 2019. When these wells are included on a Piper diagram, it is apparent they have chemistry similar to AD-34 (Figure 3). These findings suggest that impacts from the former lignite mine have affected the geochemistry of the groundwater at wells set within its footprint. The effect of the former lignite mining area on cobalt and lithium is described in more detail below.

2.1.1 Cobalt ASD

As described above, an ASD LF previously attributed the observed cobalt exceedance to impacts from the former lignite mining area (Burns and McDonnell, 2019). Additional sampling since completion of the previous ASD provides further evidence that the observed cobalt exceedances at AD-34 are due to impacts from the former mining area and are not related to the LF.

Boring logs from AD-48 through AD-50 and AD-52 through AD-57 (provided in Attachment A) were used to generate a cross-section to illustrate the extent of the fill associated with the former mining activities. Weathering of pyrite, which is present throughout the mine area, is responsible for low pH (3.3 to 6.3) and elevated sulfate (152 to 2,110 mg/L) in the groundwater (Table 2). Acidic pH and elevated sulfate concentrations are known effects of groundwater on mine waste (Johnson, 2003). As shown in Figure 4, cobalt is generally elevated wherever well screens are placed in the mine fill. Cobalt concentrations are below the GWPS in wells that are screened outside the footprint of the former mining area, such as AD-56 and AD-57. AD-48 and AD-53 are the only wells screened in mine spoils which do not have cobalt concentrations above the GWPS. However, AD-48 is set near an upgradient edge of the former mining area, and so is likely to be recharged by unimpacted groundwater. Additionally, it has slightly elevated pH compared to locations with higher cobalt concentrations AD-53 has much higher pH than the other mine spoil wells (6.3 SU in Table 2), which is consistent with low cobalt solubility at circumneutral pH (Izquierdo and Querol, 2012).

Soil was collected at select locations during the installation of monitoring wells AD-46 through AD-57 and analyzed for total cobalt. Additional samples were collected from borings advanced adjacent to existing wells AD-16 and AD-34. Cobalt was detected in all samples, with higher concentrations below 10 ft bgs, which suggests that it is naturally prevalent across the aquifer solid material (Table 3). A groundwater sample was collected from AD-34 and then passed through a 1.5-micron filter. The solid material retained on the filter was submitted for total metals analysis, with cobalt identified in the material at an estimated concentration of 2.2 milligrams per kilogram (mg/kg). This concentration is comparable to concentrations observed in the bulk soil within the footprint of the former mining area, ranging from 2.4 to 12 mg/kg (Figure 5).

Cobalt concentrations in the bulk soil samples are slightly higher in the former mining area, which could be an indicator that the fill material has higher proportions of cobalt-containing minerals (Table 3). Analysis by X-ray diffraction (XRD) identified pyrite and marcasite (both iron sulfides) at AD-34 at concentrations up to 2% by weight (Table 4). Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2019).

These lines of evidence, combined with the low concentrations of cobalt in the LF leachate and stormwater runoff pond, illustrate that the cobalt exceedance at AD-34 is not due to a release from the LF. Instead, the exceedance is due to changes in the groundwater chemistry associated with the former lignite mining area.

2.1.2 Lithium ASD

An SSL for lithium was not previously identified at the LF. As described below, the current exceedances can be attributed to impacts from the former mining area.

Lithium concentrations generally appear to be higher for wells that are located within the footprint of the former mining area (Figure 6). This relationship becomes more apparent when comparing concentrations for wells in the former mining area which are not set within the mine spoil. The observed lithium concentration at AD-50, which is screened in non-mine fill, is more than an order of magnitude lower than the concentrations at AD-52 and AD-53, both of which were installed immediately adjacent to AD-50 and screened within the mine spoil (Figure 7). Lithium concentrations are also below the GWPS at AD-39 (not shown on the cross-section), AD-56, and AD-57, which are set outside the footprint of the former mining area.

An ASD previously generated for lithium exceedances at Pirkey's East Bottom Ash Pond (EBAP) identified natural variation in the aquifer as the source of lithium near that unit. The ASD developed a proposed mechanism for lithium mobility in groundwater which pointed to desorption from clay minerals associated with naturally occurring lignite material as the source of lithium in both up and downgradient wells at the EBAP (Geosyntec, 2019b).

The total metal concentrations in the solid materials separated from the groundwater samples during filtration and the filtered groundwater concentrations were used to calculated partition coefficients values (K_d) for lithium, potassium, and sodium. These constituents were selected as they are all monovalent cations, and so have similar geochemical behavior. Partition coefficients are used to express the tendency of a chemical (e.g. lithium) to become adsorbed onto soil (or sediment). K_d is a ratio of the amount of chemical adsorbed per unit weight of the soil to the concentration of the chemical in solution (i.e., groundwater), as shown in the following equation:

$$K_d = \frac{mg\ adsorbed/kg\ soil}{mg/L\ solution}$$

K_d is characteristic of the soil, so its value varies with soil type. The K_d values for groundwater and particulate collected from AD-34 were compared to literature K_d values reported for organic-rich media such as bogs and peat beds (Table 5) (Sheppard et al., 2009; 2011). The calculated values are generally slightly lower than the literature values. However, the relationship between calculated K_d values for different constituents is consistent with the literature, with potassium being the largest (most sorbable) and sodium the smallest (least sorbable). These results support the proposed mechanism; however, there is less sorbing capacity in soil near AD-34 due to natural variations in the aquifer material.

According to XRD analysis of soil collected adjacent to AD-34, approximately 90% of the soil is composed of quartz, which is an inert mineral. Small fractions (1-2%) of clay minerals (illite, smectite), which have adsorptive capacity were identified in the XRD pattern as well. Suspended solids were separated from groundwater collected from AD-34 and analyzed for chemical

composition and mineralogy by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). Clay particles were identified in the backscattered electron micrographs of this sample by morphology (Attachment B). Aluminum was identified in the particles, which provides evidence for clay aluminosilicate minerals in addition to quartz.

The lines of evidence described above show that elevated lithium concentrations at AD-34 are not due to a release from the LF, particularly as the lithium concentration in LF leachate is much lower than in groundwater at wells set within the former mine area. Instead, changes associated with the former mining area appear to be mobilizing lithium which is natural present in the aquifer and likely associated with clay fractions in the soil aquifer material.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSLs are not due to a release from the Pirkey LF, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSLs for cobalt and lithium at AD-34 identified during assessment monitoring in February 2019 were not due to a release from the Pirkey LF. The identified SSLs were, instead, attributed to impacts from a former lignite mining area. Therefore, no further action for cobalt or lithium is warranted, and the LF will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment C.

SECTION 4

REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

Burns & McDonnell Engineering Company, Inc. 2019. Alternate Source Demonstration Evaluation Report. H. W. Pirkey Plant. Landfill CCR Management Unit. April.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.

Geosyntec Consultants. 2018. Statistical Analysis Summary – Landfill. H.W. Pirkey Power Plant. Hallsville, Texas. December.

Geosyntec Consultants, 2019a. Statistical Analysis Summary – Landfill. H.W. Pirkey Power Plant. Hallsville, Texas. July.

Geosyntec Consultants, 2019b. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, East Bottom Ash Pond. Hallsville, Texas. July.

Hitzman, M.W., Bookstrom, A.A., Slack, J.F., and Zientek, M.L., 2017. Cobalt – Styles of Deposits and the Search for Primary Deposits. USGS Open File Report 2017-1155.

Johnson, D. B. 2003. Chemical and Microbiological Characteristics of Mineral Spoils and Drainage Waters at Abandoned Coal and Metal Mines. *Water, Air, & Soil Pollution: Focus*, 3, 47-66.

Krupka, K. M. and Serne, R. J., 2002. Geochemical Factors Affecting the Behavior of Antimony, Cobalt, Europium, Technetium, and Uranium in Vadose Sediments. Pacific Northwest National Lab, PNNL-14126. December.

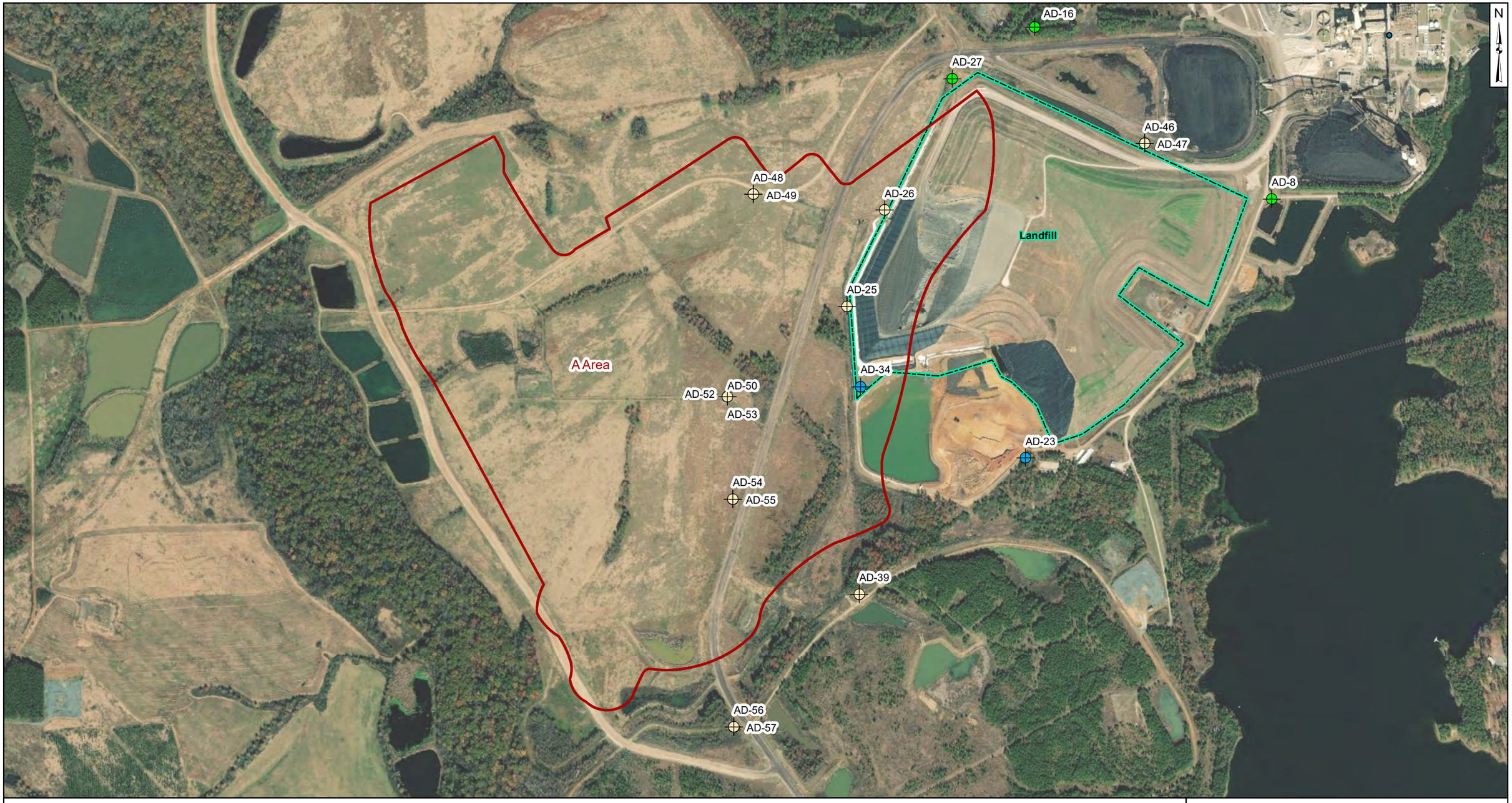
Izquierdo, M. and Querol, X., 2012. Leaching Behaviour of Elements from Coal Combustion Fly Ash: An Overview. *International Journal of Coal Geology*, 94, 54-66.

Sheppard, S., Sohlenius, G., Omberg, L.G., Borgiel, M., Grolander, S. Nordén, S. 2011. Solid/Liquid Partition Coefficients (K_d) and Plant/Soil Concentration Ratios (CR) for Selected Soil, Tills, and Sediments at Forsmark. R-11-24. Swedish Nuclear Fuel and Waste Management Co. R-11-24. November.

Sheppard, S., Long, J., Sanipelli, B., Sohlenius, G. 2009. Solid/Liquid Partition Coefficients (K_d) for Selected Soil and Sediments at Forsmark and Laxemar-Simpevarp. R-09-27. Swedish Nuclear Fuel and Waste Management Co. March.

United States Environmental Protection Agency (USEPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

FIGURES



Legend

- A Area
- Upgradient Wells
- Downgradient Wells
- Out of network

Notes
- Monitoring well coordinates, site features, and data provided by AEP.
- Area A is a former lignite (reclaimed) mine.

875 437.5 0 875
Feet

Site Layout

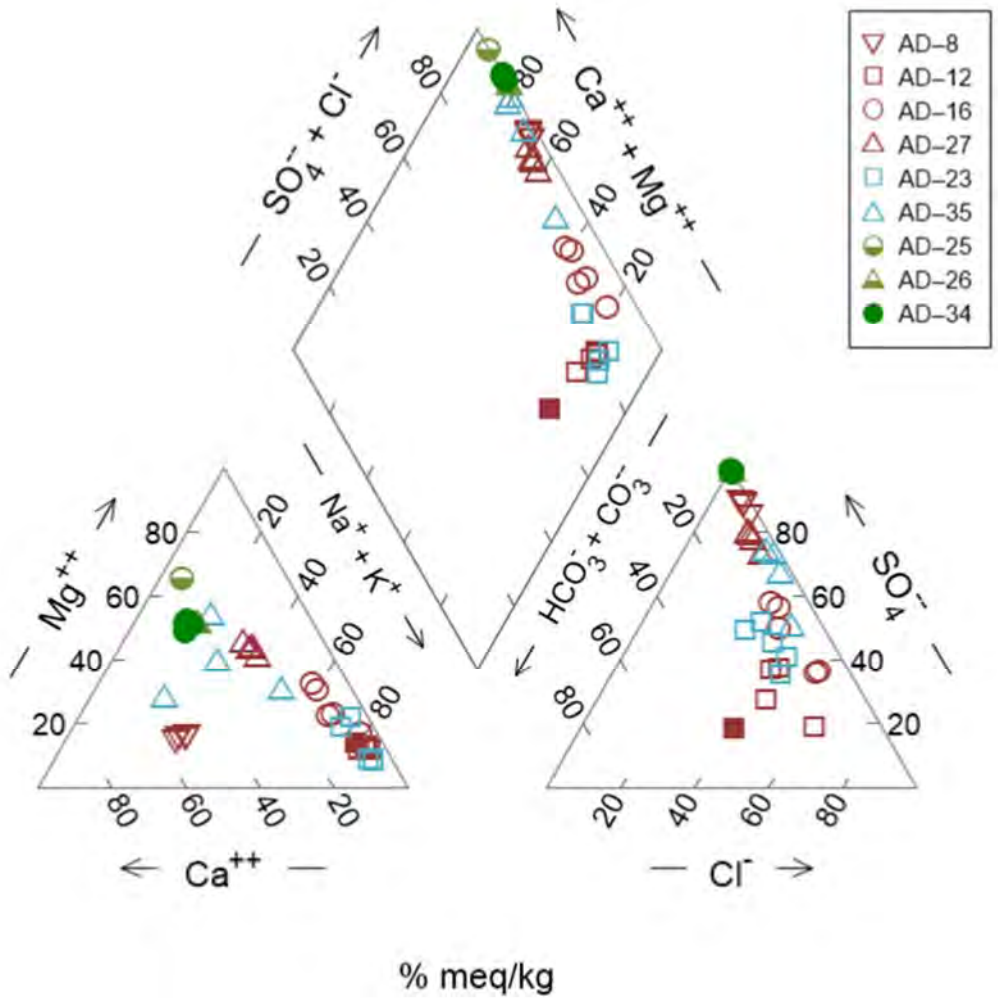
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/09/19

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Sitelayout_20190919.mxd. hduff. 9/19/2019. Project/Phase/Task.



Notes: All data with complete data sets are shown except for AD-8 2/28/2019 data, which appeared to have an outlier.

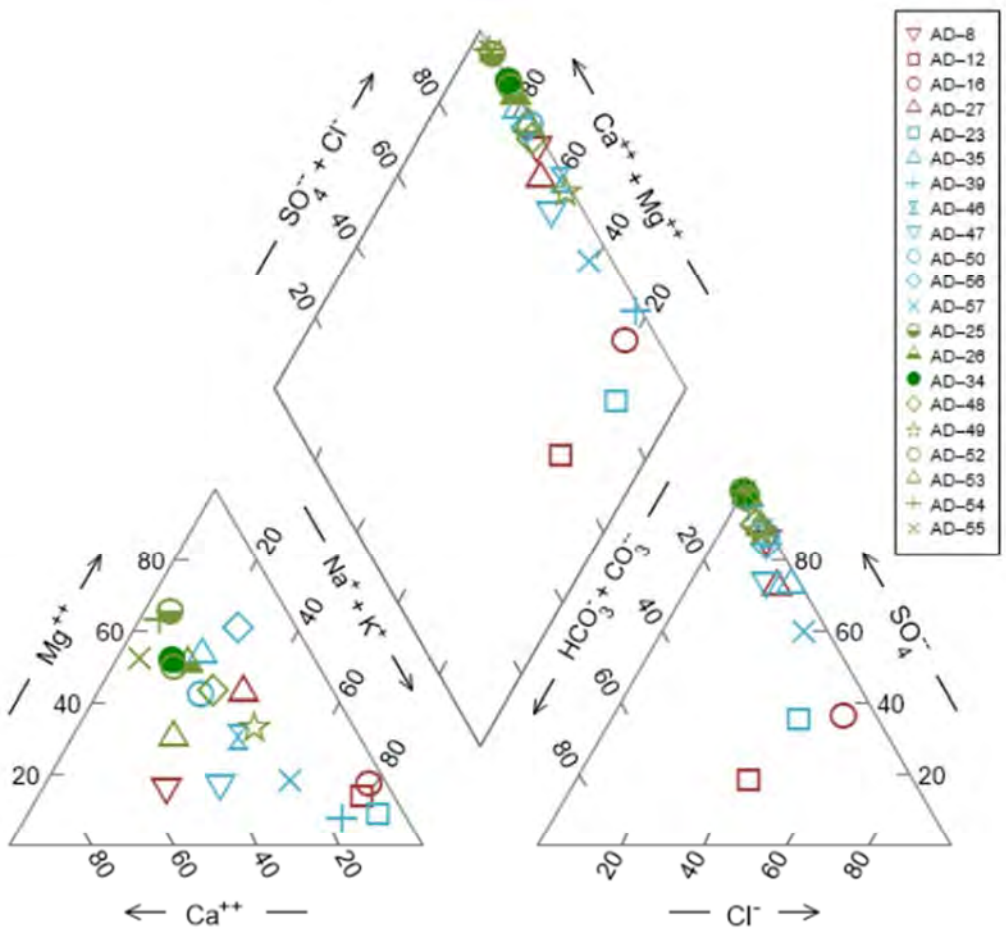
Red symbology: Upgradient Locations
Blue symbology: Downgradient Locations
Green symbology: Downgradient locations screened in mine spoils.

Piper Diagram – Select Wells
Pirkey Landfill

Geosyntec consultants | AMERICAN ELECTRIC POWER | Figure 2

Columbus, Ohio | 19-Sep-2019

internal info: path, date revised, author



Notes: Wells in the LF network use February 2019 data, except AD-8 which used August 2018 due to an apparent outlier. Wells out of the network use August 2019 data.

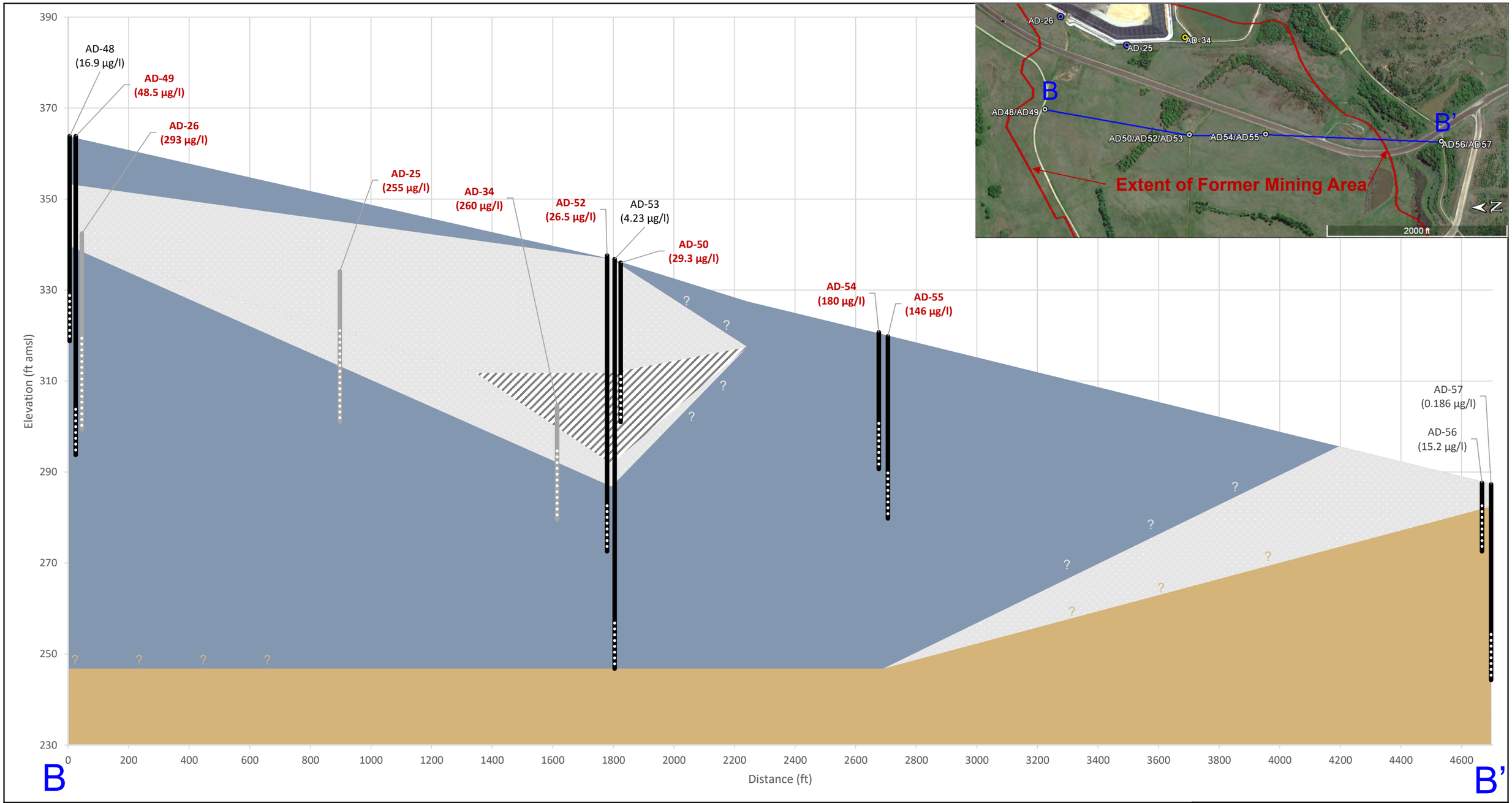
Red symbology: Upgradient Locations
Blue symbology: Downgradient Locations
Green symbology: Downgradient locations screened in mine fill.

Piper Diagram – Landfill Area Wells
Pirkey Landfill

Geosyntec consultants | AMERICAN ELECTRIC POWER | Figure 3

Columbus, Ohio | 19-Sep-2019

internal info: path, date revised, author



Legend

- Mine Spoil (clay, gray, lignite/other inclusions)
- Other Fill (sand to sandy clay, to clayey gravel, gray, some lignite/other inclusions)
- No recovery (assumed same lithology as Other Fill)
- Native sediments (gray sands and clays)
- Monitoring Well (Li Conc.)
- Projected Monitoring Well
- Well Screen
- Inferred Contact

Notes:

Gray wells are projected onto the plane of the cross section, and are generally screened within fill and mine spoil. Lithology for these wells was not used to construct cross section. Positions are approximate.

Cobalt concentrations in micrograms per liter (µg/l)

Groundwater results for all locations collected August 2019, except AD-34 collected February 2019

Bolded locations have concentrations which exceed the groundwater protection standard (GWPS) of 26 µg/L

Landfill Area Cross Section with Cobalt Concentrations

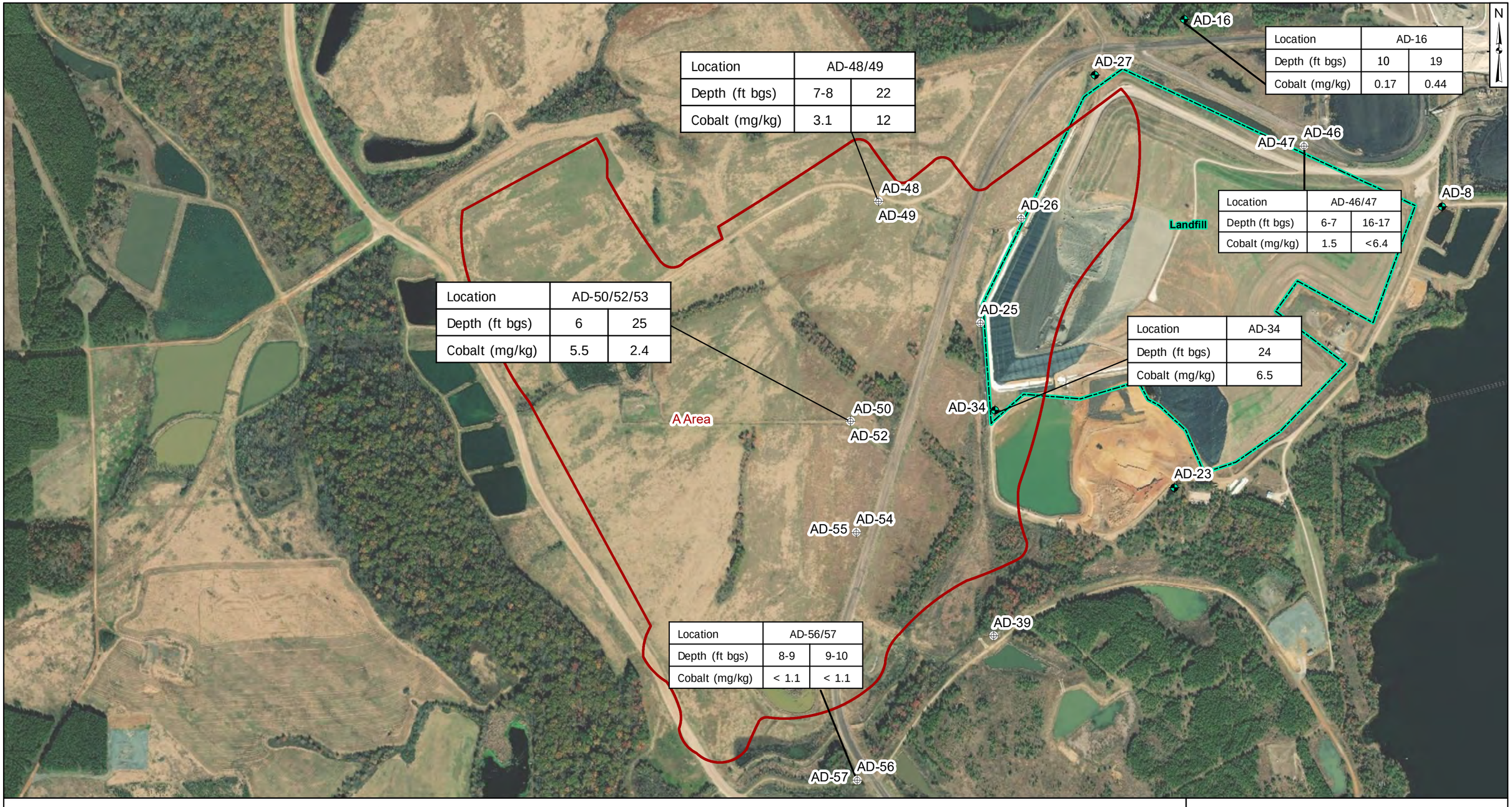
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

CHA8462 | September 2019

Figure 4

\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-08 ASDs_2nd Round 2018\A-Landfill Area Cross section



Location	AD-16	
Depth (ft bgs)	10	19
Cobalt (mg/kg)	0.17	0.44

Location	AD-48/49	
Depth (ft bgs)	7-8	22
Cobalt (mg/kg)	3.1	12

Location	AD-46/47	
Depth (ft bgs)	6-7	16-17
Cobalt (mg/kg)	1.5	<6.4

Location	AD-50/52/53	
Depth (ft bgs)	6	25
Cobalt (mg/kg)	5.5	2.4

Location	AD-34
Depth (ft bgs)	24
Cobalt (mg/kg)	6.5

Location	AD-56/57	
Depth (ft bgs)	8-9	9-10
Cobalt (mg/kg)	< 1.1	< 1.1

Legend

- Out of Network
- Landfill
- Landfill
- A Area

Notes
- Monitoring well coordinates, site features, and data provided by AEP.
- Cobalt concentrations displayed in milligrams per kilogram (mg/kg).
- ft bgs: feet below ground surface.
- A Area is former lignite (reclaimed) mine.
- Non detectds are shown as less than the reporting limit.

600 300 0 600
Feet

Cobalt Soil Values - Landfill Area
August 2019

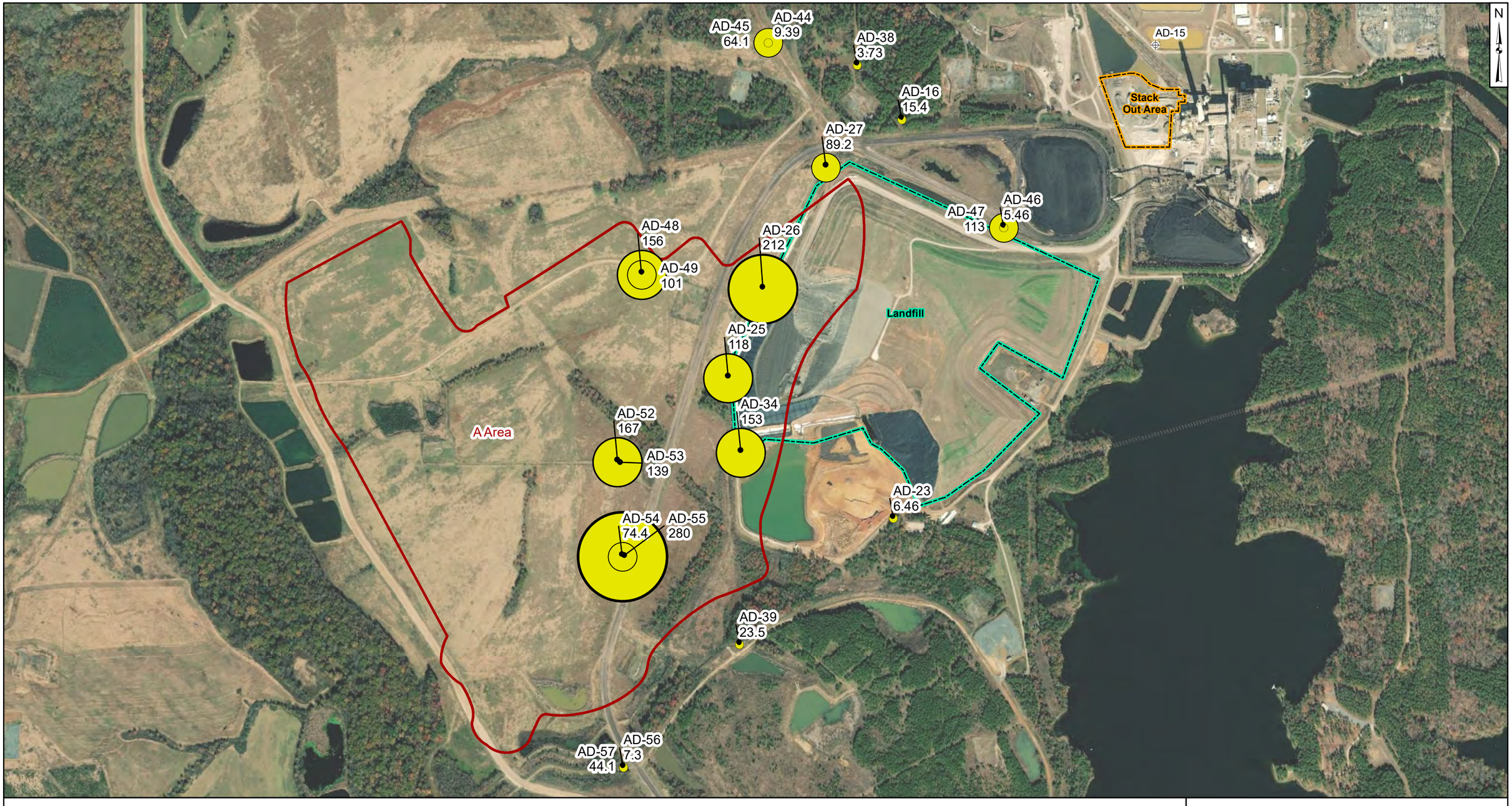
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/09/23

Figure 5

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_PirkeyLF_CoSoil_20190916.mxd. hduff. 9/23/2019. Project/Phase/Task.



Legend

- A Area
- Landfill
- Stack Out Area

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- Location of AD-15 is approximate.
- Circle size is proportional to lithium concentration.
- Lithium concentrations displayed in micrograms per liter (ug/L) and are represented with data from the August 2019 sampling event. Wells AD-16, AD-23, AD-27, and AD-34 are representated with data from the Feburary 2019 sampling event.
- Area A is a former lignite (reclaimed) mine.

900 450 0 900
Feet

Spatial Distribution of Lithium in Groundwater

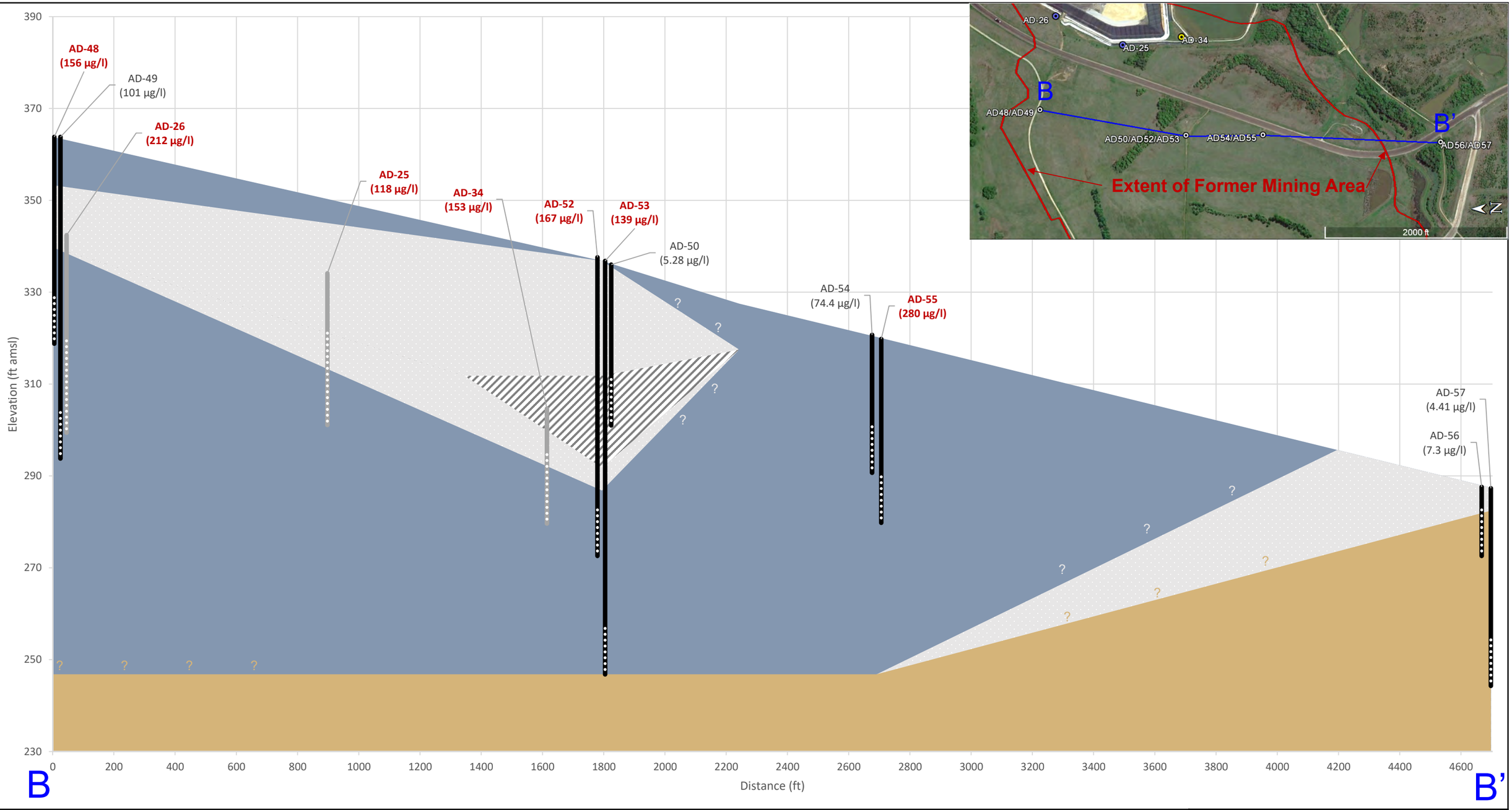
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/09/17

Figure **6**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_PirkeyLF_Li_20190916.mxd. ARevezzo. 9/17/2019. Project/Phase/Task.



Legend

- Mine Spoil (clay, gray, lignite/other inclusions)
- Other Fill (sand to sandy clay, to clayey gravel, gray, some lignite/other inclusions)
- No recovery (assumed same lithology as Other Fill)
- Native sediments (gray sands and clays)
- Monitoring Well (Li Conc.)
- Projected Monitoring Well
- Well Screen
- Inferred Contact

Notes:

Gray wells are projected onto the plane of the cross section, and are generally screened within fill and mine spoil. Lithology for these wells was not used to construct cross section. Positions are approximate.

Lithium concentrations in micrograms per liter (µg/l)

Groundwater results for all locations collected August 2019, except AD-34 collected February 2019

Bolded locations have concentrations which exceed the groundwater protection standard (GWPS) of 110 µg/L

Landfill Area Cross Section with Lithium Concentrations

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

CHA8462 | September 2019

Figure 7

\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-08 ASDs_2nd Round 2018\A-Landfill Area Cross section

TABLES

Table 1: Leachate and Stormwater Pond Data Comparison
East Bottom Ash Pond - H.W. Pirkey Plant

Geosyntec Consultants, Inc.

Sample	Sample Date	Cobalt Concentration (µg/L)	Lithium Concentration (µg/L)
Leachate	2/11/2019	0.43 J	42
Leachate Stormwater Pond	2/11/2019	0.50 J	14 J
AD-34	LCL	272	145
	2/27/2019	260	153

Notes:

mg/L - milligram per liter

J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.

LCL - lower confidence limit

Table 2: Groundwater Concentrations
East Bottom Ash Pond - H.W. Pirkey Plant

Geosyntec Consultants, Inc.

Location	Included in Network?	Screened in Mine Fill?	Sample Date	pH (SU)	Cobalt Concentration (µg/L)	Lithium Concentration (µg/L)	Sulfate Concentration (mg/L)
AD-8	Yes	No	2/28/2019	5.7	0.8 J	2.0	175
AD-12	Yes	No	2/27/2019	5.2	1.37	6.88	3.6
AD-16	Yes	No	2/27/2019	4.3	3.21	15.4	17.7
AD-23	Yes	No	2/28/2019	5.1	1.0 J	6.46	7.2
AD-25	No	Yes	8/13/2019	3.6	255	118	775
AD-26	No	Yes	8/16/2019	3.9	293	212	1490
AD-27	Yes	No	2/28/2019	4.7	18.9	89.2	52.8
AD-34	Yes	Yes	2/27/2019	4.7	260	153	970
AD-35	Yes - Abandoned	No	8/20/2018	4.2	11.9	8.76	149
AD-38	No	No	8/15/2019	4.2	5.46	3.73	6.1
AD-39	No	No	8/16/2019	5.4	5.15	23.5	272
AD-44	No	No	8/15/2019	4.5	4.92	9.39	17.4
AD-45	No	No	8/15/2019	5.5	0.331	64.1	16.8
AD-46	No	No	8/15/2019	4.8	13.6	5.46	231
AD-47	No	No	8/15/2019	4.8	4.05	113	37.8
AD-48	No	Yes	8/15/2019	5.6	16.9	156	152
AD-49	No	Yes	8/15/2019	5.5	48.5	101	200
AD-50	No	No	8/16/2019	5.3	29.3	5.28	302
AD-52	No	Yes	8/16/2019	5.6	26.5	167	642
AD-53	No	Yes	8/16/2019	6.3	4.23	139	322
AD-54	No	Yes	8/16/2019	3.7	180	74.4	1290
AD-55	No	Yes	8/16/2019	3.3	146	280	2110
AD-56	No	No	8/16/2019	4.7	15.2	7.3	130
AD-57	No	No	8/16/2019	4.0	0.186	44.1	45.1

Notes:
SU - specific units
µg/L - micrograms per liter
mg/L - milligrams per liter
J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.

Table 3: Soil Cobalt Data
Landfill - H.W. Pirkey Plant

Geosyntec Consultants, Inc.

Location ID	Sample Depth (ft bgs)	Cobalt (mg/kg)
Bulk Soil Samples		
AD-16	10	0.17
	19	0.44
AD-34	6	1.10
	24	6.50
AD-46/47	6	1.5 J
	16	<6.40
AD-48/49	7	3.1 J
	22	12.0
AD-50/52/53	6	5.5 J
	25	2.4 J
AD-56/57	15	< 1.1
	35	<1.1
Solid Material Retained After Filtration		
AD-34	10-25	2.4 J

Notes:
< - Not detected. Result shown as less than the method detection limit.
mg/kg- milligram per kilogram
ft bgs - feet below ground surface
J - Estimated value
Samples shaded gray were not collected from mine fill.
Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

Table 4: AD-34 X-Ray Diffraction Results *Geosyntec Consultants, Inc.*
Landfill - H. W. Pirkey Plant

Depth	6 ft bgs	24 ft bgs
Quartz	94	91
O Feldspar	2	2
P Feldspar	1	1
Calcite	--	--
Dolomite	--	--
Siderite	1	1
Pyrite/Marcasite	1	2
Illite/Smectite	--	1
Illite	1	1
Kaolinite	--	--
Chlorite	--	--

Notes:
-- : not detected
Results are reported as percentages.

Table 5: Calculated Site-Specific Partition Coefficients
Landfill - H. W. Pirkey Plant

Source	AD-34			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.18	1.1	6	43-370
K	8.1	170	21	42-1200
Na	17	18	1	5.2-82

Notes:
mg/L: milligrams per liter
mg/kg: milligrams per kilogram
L/kg: liters per kilogram
Kd: partition coefficient
Adsorbed values are total metals concentrations reported by USEPA Method 6010B.
Literature values represent maximum and minimum values for the parameter as reported in Sheppard et al, 2009 (Table 4-1, all sites) and Sheppard et al, 2011 (Table 3-3 cultivated peat and wetland peat only).

ATTACHMENT A

Boring Logs

Drilling Log

BURNS McDONNELL	Project Name: AEP Pirkey CSM	Project No.: 111173	Boring/Monitoring Well Number: SB-07
	Coordinates: N 6872868 E 3201272.9	Ground Elevation: 363.80	Page: 1 of 5
	Total Depth (feet): 70 / Hole Size (inches): 6.75"	Driller: J. Smith	
Drilling Rig: Ardco 4x4		Drilling Company: MHC X-Ploration	
Date: 2/28/2019	Logged By: C. Hoglund	Reviewed by:	Approved by:

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
363	1	SILT and very fine grained SAND, dark grayish Brown (10YR 4/2), trace to little clay, wet, low to medium consistency, low to medium plasticity; FILL.		NA	NA	NA	NA	NA	NA	NA	
362	2	SAND, reddish Yellow (7.5YR 6/6), very fine to fine grained, poorly sorted, with rock fragments (gravel, ironstone, and sandstone), with to some clay, soft to medium consistency, medium to high plasticity; FILL. Mine Reclaim.									
361	3										Log cuttings from 0'-5.0'.
360	4	- with clay below 4.0'									
359	5										
358	6	CLAY, light Brown (7.5YR 6/4), trace silt, trace very fine grained sand, iron staining throughout, some inclusions (sandstone, and gravel), soft to medium; FILL. Mine Reclaim.									
357	7	CLAY, dark Gray (7.5YR 4/1), with very fine grained sand, some to little silt, with to some orange, red, and light gray clay, some inclusions (lignite, coal, ironstone, and gravel), damp, medium to stiff, medium to high plasticity; FILL. Mine Reclaim.		MC	1		NA	2.9/5	NA	NA	Sampled SB-7/7'-8' (1045)
356	8										
355	9	- thin very fine grained sand seam, some to little clay, moist at 8.9'									
354	10										No free water observed
353	11	SAND, Gray (10YR 5/1), very fine grained, poorly graded, little to some silt, damp to wet, silty sand seam at top, low to medium plasticity; SP.									
352	12	SAND, Gray (10YR 5/1), with silt, trace clay, few to trace inclusions (lignite, coal, and sandstone), damp, medium density; SP.		MC	2		NA	4.5/5	NA	NA	
351	13	SAND and GRAVEL, Gray (10YR 5/1), very fine grained sand, poorly sorted, little to some silt, damp, trace to few lignite clasts;									
350											

Depth to water while drilling

Depth to water after drilling

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-07
Page	2 of 5
Date	2/28/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
349	15	SAND and GRAVEL, Gray (10YR 5/1), very fine grained sand, poorly sorted, little to some silt, damp, trace to few lignite clasts; - trace to few white to light gray angular sanstone rock fragments below 14.0'		MC	2		NA	4.5/5	NA	NA	
348	16										
347	17	SAND, dark Gray (10YR 4/1), very fine grained, poorly sorted, with clay, trace muscovite flakes, trace to few lignite clasts, some silt, damp, soft, medium plasticity; SC.		MC	3		NA	4.3/5	NA	NA	
346	18										
345	19	- moist, trace clay below 18.5'									
344	20										
343	21	SAND, dark Gray (10YR 4/1), very fine grained, poorly graded, trace to little clay, trace to little silt, trace lignite-clay clasts, moist, medium to dense, low plasticity; SP-SC.									
342	22	SAND, Gray (10YR 5/1), very fine grained, poorly graded, some silte, few muscovite flakes, moist to wet; SP.		MC	4		NA	2.5/5	NA	NA	Sampled SB-7/22'-23'
341	23	- trace to few inclusions (lignite, coal, ironstone, sandstone, and gravel) below 23.0'									
340	24	CLAY, dark Gray (10YR 4/1) with very fine grained sand, some silt, trace to few inclusions (lignite, coal, sandstone, and gravel), damp, low to medium consistency, low to medium plasticity; FILL. Mine Reclaim.									
339	25	CLAY, Gray (10YR 5/1), some silt, few very fine grained sand, little to some inclusions (coal, lignite, sandstone, ironstone, and gravel), medium consistency, low to medium plasticity; FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	Switch to rock drill bit at 25.0' feet. Begin logging from soil cuttings below 25.0'
338	26										
337	27										
336	28										
335											

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-07
Page	3 of 5
Date	2/28/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
334	30	CLAY, Gray (10YR 5/1), some silt, few very fine grained sand, little to some inclusions (coal, lignite, sandstone, ironstone, and gravel), medium consistency, low to medium plasticity; FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	
333	31										
332	32										
331	33	CLAY, Gray (10YR 5/1), some silt, trace to little very fine grained sand, few to some inclusions (lignite, coal, sandstone, ironstone and gravel), medium consistency, low to medium plasticity; FILL. Mine Reclaim.									
330	34										
329	35										
328	36										
327	37										
326	38										
325	39										
324	40										
323	41										
322	42										
321	43										
320											

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-07
Page	4 of 5
Date	2/28/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
319	45	CLAY, Gray (10YR 5/1), some silt, trace to little very fine grained sand, few to some inclusions (lignite, coal, sandstone, ironstone and gravel), medium consistency, low to medium plasticity; FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	
318	46										
317	47										
316	48										
315	49										
314	50										
313	51										
312	52										
311	53										
310	54										
309	55										
308	56										
307	57										
306	58										
305											

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-07
Page	5 of 5
Date	2/28/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
304	60	CLAY, Gray (10YR 5/1), some silt, trace to little very fine grained sand, few to some inclusions (lignite, coal, sandstone, ironstone and gravel), medium consistency, low to medium plasticity; FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	
303	61	- some to with inclusions (ironstone, sandstone, coal, lignite, and red clay) below 59.0'									
302	62										
301	63										
300	64										
299	65	- trace to few red clay clasts below 65.0'									
298	66										
297	67										
296	68										
295	69										
294	70	Boring terminated at 70 feet bgs.									Temporary Piezometer Installed on 2/28/2019
	71										
	72										
	73										

Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-48 (SB-7S)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	300920.8669
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924528.403
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

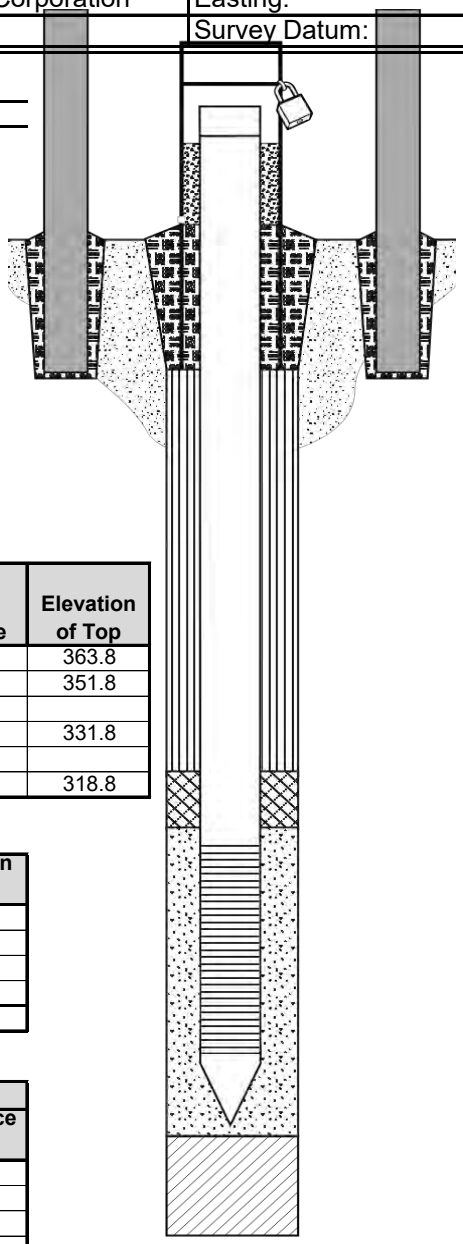
Elevations	
Top of Casing (TOC)	366.4
Ground Surface (GS)	363.8
Reference Point (RP)	ground surface

Dates	
Drilling/Installation Start	3/3/2019
Installation Complete	3/3/2019
Well Completed	3/3/2019
Development Start	3/6/2019
Development Complete	3/6/2019

Annular Material Measurements	Depth to Top from GS	Total Footage	Elevation of Top
Annular Seal	0	12.0	363.8
Bentonite Seal	12	20.0	351.8
Secondary Filter Pack			
Filter Pack	32	13.0	331.8
Backfill	0		
Bottom of Borehole	45		318.8

Casing Materials Measurements	Total Footage	Elevation of Top
Total Riser Installed	35.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	332.09
Bottom Cap	0.28	322.09
Total Depth from TOC	44.59	

Groundwater Levels		
Date & Time	Depth	Reference Point



Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
Material: steel
Size: 4"
Length: 5'
Pea Gravel (Y/N): N
Weep Hole (Y/N): N
Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
Dimensions: 4' x 4' x 4"
Material: concrete

Annular Seal:
Type & Size: bentonite chips 3/8"
Manufacturer: Cetco
Amount Used: (included with bentonite seal)

Bentonite Seal:
Type & Size: pellets 3/8"
Manufacturer: PDS
Amount Used: 6 bags

Secondary Filter Pack:
Type & Size: --
Manufacturer: --
Amount Used: --

Primary Filter Pack:
Type & Size: sand 16/30
Manufacturer: U.S. Silica Company
Amount Used: 7.5 bags

Well Casing:
Type: PVC
Diameter: 2"
Sch. or Weight: Sch. 40
Manufacturer: Campbell Monoflex
Screen Type: PVC factory slot
Screen Slot Size: 0.010"
Bottom Cap Type: threaded

Centralizers (Y/N): N
Material: --
Number: --
Depth(s): --

Backfill Material:
Type & Size: NA
Manufacturer: --
Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508722

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/3/2019** Drilling End Date: **3/3/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**45**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
32	**45**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**32**	**Bentonite 6 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**45**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**35**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**35**	**45**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

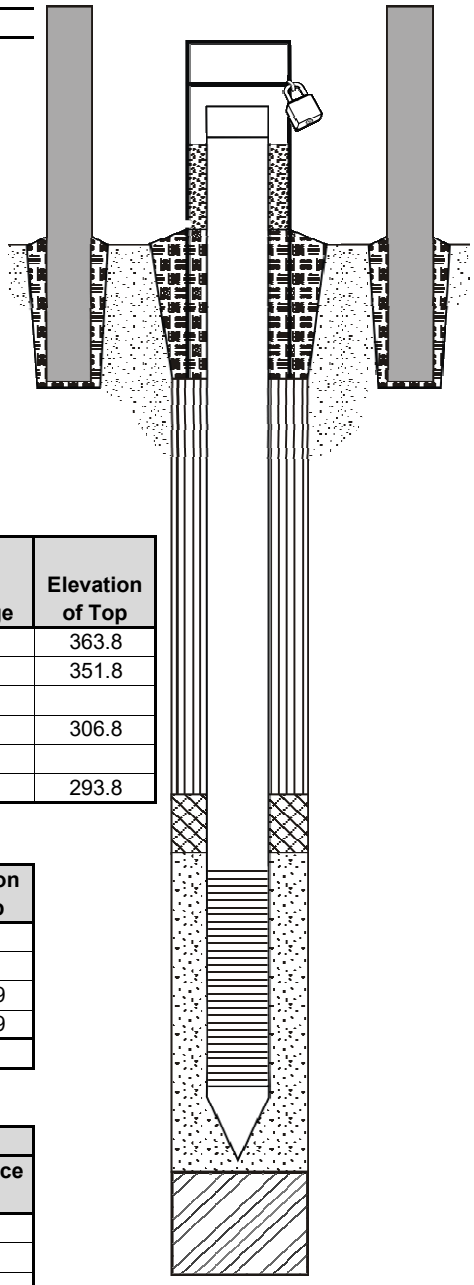
Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-49 (SB-7D)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	300924.7371
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924521.039
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

Elevations	
Top of Casing (TOC)	366.5
Ground Surface (GS)	363.8
Reference Point (RP)	ground surface

Dates	
Drilling/Installation Start	2/28/2019
Installation Complete	2/28/2019
Well Completed	2/28/2019
Development Start	3/4/2019
Development Complete	3/4/2019



Annular Material Measurements	Depth to Top from GS	Total Footage	Elevation of Top
Annular Seal	0	12.0	363.8
Bentonite Seal	12	45.0	351.8
Secondary Filter Pack			
Filter Pack	57	13.0	306.8
Backfill	0		
Bottom of Borehole	70		293.8

Casing Materials Measurements	Total Footage	Elevation of Top
Total Riser Installed	60.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	307.19
Bottom Cap	0.28	297.19
Total Depth from TOC	69.59	

Groundwater Levels		
Date & Time	Depth	Reference Point

Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
- Material: steel
- Size: 4"
- Length: 5'
- Pea Gravel (Y/N): N
- Weep Hole (Y/N): N
- Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
- Dimensions: 4' x 4' x 4"
- Material: concrete

Annular Seal:
- Type & Size: bentonite chips
- Manufacturer: NA
- Amount Used: (included with bentonite seal)

Bentonite Seal:
- Type & Size: chips
- Manufacturer: NA
- Amount Used: 10 bags

Secondary Filter Pack:
- Type & Size: --
- Manufacturer: --
- Amount Used: --

Primary Filter Pack:
- Type & Size: sand 16/30
- Manufacturer: NA
- Amount Used: 5 bags

Well Casing:
- Type: PVC
- Diameter: 2"
- Sch. or Weight: Sch. 40
- Manufacturer: Environmental Manufacturing
- Screen Type: PVC factory slot
- Screen Slot Size: 0.010"
- Bottom Cap Type: threaded

Centralizers (Y/N): N
- Material: --
- Number: --
- Depth(s): --

Backfill Material:
- Type & Size: NA
- Manufacturer: --
- Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508720

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
57	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**57**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**70**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**60**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**60**	**70**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Drilling Log

BURNS McDONNELL	Project Name: AEP Pirkey CSM	Project No.: 111173	Boring/Monitoring Well Number: SB-08
	Coordinates: N 6871089.8 E 3201042.6	Ground Elevation: 336.80	Page: 1 of 7
	Total Depth (feet): 93 / Hole Size (inches): 6.75"	Driller: J. Smith	
Drilling Rig: Ardco 4x4		Drilling Company: MHC X-Ploration	
Date: 2/24/2019 to 2/26/2019	Logged By: C. Hoglund	Reviewed by:	Approved by:

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
336	1	CLAY, Red (2.5YR 5/6), with silt, some very fine grained sand, little to some lignite and rock fragments, wet, medium to high plasticity, low consitency; FILL.									Depth to water while drilling ▽ / Depth to water after drilling ▼
335	2										
334	3			HA	1		NA	5/5			Hand dig from 0.0'-5.0'
333	4	- with very fine grained sand below 4.0'									
332	5										
331	6	CLAY, dark Gray (10YR 4/1) to dark grayish Brown (10YR 4/2), with silt, with very fine sand, damp, medium to stiff, low to medium plasticity; FILL. - with silt to very fine sand lenses - few to little iron staining lenses, few ironstone inclusions									
330	7										
329	8	- trace to few very fine grained sandstone inclusions, little to some lignite and rock fragments below 7.0' - increased very fine grained sand and inclusions below 8.0'		MC	1		NA	4/5	NA	NA	
328	9										
327	10										
326	11	SAND, Gray (10YR 6/1) to dark Gray (10YR 4/1), very fine grained, poorly sorted, trace silt, some light gray thin beds, trace to few black coal lenses and streaks, moist to damp, low to medium density; SP.									No free water observed
325	12	SAND, Gray (10YR 6/1) to dark Gray (10YR 4/1), very fine graded, poorly sorted, trace to little clay, few to some inclusions (sandstone, ironstone, lignite, and rock fragments), trace to few thin sandstone beds, damp to moist, low to medium plasticity; SP.		MC	2		NA	3.2/5	NA	NA	
324	13										
323											

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-08
Page	2 of 7
Date	2/24/2019 to 2/26/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
322	15			MC	2		NA	3.2/5	NA	NA	
321	16	SAND, Gray (10YR 6/1) to dark Gray (10YR 4/1), with clay, some silt, few to some inclusions (sandstone, lignite, ironstone, and rock fragments), moist, low to medium density, low to medium plasticity; SC.									
320	17	- with iron staining, massive, below 16.3'		MC	3		NA	2.1/5	NA	NA	
319	18										
318	19										
317	20										
316	21										
315	22										
314	23			MC	4		NA	0.6/5	NA	NA	
313	24										
312	25										
311	26	No Recovery from 25.0'-45.0'.	NR								
310	27			MC	5		NA	0/5	NA	NA	
309	28										
308											

Drilling Log, continued

BURNS McDONNELL

Project Name: AEP Pirkey CSM
Project Number: 111173
Boring/Monitoring Well Number: SB-08
Page: 3 of 7
Date: 2/24/2019 to 2/26/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
307	30	No Recovery from 25.0'-45.0'.	NR	MC	5		NA	0/5	NA	NA	
306	31										
305	32			MC	6		NA	0/5	NA	NA	
304	33										
303	34										
302	35										
301	36										
300	37			MC	7		NA	0/5	NA	NA	
299	38										
298	39										
297	40			NA	NA	NA	NA	NA	NA	NA	Switch to rock drill bit. No Recovery.
296	41										
295	42										
294	43										
293											

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-08
Page	4 of 7
Date	2/24/2019 to 2/26/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
		No Recovery from 25.0'-45.0'.	NR	NA	NA	NA	NA	NA	NA	NA	
292	45	CLAY, Gray (10YR 6/1 to 5/1), with sand, some to few silt, some inclusions (sandstone, lignite, coal, and gravel), low to medium consistency, medium to high plasticity; CL.									Offset 6.0' north. Resume drilling. Begin logging from soil cuttings below 45.0'.
291	46										
290	47										
289	48										
288	49										
287	50	- increased lignite inclusions below 49.8'									
286	51	CLAY, Gray (10YR 6/1) to dark Gray (10YR 4/1), with sand, some silt, some to with inclusions (lignite, coal, red clay, ironstone, sandstone, and gravel), low to medium consistency, medium to high plasticity; FILL. Mine Reclaim.									
285	52										
284	53										
283	54										
282	55										
281	56										
280	57										
279	58										
278											

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-08
Page	5 of 7
Date	2/24/2019 to 2/26/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
277	60	CLAY, Gray (10YR 6/1) to dark Gray (10YR 4/1), with sand, some silt, some to with inclusions (lignite, coal, red clay, ironstone, sandstone, and gravel), low to medium consistency, medium to high plasticity; FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	
276	61										
275	62										
274	63										
273	64										
272	65										
271	66										
270	67										
269	68										
268	69										
267	70										
266	71										
265	72										
264	73										
263											

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-08
Page	6 of 7
Date	2/24/2019 to 2/26/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
	74	CLAY, Gray (10YR 6/1) to dark Gray (10YR 4/1), with sand, some silt, some to with inclusions (lignite, coal, red clay, ironstone, sandstone, and gravel), low to medium consistency, medium to high plasticity; FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	
262	75										
261	76										
260	77										
259	78										
258	79										
257	80										
256	81										
255	82										
254	83										
253	84										
252	85										
251	86										
250	87										
249	88										

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-08
Page	7 of 7
Date	2/24/2019 to 2/26/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
	89			NA	NA	NA	NA	NA	NA	NA	
247	90	CLAY, light Gray (10YR 7/1), some silt, medium to stiff, low to medium plasticity; CL.									
246	91										
245	92										
244	93	Boring terminated at 93 feet bgs.									Temporary Piezometer Installed on 2/26/2019
	94										
	95										
	96										
	97										
	98										
	99										
	100										
	101										
	102										
	103										

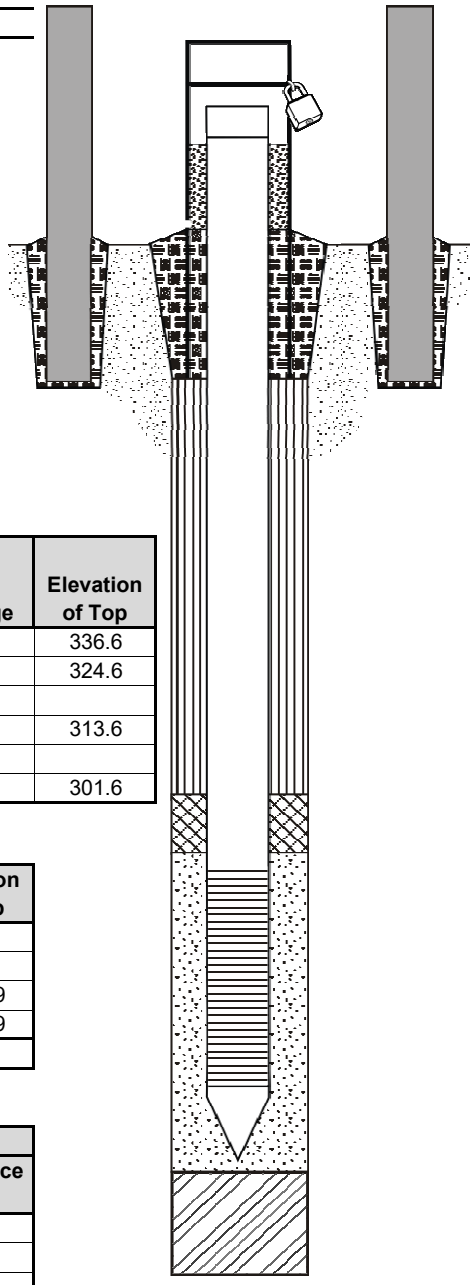
Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-50 (SB-8S)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	299140.5817
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924282.637
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

Elevations	
Top of Casing (TOC)	339.0
Ground Surface (GS)	336.6
Reference Point (RP)	ground surface

Dates	
Drilling/Installation Start	2/27/2019
Installation Complete	2/27/2019
Well Completed	2/27/2019
Development Start	2/28/2019
Development Complete	3/1/2019



Annular Material Measurements	Depth to Top from GS	Total Footage	Elevation of Top
Annular Seal	0	12.0	336.6
Bentonite Seal	12	11.0	324.6
Secondary Filter Pack			
Filter Pack	23	12.0	313.6
Backfill	0		
Bottom of Borehole	35		301.6

Casing Materials Measurements	Total Footage	Elevation of Top
Total Riser Installed	25.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	314.69
Bottom Cap	0.28	304.69
Total Depth from TOC	34.59	

Groundwater Levels		
Date & Time	Depth	Reference Point

Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
- Material: steel
- Size: 4"
- Length: 5'
- Pea Gravel (Y/N): N
- Weep Hole (Y/N): N
- Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
- Dimensions: 4' x 4' x 4"
- Material: concrete

Annular Seal:
- Type & Size: Chips
- Manufacturer: NA
- Amount Used: (included with bentonite seal)

Bentonite Seal:
- Type & Size: Medium Chips
- Manufacturer: NA
- Amount Used: 4 bags

Secondary Filter Pack:
- Type & Size: --
- Manufacturer: --
- Amount Used: --

Primary Filter Pack:
- Type & Size: sand 16/30
- Manufacturer: NA
- Amount Used: 2 bags

Well Casing:
- Type: PVC
- Diameter: 2"
- Sch. or Weight: Sch. 40
- Manufacturer: Environmental Manufacturing
- Screen Type: PVC factory slot
- Screen Slot Size: 0.010"
- Bottom Cap Type: threaded

Centralizers (Y/N): N
- Material: --
- Number: --
- Depth(s): --

Backfill Material:
- Type & Size: NA
- Manufacturer: --
- Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508724

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**35**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**35**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**23**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**35**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**25**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**25**	**35**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

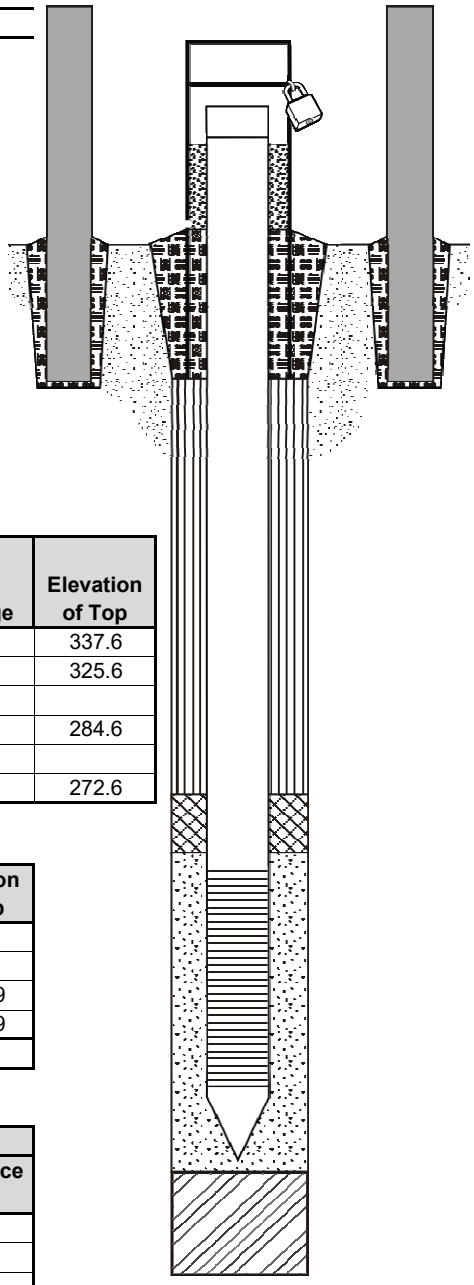
Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-52 (SB-8I)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	299148.2762
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924262.209
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

Elevations	
Top of Casing (TOC)	340.7
Ground Surface (GS)	337.6
Reference Point (RP)	ground surface

Dates	
Drilling/Installation Start	2/27/2019
Installation Complete	2/27/2019
Well Completed	2/27/2019
Development Start	2/28/2019
Development Complete	3/1/2019



Annular Material Measurements	Depth to Top from GS	Total Footage	Elevation of Top
Annular Seal	0	12.0	337.6
Bentonite Seal	12	41.0	325.6
Secondary Filter Pack			
Filter Pack	53	12.0	284.6
Backfill	0		
Bottom of Borehole	65		272.6

Casing Materials Measurements	Total Footage	Elevation of Top
Total Riser Installed	55.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	286.39
Bottom Cap	0.28	276.39
Total Depth from TOC	64.59	

Groundwater Levels		
Date & Time	Depth	Reference Point

Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
- Material: steel
- Size: 4"
- Length: 5'
- Pea Gravel (Y/N): N
- Weep Hole (Y/N): N
- Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
- Dimensions: 4' x 4' x 4"
- Material: concrete

Annular Seal:
- Type & Size: Chips
- Manufacturer: NA
- Amount Used: (included with bentonite seal)

Bentonite Seal:
- Type & Size: Medium Chips
- Manufacturer: NA
- Amount Used: 4 bags

Secondary Filter Pack:
- Type & Size: --
- Manufacturer: --
- Amount Used: --

Primary Filter Pack:
- Type & Size: sand 16/30
- Manufacturer: NA
- Amount Used: NA

Well Casing:
- Type: PVC
- Diameter: 2"
- Sch. or Weight: Sch. 40
- Manufacturer: Environmental Manufacturing
- Screen Type: PVC factory slot
- Screen Slot Size: 0.010"
- Bottom Cap Type: threaded

Centralizers (Y/N): N
- Material: --
- Number: --
- Depth(s): --

Backfill Material:
- Type & Size: NA
- Manufacturer: --
- Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508729

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 medium (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**65**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
52	**65**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**53**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**65**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

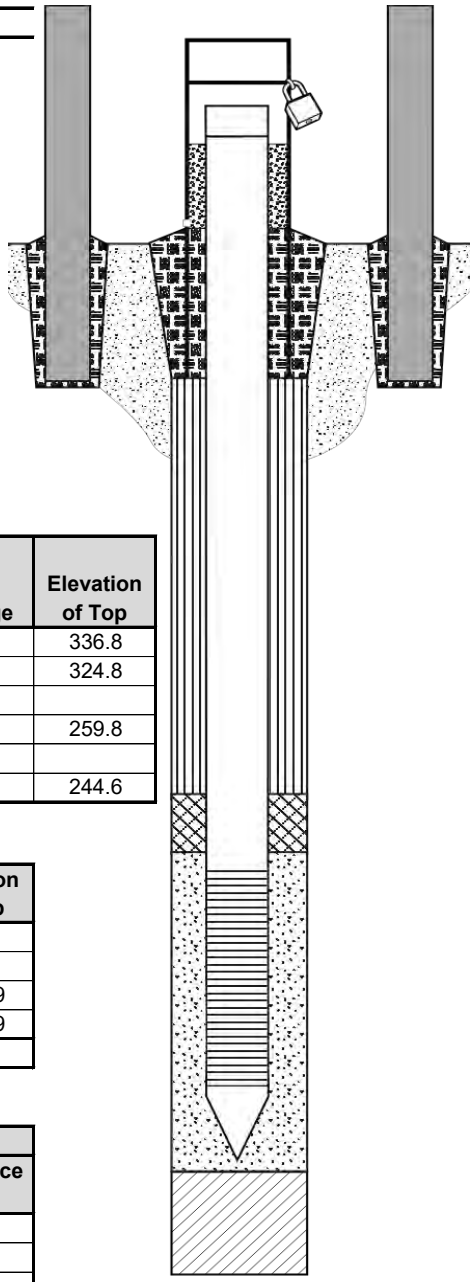
Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-53 (SB-8D)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	299148.8657
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924273.815
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

Elevations	
Top of Casing (TOC)	339.4
Ground Surface (GS)	336.8
Reference Point (RP)	ground surface

Dates	
Drilling/Installation Start	2/24/2019
Installation Complete	2/26/2019
Well Completed	2/26/2019
Development Start	2/28/2019
Development Complete	3/1/2019



Annular Material Measurements	Depth to Top from GS	Total Footage	Elevation of Top
Annular Seal	0	12.0	336.8
Bentonite Seal	12	65.0	324.8
Secondary Filter Pack			
Filter Pack	77	16.0	259.8
Backfill	0		
Bottom of Borehole	93		244.6

Casing Materials Measurements	Total Footage	Elevation of Top
Total Riser Installed	80.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	261.39
Bottom Cap	0.28	251.39
Total Depth from TOC	89.59	

Groundwater Levels		
Date & Time	Depth	Reference Point

Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
- Material: steel
- Size: 4"
- Length: 5'
- Pea Gravel (Y/N): N
- Weep Hole (Y/N): N
- Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
- Dimensions: 4' x 4' x 4"
- Material: concrete

Annular Seal:
- Type & Size: Chips
- Manufacturer: NA
- Amount Used: (included with bentonite seal)

Bentonite Seal:
- Type & Size: Medium Chips
- Manufacturer: NA
- Amount Used: 16 bags

Secondary Filter Pack:
- Type & Size: --
- Manufacturer: --
- Amount Used: --

Primary Filter Pack:
- Type & Size: sand 16/30
- Manufacturer: NA
- Amount Used: 6 bags

Well Casing:
- Type: PVC
- Diameter: 2"
- Sch. or Weight: Sch. 40
- Manufacturer: Environmental Manufacturing
- Screen Type: PVC factory slot
- Screen Slot Size: 0.010"
- Bottom Cap Type: threaded

Centralizers (Y/N): N
- Material: --
- Number: --
- Depth(s): --

Backfill Material:
- Type & Size: NA
- Manufacturer: --
- Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508777

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/26/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**93**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
77	**93**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**77**	**Bentonite 15 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**90**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**
90	**93**	**gray clay (old pit base?)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**80**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**80**	**90**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Drilling Log

BURNS McDONNELL	Project Name: AEP Pirkey CSM	Project No.: 111173	Boring/Monitoring Well Number: SB-09
	Coordinates: N 6870180 E 3201109.5	Ground Elevation: 319.80	Page: 1 of 5
	Total Depth (feet): 60 / Hole Size (inches): 6.75"	Driller: J. Smith	
Drilling Rig: Ardco 4x4		Drilling Company: MHC X-Ploration	
Date: 3/4/2019	Logged By: D. Barker	Reviewed by:	Approved by:

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
319	1	CLAY, Gray (7.5YR 6/1) to light Gray (7.5YR 7/1), with silt and sand, strong Brown (7.5YR 5/6 to 5/8) and Red (2.5YR 4/6 to 4/8), damp, soft, high plasticity; FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	Log from soil cuttings from 0'-5'.
318	2										
317	3										
316	4										
315	5										
314	6	SILT, with clay, with very fine grained sand, very dark Gray (7.5YR 3/1) to dark Brown (7.5YR 3/2) to strong Brown (7.5YR 5/6), damp, soft, trace plasticity; FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	Sampled SB-09 5'-6'
		3 Feet of slough (Based on driller's feel).									
313	7										
312	8							0.5/5			
311	9										
310	10	SAND, with silt, with clay, pinkish Gray (7.5YR 7/2) to strong Brown (7/5YR 5/6) to Red (2.5YR 4/6 to 4/8), very fine to fine grained, damp, loose; FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	No free water observed
309	11	CLAY, trace silt, trace sand, very dark Gray (7.5YR 3/1) to dark Brown (7.5YR 3/2) to Brown (7.5YR 5/3), damp, soft, high plasticity; FILL. Mine Reclaim									
308	12							0.5/5			
307	13										
306											

Depth to water while drilling

Depth to water after drilling

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-09
Page	2 of 5
Date	3/4/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
305	15	CLAY, trace silt, trace sand, very dark Gray (7.5YR 3/1) to dark Brown (7.5YR 3/2) to Brown (7.5YR 5/3), damp, soft, high plasticity; FILL. Mine Reclaim		NA	NA	NA	NA	NA 0.5/5	NA	NA	
304	16	SAND, with silt, with clay, very dark Gray (7.5YR 3/1) to dark Brown (7.5YR 3/2), very fine grained, damp; FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	
303	17	1 Foot of slough (Based on driller's feel).									
302	18	SILT and SAND and CLAY, pinkish White (7.5YR 8/2) to dark Red (2.5YR 3/6), very fine to fine grained; FILL. Mine Reclaim.						0.5/5			
301	19										
300	20										
299	21	SILT, with sand, with clay, very dark Gray (7.5YR 3/1) to dark Brown (7.5YR 3/2), very fine to fine grained, damp, soft to hard, medium plasticity; FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	Log from soil cuttings below 20.0'. Sampled SB-09 20'-21'
298	22										
297	23										
296	24										
295	25										
294	26	SILT and SAND and CLAY, reddish Yellow (7.5YR 6/6); FILL. Mine Reclaim.									
293	27										
292	28										
291											

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-09
Page	3 of 5
Date	3/4/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
290	30	SILT and SAND and CLAY, reddish Yellow (7.5YR 6/6); FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	
289	31										
288	32										
287	33										
286	34										
285	35										
284	36										
283	37										
282	38										
281	39										
280	40	SILT and SAND and CLAY, reddish Yellow (7.5YR 6/6), with cemented sand fragments, with lignite fragments; FILL. Mine Reclaim.									
279	41										
278	42										
277	43										
276											

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-09
Page	4 of 5
Date	3/4/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
275	45	SILT and SAND and CLAY, reddish Yellow (7.5YR 6/6), with cemented sand fragments, with lignite fragments; FILL. Mine Reclaim.		NA	NA	NA	NA	NA	NA	NA	
274	46										
273	47										
272	48										
271	49										
270	50										
269	51	SILT and SAND and CLAY, dark Gray (7.5YR 4/1), with cemented sand fragments, with lignite fragments, damp, soft to medium, high plasticity; FILL. Mine Reclaim.									
268	52										
267	53										
266	54										
265	55										
264	56										
263	57										
262	58										
261											

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-09
Page	5 of 5
Date	3/4/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
				NA	NA	NA	NA	NA	NA	NA	
260	60	Boring terminated at 60 feet bgs.									Temporary Piezometer Installed on 3/4/2019
	61										
	62										
	63										
	64										
	65										
	66										
	67										
	68										
	69										
	70										
	71										
	72										
	73										

Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-54 (SB-9S)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	298239.4104
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924320.3597
Driller:	Jason Smith	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

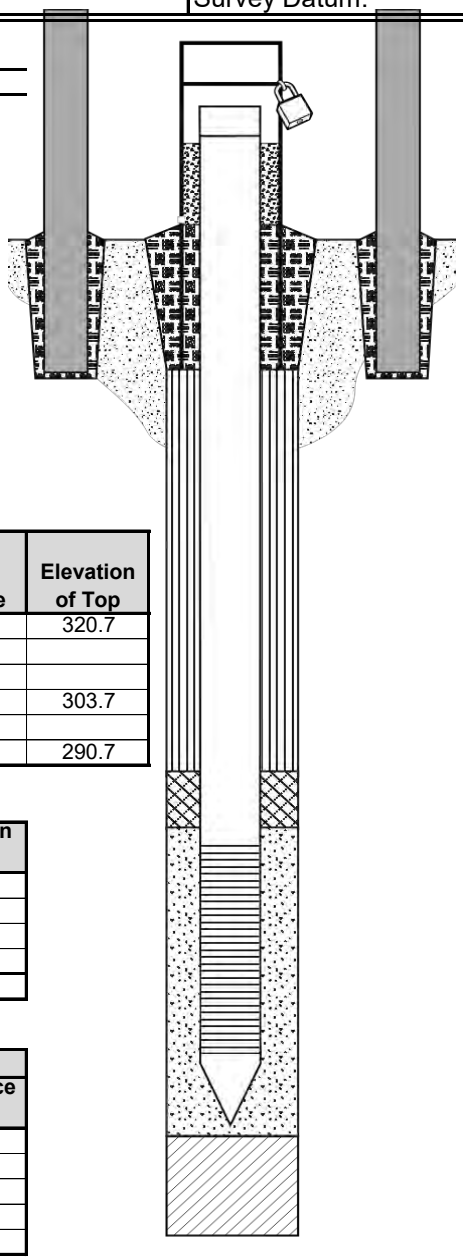
Elevations	
Top of Casing (TOC)	323.7
Ground Surface (GS)	320.7
Reference Point (RP)	ground surface

Dates	
Drilling/Installation Start	3/5/2019
Installation Complete	3/5/2019
Well Completed	3/18-25/2019
Development Start	3/6/2019
Development Complete	3/6/2019

Annular Material Measurements	Depth to Top from GS	Total Footage	Elevation of Top
Annular Seal		17.0	320.7
Bentonite Seal	0		
Secondary Filter Pack			
Filter Pack	17	13.0	303.7
Backfill	0		
Bottom of Borehole	30		290.7

Casing Materials Measurements	Total Footage	Elevation of Top
Total Riser Installed	30.00	NA
Total Riser Cutoff	7.12	NA
Screen	10.00	300.82
Bottom Cap	0.43	290.82
Total Depth from TOC	33.31	

Groundwater Levels		
Date & Time	Depth	Reference Point



Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
Material: steel
Size: 4"
Length: 5'
Pea Gravel (Y/N): N
Weep Hole (Y/N): N
Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
Dimensions: 4' x 4' x 4"
Material: concrete

Annular Seal:
Type & Size: bentonite chips 3/8"
Manufacturer: Cetco
Amount Used: 1 bag / 50 lbs

Bentonite Seal:
Type & Size: pellets 3/8"
Manufacturer: PDS
Amount Used: 1 bucket / 50 lbs

Secondary Filter Pack:
Type & Size: --
Manufacturer: --
Amount Used: --

Primary Filter Pack:
Type & Size: sand 16/30
Manufacturer: U.S. Silica Company
Amount Used: 7.5 bags / 375 lbs

Well Casing:
Type: PVC
Diameter: 2"
Sch. or Weight: Sch. 40
Manufacturer: Campbell Monoflex
Screen Type: PVC factory slot
Screen Slot Size: 0.010"
Bottom Cap Type: threaded

Centralizers (Y/N): N
Material: --
Number: --
Depth(s): --

Backfill Material:
Type & Size: NA
Manufacturer: --
Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508781

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/5/2019** Drilling End Date: **3/5/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**30**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
17	**30**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**17**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**30**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**20**	**30**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-55 (SB-9D)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	298238.4991
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924332.0518
Driller:	Jason Smith	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

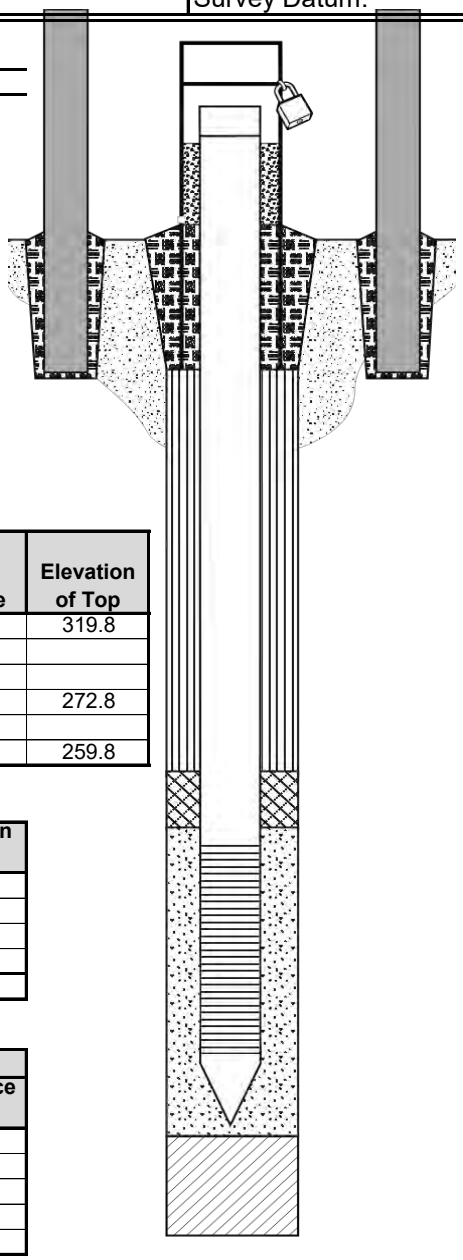
Elevations	
Top of Casing (TOC)	321.9
Ground Surface (GS)	319.8
Reference Point (RP)	ground surface

Dates	
Drilling/Installation Start	3/4/2019
Installation Complete	3/4/2019
Well Completed	3/18-25/2019
Development Start	3/5/2019
Development Complete	3/5/2019

Annular Material Measurements	Depth to Top from GS	Total Footage	Elevation of Top
Annular Seal		47.0	319.8
Bentonite Seal	0		
Secondary Filter Pack			
Filter Pack	47	13.0	272.8
Backfill	0		
Bottom of Borehole	60		259.8

Casing Materials Measurements	Total Footage	Elevation of Top
Total Riser Installed	60.00	NA
Total Riser Cutoff	7.89	NA
Screen	10.00	269.79
Bottom Cap	0.43	259.79
Total Depth from TOC	62.54	

Groundwater Levels		
Date & Time	Depth	Reference Point



Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
Material: steel
Size: 4"
Length: 5'
Pea Gravel (Y/N): N
Weep Hole (Y/N): N
Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
Dimensions: 4' x 4' x 4"
Material: concrete

Annular Seal:
Type & Size: bentonite chips 3/8"
Manufacturer: Cetco
Amount Used: 8 bags / 400 lbs

Bentonite Seal:
Type & Size: pellets 3/8"
Manufacturer: PDS
Amount Used: 2 buckets / 100 lbs

Secondary Filter Pack:
Type & Size: --
Manufacturer: --
Amount Used: --

Primary Filter Pack:
Type & Size: sand 16/30
Manufacturer: U.S. Silica Company
Amount Used: 5 bags / 250 lbs

Well Casing:
Type: PVC
Diameter: 2"
Sch. or Weight: Sch. 40
Manufacturer: Campbell Monoflex
Screen Type: PVC factory slot
Screen Slot Size: 0.010"
Bottom Cap Type: threaded

Centralizers (Y/N): N
Material: --
Number: --
Depth(s): --

Backfill Material:
Type & Size: NA
Manufacturer: --
Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508779

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/4/2019** Drilling End Date: **3/4/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**60**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
48	**60**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**48**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**60**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Drilling Log

BURNS McDONNELL	Project Name: AEP Pirkey CSM	Project No.: 111173	Boring/Monitoring Well Number: SB-11
	Coordinates:	Ground Elevation:	Page: 1 of 3
	Total Depth (feet): 43 / Hole Size (inches): 6.75"	Driller: J. Smith	
Drilling Rig: Ardco 4x4		Drilling Company: MHC X-Ploration	
Date: 3/7/2019	Logged By: J.Hermanson	Reviewed by:	Approved by:

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
	0	SILT, Brown (7.5YR 4/2), with very fine grained sand, damp, low to medium, low to medium plasticity; FILL.									▽ Depth to water while drilling ▼ Depth to water after drilling
	1–5	clayey GRAVEL, gravel-sand-clay mixture, strong Brown (7.5YR 5/6), coarse grained gravel, fine grained sand, wet, trace to medium plasticity; FILL.		MC	1		NA	4/5	NA	NA	
	5–7	CLAY, dark yellowish Brown (10YR 4/6), some sand, damp to moist, medium plasticity; CL.		MC	2		NA	3/5	NA	NA	
	7–8	SAND, light Gray (7.5YR 7/1), fine grained, trace clay, damp, medium density; SP.									
	8–9	CLAY, light Gray (7.5YR 7/1) with reddish Brown (5YR 5/9) mottling, some sand, damp to moist, trace to medium plasticity; CL.									
	10–11	SAND, pinkish Gray (7.5YR 7/2), fine grained, trace clay, wet, medium density; SP.									▽ Free water observed at approximately 10.0'
	11–12	CLAY, light reddish Gray (2.5YR 7/1), trace sand, damp, medium density, medium plasticity; CL.		MC	3		NA	3/5	NA	NA	
	12–13										

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-11
Page	2 of 3
Date	3/7/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
	15	clayey GRAVEL, gravel-sand-clay mixture, strong Brown (7.5YR 5/6), fine grained gravel, fine grained sand, moist to wet; GC.		MC	3		NA	3/5	NA	NA	
	16	CLAY, light Gray (7.5YR 7/1), trace sand, damp to moist, soft to medium, medium plasticity; CL. - increasing sand and moisture content below 15.6'									
	17	CLAY, light Gray (5YR 7/1), some sand, with sand laminations, damp to moist, medium to stiff, trace to medium plasticity; CL. - increased moisture content below 17.5'		MC	4		NA	4/5	NA	NA	
	18	SAND, Gray (7.5YR 5/1), very fine grained, with clay laminations, trace iron ore laminations, dry, dense; SP.									
	19										
	20										
	21			MC	5		NA	4/5	NA	NA	
	22										
	23										
	24	- iron ore laminations grade out, increased sand content below 24.0'									
	25										
	26										
	27			MC	6		NA	5/10	NA	NA	
	28										

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-11
Page	3 of 3
Date	3/7/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
	30	SAND, Gray (7.5YR 5/1), very fine grained, with clay laminations, trace iron ore laminations, dry, dense; SP.		MC	6		NA	5/10	NA	NA	
	35			MC	7		NA	8/8	NA	NA	
	40	SAND, dark Gray (7.5YR 4/1), very fine grained, trace clay, moist, medium density; SP.									
	42	SAND, Gray (7.5YR 5/1), very fine grained, with clay laminations, dry, dense; SP.									
	43	Refusal on obstruction - End of boring at 43 feet bgs.									Abandoned with cement-bentonite grout on 3/7/2019

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19

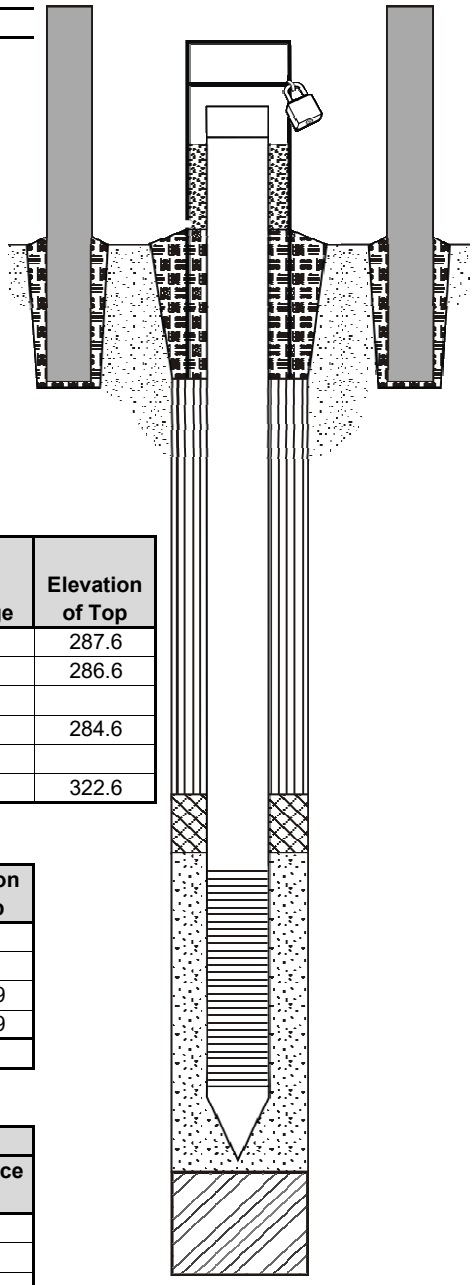
Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-56 (SB-11S)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	296233.6811
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924310.063
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

Elevations	
Top of Casing (TOC)	290.0
Ground Surface (GS)	287.6
Reference Point (RP)	ground surface

Dates	
Drilling/Installation Start	3/8/2019
Installation Complete	3/8/2019
Well Completed	3/8/2019
Development Start	3/10/2019
Development Complete	3/11/2019



Annular Material Measurements	Depth to Top from GS	Total Footage	Elevation of Top
Annular Seal	0	1.0	287.6
Bentonite Seal	1	2.0	286.6
Secondary Filter Pack			
Filter Pack	3	12.0	284.6
Backfill	0		
Bottom of Borehole	15		322.6

Casing Materials Measurements	Total Footage	Elevation of Top
Total Riser Installed	5.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	336.39
Bottom Cap	0.28	326.39
Total Depth from TOC	14.59	

Groundwater Levels		
Date & Time	Depth	Reference Point

Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
- Material: steel
- Size: 4"
- Length: 5'
- Pea Gravel (Y/N): N
- Weep Hole (Y/N): N
- Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
- Dimensions: 4' x 4' x 4"
- Material: concrete

Annular Seal:
- Type & Size: Chips
- Manufacturer: NA
- Amount Used: (included with bentonite seal)

Bentonite Seal:
- Type & Size: Medium Chips
- Manufacturer: NA
- Amount Used: 1 bag

Secondary Filter Pack:
- Type & Size: --
- Manufacturer: --
- Amount Used: --

Primary Filter Pack:
- Type & Size: sand 16/30
- Manufacturer: NA
- Amount Used: 6 bags

Well Casing:
- Type: PVC
- Diameter: 2"
- Sch. or Weight: Sch. 40
- Manufacturer: Environmental Manufacturing
- Screen Type: PVC factory slot
- Screen Slot Size: 0.010"
- Bottom Cap Type: threaded

Centralizers (Y/N): N
- Material: --
- Number: --
- Depth(s): --

Backfill Material:
- Type & Size: NA
- Manufacturer: --
- Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508718

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/8/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**15**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**15**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement**
1	**3**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**5**	**15**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

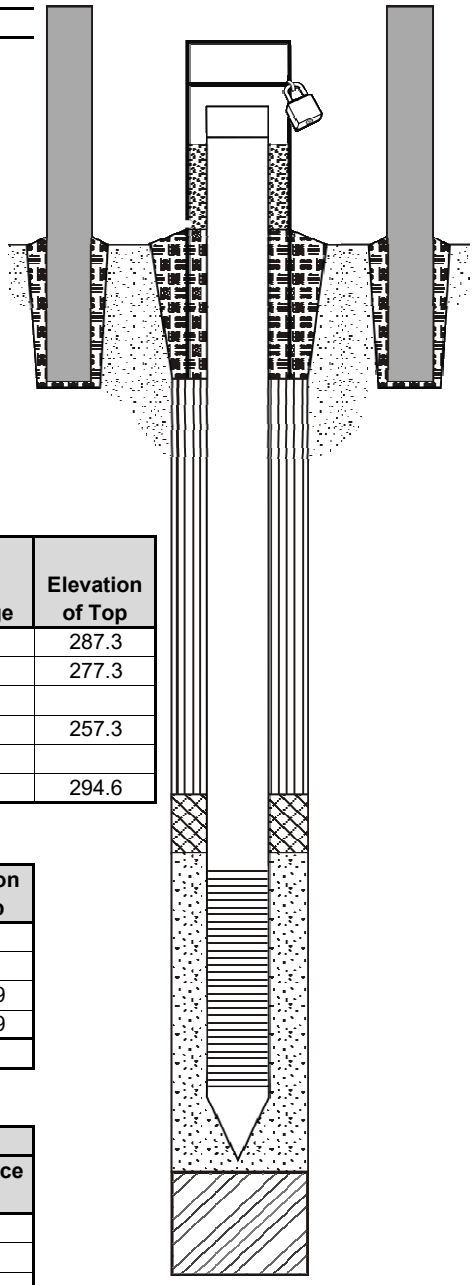
Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-57 (SB-11D)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	296232.0764
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924300.047
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

Elevations	
Top of Casing (TOC)	290.0
Ground Surface (GS)	287.3
Reference Point (RP)	ground surface

Dates	
Drilling/Installation Start	3/7/2019
Installation Complete	3/8/2019
Well Completed	3/8/2019
Development Start	3/10/2019
Development Complete	3/11/2019



Annular Material Measurements	Depth to Top from GS	Total Footage	Elevation of Top
Annular Seal	0	10.0	287.3
Bentonite Seal	10	20.0	277.3
Secondary Filter Pack			
Filter Pack	30	13.0	257.3
Backfill	0		
Bottom of Borehole	43		294.6

Casing Materials Measurements	Total Footage	Elevation of Top
Total Riser Installed	33.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	308.39
Bottom Cap	0.28	298.39
Total Depth from TOC	42.59	

Groundwater Levels		
Date & Time	Depth	Reference Point

Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
- Material: steel
- Size: 4"
- Length: 5'
- Pea Gravel (Y/N): N
- Weep Hole (Y/N): N
- Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
- Dimensions: 4' x 4' x 4"
- Material: concrete

Annular Seal:
- Type & Size: Chips
- Manufacturer: NA
- Amount Used: (included with bentonite seal)

Bentonite Seal:
- Type & Size: Medium Chips
- Manufacturer: NA
- Amount Used: 5 bags

Secondary Filter Pack:
- Type & Size: --
- Manufacturer: --
- Amount Used: --

Primary Filter Pack:
- Type & Size: sand 16/30
- Manufacturer: NA
- Amount Used: 5 bags

Well Casing:
- Type: PVC
- Diameter: 2"
- Sch. or Weight: Sch. 40
- Manufacturer: Environmental Manufacturing
- Screen Type: PVC factory slot
- Screen Slot Size: 0.010"
- Bottom Cap Type: threaded

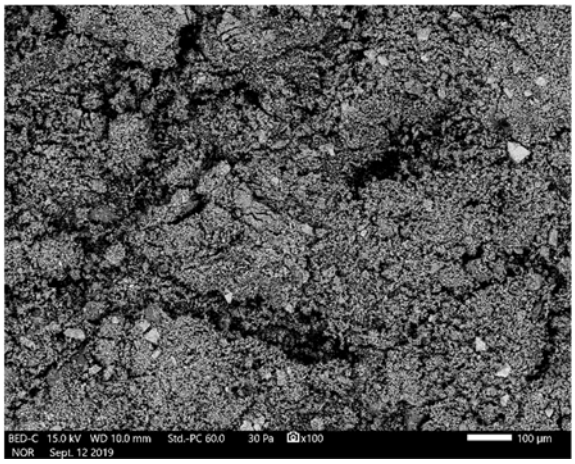
Centralizers (Y/N): N
- Material: --
- Number: --
- Depth(s): --

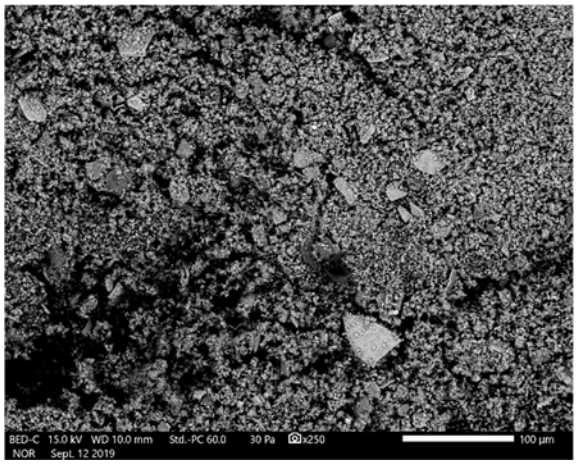
Backfill Material:
- Type & Size: NA
- Manufacturer: --
- Amount Used: --

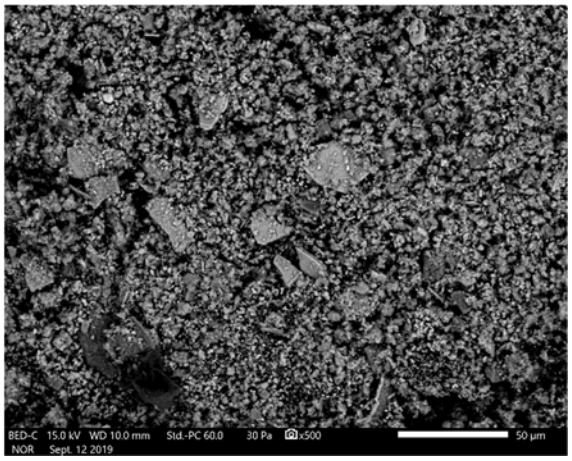
ATTACHMENT B
SEM/EDS Analysis

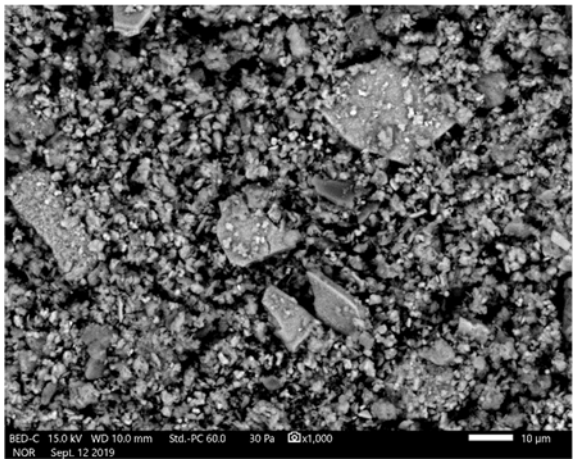
September 12, 2019

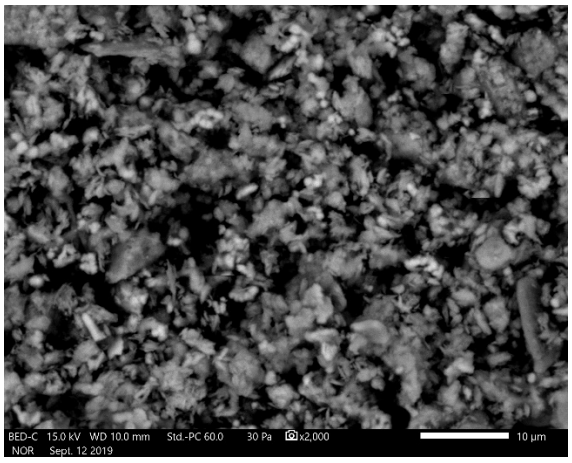
Geosyntec
CTLGroup 150350

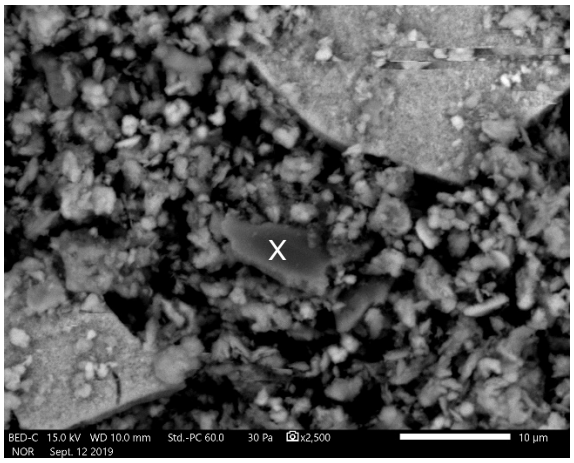


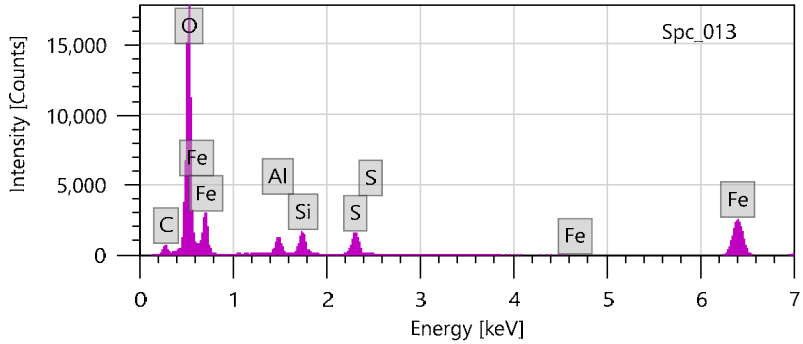












Sample AD-34. BSE spectrum is an area scan for the region shown at 2,000X. Most large blocky particles are quartz or feldspar. X is clay.

CTLGROUP
www.CTLGroup.com

ATTACHMENT C
Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD LF CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864	Texas	10/3/2019
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant Landfill Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

January 7, 2020

CHA8462

TABLE OF CONTENTS

FIGURES

TABLES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LF	Landfill
MCL	Maximum Contaminant Level
RCRA	Resource Conservation and Recovery Act
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
SU	Standard Units
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the Landfill (LF). Eight background monitoring events were conducted at the LF, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. Interwell tests were used to calculate background for pH, sulfate, and total dissolved solids (TDS), and intrawell tests were used for boron, calcium, chloride, and fluoride. During the initial detection monitoring event completed in August 2017, statistically significant increases (SSIs) for boron, sulfate, and TDS were observed, and the unit transitioned to assessment monitoring. Semi-annual assessment monitoring events were conducted at the LF between March 2018 and May 2019 in accordance with 40 CFR 257.95.

In 2019, AEP collected additional geologic data in the vicinity of the LF and updated the conceptual site model. Based on this updated interpretation, it has been determined that interwell upper prediction limits (UPLs) are not appropriate for detection monitoring.

United States Environmental Protection Agency (USEPA) regulations (USEPA, 2015) regarding detection monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration (ASD) when an SSI is identified (40 CFR 257.94(e)(2)):

> *The owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.*

Pursuant to 40 CFR 257.94(e)(2) of the CCR Rule (40 CFR 257), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report, which documents: (1) the change from interwell to intrawell background values for all Appendix III parameters; (2) the alternative source for sulfate and TDS (statistical evaluation cause) in August 2017; (3) exceedances and possible exceedances observed for Appendix III parameters between August 2017 and February 2019; and (iv) the alternative source for boron (natural variation) in August 2017.

SECTION 2

SUMMARY OF GROUNDWATER MONITORING

2.1 Monitoring Network

The groundwater monitoring network for the Pirkey LF currently consists of three upgradient wells (AD-8, AD-16, and AD-27), and three downgradient wells (AD-23, AD-34, and AD-36) (Figure 1). Following the initial detection monitoring event, these wells have been monitored on a semi-annual basis in accordance with 40 CFR 257.95 for Appendix IV parameters. AD-35 was monitored between August 2017 and August 2018 as a downgradient well in the monitoring network before being removed in November 2018 due to landfill expansion activities. Thus, a discussion of AD-35 is not included in this report. AD-35 was replaced by a new downgradient monitoring well, AD-36, which was installed in April 2019 and added to the monitoring network. Eight sampling events are currently being completed at AD-36 to establish background at this well.

2.2 Statistics Completed to Date

2.2.1 Background Established 2018

Between May 2016 and April 2017, sampling was completed at each of the network wells to establish background concentrations for Appendix III and Appendix IV parameters under the CCR rule. The monitoring well data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis in accordance with the statistical analysis plan developed for the unit (AEP, 2017) and USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The background data were reviewed for outliers, which were removed (when appropriate) prior to calculating UPLs for each Appendix III parameter to represent background values. Interwell tests were selected for pH, sulfate, and TDS, whereas intrawell tests were selected for boron, calcium, chloride, and fluoride (Geosyntec, 2018a).

A 1-of-2 resample plan was established for both interwell and intrawell tests to determine if there were exceedances above background values. In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of an additional sample to confirm whether there had been an exceedance. If the resample confirms the exceedance, an SSI is identified and the unit transitions to assessment monitoring. If the resample falls within the statistical limit, the initial exceedance is considered to be a false positive result and no further action is necessary. In the case of an SSI, an ASD may be prepared in accordance with 40 CFR 257.94(e)(2), which documents that a source other than the unit caused the SSI and permits the unit to remain in detection monitoring.

2.2.2 Initial Detection Monitoring Event

Detection monitoring began in August 2017 after the background monitoring period. The initial detection monitoring event was completed in August and December 2017. This event resulted in SSIs above background for boron at AD-23 and sulfate and TDS at AD-34 (Geosyntec, 2018a).

Table 1 summarizes the analytical results and compares the results with calculated prediction limits. As shown in Table 1:

- Boron concentrations of 0.0402 mg/L (initial sample) and 0.0450 mg/L (verification sample) exceeded the UPL of 0.030 mg/L at AD-23;
- Sulfate concentrations of 1,231 and 1,020 mg/L exceeded the interwell UPL of 207 mg/L at AD-34; and
- TDS values of 1,128 and 1,260 mg/L exceeded the interwell UPL of 335 mg/L at AD-34.

2.2.3 Assessment Monitoring

The unit transitioned to assessment monitoring after SSIs were identified for boron, sulfate, and TDS. An alternative source for these parameters was not identified at that time. Therefore, background limits were established for the Appendix IV parameters using upper tolerance limits (UTLs) constructed with 95% confidence and 95% coverage using pooled upgradient well data in accordance with the facility's statistical analysis plan (AEP, 2017) and the *Unified Guidance* (USEPA, 2009). Next, the groundwater protection standard (GWPS) for each parameter was established as the greater of the background concentration and either the Maximum Contaminant Level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2).

Two assessment monitoring events for Appendix IV parameters were conducted in March 2018 and August 2018 in accordance with 40 CFR 257.95(b) and 40 CFR 257.95(d)(1), respectively. Following the August 2018 assessment monitoring event, statistically significant levels (SSLs) for cadmium and cobalt were identified at well AD-34 (Geosyntec, 2018b). Specifically:

- The lower confidence limit (LCL) for cadmium (0.00511 mg/L) was above the GWPS of 0.00500 mg/L; and
- The LCL for cobalt (0.277 mg/L) was above the GWPS of 0.0260 mg/L.

An ASD concluding that the elevated concentrations could be attributed to lignite mine spoils in the vicinity of AD-34 was completed (Burns & McDonnell, 2019); thus, the LF unit remained in assessment monitoring.

Following an assessment monitoring event in February 2019, which was completed in accordance with 40 CFR 257.95(d)(1), the data were submitted to GSC for statistical analysis. GWPSs were re-established for the Appendix IV parameters in accordance with the statistical analysis plan

developed for the unit. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at an SSL above the GWPS. SSLs for cobalt and lithium were identified at well AD-34 (Geosyntec, 2019a). Specifically:

- The LCL for cobalt at AD-34 was 0.272 mg/L, which exceeded the GWPS of 0.026 mg/L; and,
- The LCL for lithium at AD-34 was 0.145 mg/L, which exceeded the GWPS of 0.110 mg/L.

An ASD was successfully completed which argued that the cobalt and lithium concentrations were related to the mine spoils near AD-34 (Geosyntec, 2019b).

2.3 Need for Updated Statistical Tests

SSLs of cadmium, cobalt, and lithium were identified at AD-34 during assessment monitoring; however, the elevated concentrations were attributed in ASDs to the presence of lignite mine spoils in the vicinity of AD-34. No other SSLs were identified for the Appendix IV parameters.

The presence of the lignite mine spoils also affects the concentrations of detection monitoring parameters at wells located near the spoils. The SSIs for sulfate and TDS identified during the first detection monitoring event were based on observed exceedances of an interwell UPL for these parameters. At the time an alternative source could not be determined for boron, sulfate, and TDS. However, based on updated knowledge of the site geology and geochemistry, as described subsequently in Section 3, the use of intrawell statistics is more appropriate to evaluate possible exceedances of Appendix III parameters.

SECTION 3

REVIEW OF SITE CONDITIONS

3.1 Site Layout

The LF, including closed, active, and areas under construction, occupies approximately 137 acres (Figure 1). The LF is bound by Brandy Branch Reservoir to the east, the Stormwater Runoff Pond (pond south of AD-34 and AD-36) to the south, former lignite mining areas to the west, and a coal pile and coal pile runoff pond to the north. A portion of the west side of the LF is underlain by former lignite mining (reclaimed) land, which is identified as 'A Area' in Figure 1. The local surface topography slopes to the southwest towards Hatley Creek, located approximately 0.7 miles west of the LF. As discussed in Section 2.1, groundwater in the vicinity of the LF is monitored with a network of upgradient and downgradient wells. As shown in Figure 1, AD-34 is the only downgradient well in the LF monitoring network which is set within mine spoil in the former mining area (A Area).

3.2 Site Geochemistry

A geochemical investigation shows that wells screened within the former mining area have a different groundwater composition than wells screened in undisturbed geology. A Piper diagram was generated to assess whether major ion concentrations are affected by screen placement in the mine spoil area (Figure 2). The Piper diagram shows that AD-34 groundwater appears more similar to wells which were screened in the mine spoil area (AD-25, AD-26, AD-48, AD-49, AD-52 through AD-55) than wells that are in the well network. Groundwater in the mine spoil area is dominated by sulfate and magnesium, whereas wells screened in native material have higher proportions of chloride, sodium, and potassium.

Sulfate and TDS are elevated in wells screened within mine spoils in A Area adjacent to the LF, as shown in Figures 3 and 4, respectively. Increased sulfate and TDS concentrations in waters affected by mine spoils are well known (Skousen and Zipper, 2014; Cunningham and Jones, 1990). The effect of mine spoils on the sulfate and TDS concentrations is supported by the lower reported values at AD-50 (illustrated with a smaller radius circle), which is set within the mine spoil footprint but screened in clean fill.

AD-54 and AD-55, which have the highest sulfate and TDS concentrations in the area, are located more than 1,400 feet from the edge of the LF. Groundwater seepage velocities in the area are consistently less than 25 feet per year (AEP, 2019). Impacts from waste placement would take more than fifty years to reach the AD-54/AD-55 cluster, and waste placement did not start at the unit until 1985. Therefore, elevated concentrations of sulfate and TDS within the mine spoil area are unlikely to be related to a release from the unit and instead can be attributed to the effects of the mine spoils on groundwater chemistry.

Additionally, the concentrations of all Appendix III parameters at AD-34 are consistent over time. As shown in Figure 5, the August 2017 and December 2017 values, which were considered SSIs for sulfate and TDS in the initial statistical evaluation, are within the normal range for this monitoring well. This suggests that there are not ongoing impacts that are affecting groundwater chemistry at AD-34, which would be indicative of a release.

Because AD-34 is the only well in the monitoring network that is screened within mine spoils, intrawell statistics are more appropriate for screening Appendix III parameters for SSIs than the interwell approach.

SECTION 4

STATISTICAL REVISION

4.1 Statistical Output from Groundwater Stats Consulting

The presence of mine spoils near AD-34 and their effect on groundwater chemistry was not known when interwell statistics were selected to calculate background concentrations for pH, sulfate, and TDS following the background monitoring period. After AEP updated their conceptual site model in 2019 and became aware of the issue, the need to modify the statistical tests for these parameters became apparent.

Statistical analysis of the LF data was revised in accordance with the January 2017 Statistical Analysis Plan (AEP, 2017). Intrawell prediction limits were calculated for pH, sulfate, and TDS using the background dataset collected prior to initiation of detection monitoring (Table 2). The intrawell background value UPLs for all Appendix III parameters were then used to determine SSIs at the LF downgradient well network for the detection monitoring data collected between August 2017 and February 2019, which are summarized in Table 3. The tests were selected with using a one-of-two retesting procedure.

The revised statistical output for pH, sulfate, and TDS is provided in Attachment A. While all parameters are included, only the tests for pH, sulfate, and TDS were revised.

4.2 Review of August 2017-February 2019 Detection Monitoring Results

Bold values in Table 1 highlight concentrations above the UPL for Appendix III parameters using the current intrawell background values. Exceedances and possible exceedances were noted for boron, chloride, and pH. An exceedance was only confirmed if two consecutive samples were above the UPL based on the selected one-of-two retesting procedure. These exceedances or possible exceedances are discussed below.

4.2.1 August 2017

As discussed in Section 2.2.2, boron concentrations in well AD-23 for the first detection monitoring event exceeded the intrawell UPL of 0.0300 mg/L, resulting in an SSI. The boron concentrations were 0.0402 mg/L for the August 2017 (initial) and 0.0450 mg/L for the December 2017 (verification) sampling events. However, subsequent samples collected from March 2018 through May 2019 were below the UPL, as shown in Figure 6. Additionally, Figure 7 shows that upgradient well AD-8 has consistently higher concentrations of boron than AD-23. Based on a broader understanding of spatial and temporal variations at the LF, it is concluded that the August and December 2017 boron values represent a temporary increase of natural origin and do not suggest a release from the LF. Therefore, natural variation was determined to be the alternative

source for this exceedance. Certification of this ASD by a certified professional engineer is included with this report as Attachment B.

4.2.2 March 2018

A possible exceedance for boron was noted for well AD-34 in March 2018. Boron was detected at 0.171 mg/L, which is above the intrawell UPL of 0.120 mg/L. Verification sampling was not completed at the time because the unit had transitioned to assessment monitoring, but the subsequent semi-annual monitoring result in August 2018 was below the UPL, as shown in Figure 8. This result is now being considered the verification sampling event; thus, no SSI was identified for boron at AD-34 for the March 2018 sampling event. Subsequent samples for boron at AD-34 were also below the intrawell UPL, suggesting that the March 2018 concentration was a natural variation and not a release from the LF.

4.2.3 August 2018

A possible exceedance for chloride was noted for wells AD-23 and AD-34 in August 2018. Chloride was detected at 9 mg/l in well AD-23, which is above the intrawell UPL of 7.89 mg/L, and at 10 mg/L in well AD-34, which is above the intrawell UPL of 9.2 mg/L. Verification sampling was not completed at the time because the unit had transitioned to assessment monitoring, but subsequent semi-annual monitoring results in February 2019 were below intrawell UPLs for both wells, as shown in Figure 9. These results are now being considered the verification sampling events for both wells; thus, no SSIs were identified for chloride at either well for the August 2018 sampling event.

4.2.4 February 2019

A possible exceedance for pH (5.1 standard units [SU]) was identified at well AD-23 in February 2019. Verification sampling was completed in May 2019, and the pH result of 4.8 did not exceed the intrawell UPL for pH of 4.8 at AD-23. Thus, no SSI was identified.

4.3 Return to Detection Monitoring

SSIs for boron, sulfate, and TDS were concluded for the first detection monitoring period in August 2017, and the evaluation of alternative sources was not pursued given the conceptual site model available at the time. However, with the updated statistical tests for sulfate and TDS presented in this report, there is no longer an SSI of sulfate and TDS at AD-34. Further, the initial higher concentrations for boron are now considered to be representative of natural variation rather than an SSI, as described in Section 4.2.1.

The completion of this ASD to address the SSIs initially reported for boron, sulfate, and TDS removes the regulatory need for assessment monitoring of the LF. Therefore, all data collected during the previous assessment monitoring periods may be evaluated as detection monitoring

events. As demonstrated in Section 4, SSIs are not determined for any of the Appendix III parameters monitored for the LF.

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

Well AD-34 is the only monitoring location within the Pirkey LF monitoring network that is set within a former mining area. The placement of mine spoils within the former mining area has resulted in different groundwater geochemistry at AD-34 compared to the other locations in the LF network. The information presented in this report supports the position that the detection monitoring statistics should be revised to use intrawell tests for all Appendix III parameters. Revised intrawell prediction limits were calculated using a one-of-two resampling procedure. Using the revised UPLs for sulfate and TDS, no exceedances of sulfate or TDS were identified during the August 2017 detection monitoring event.

All sampling events for Appendix III parameters completed since the end of the background monitoring period were evaluated in Section 4 using intrawell background value UPLs. One SSI was identified for boron during the August 2017 detection monitoring event. Section 4.2.1 of this report provides lines of evidence showing that an alternative source (natural variation) is responsible for the boron SSI. No other SSIs were observed in the sampling events completed from August 2017 through February 2019.

This ASD for sulfate and TDS (statistical evaluation cause) and boron (natural variation) was prepared in accordance with 40 CFR 257.94(e)(2). Certification of this ASD is provided in Attachment B. The unit will return to detection monitoring, and a public posting will be made in accordance with 40 CFR 257.95(e).

SECTION 6

REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

AEP, 2019. Annual Groundwater Monitoring Report. Southwestern Electric Power Company – H.W. Pirkey Plant Landfill CCR Management Unit. January.

Burns & McDonnell Engineering Company, Inc. 2019. Alternate Source Demonstration Evaluation Report. H. W. Pirkey Plant. Landfill CCR Management Unit. April.

Cunningham, W.L. and Jones. R. L. 1990. Long-Term Effects of Surface Coal Mining on Ground-Water Levels and Quality in Two Small Watersheds in Eastern Ohio. USGS Water-Resources Investigations Report 90-4136.

Geosyntec Consultants. 2018a. Statistical Analysis Summary – Landfill. H.W. Pirkey Power Plant. Hallsville, Texas. January.

Geosyntec Consultants. 2018b. Statistical Analysis Summary – Landfill. H.W. Pirkey Power Plant. Hallsville, Texas. December.

Geosyntec Consultants. 2019a. Statistical Analysis Summary – Landfill. H.W. Pirkey Power Plant. Hallsville, Texas. July.

Geosyntec Consultants, 2019b. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, East Bottom Ash Pond. Hallsville, Texas. September.

Skousen, J. and Zipper, C.E., 2014. Post-mining policies and practices in the Eastern USA coal region. International Journal of Coal Science & Technology, 1, pp.135-151.

United States Environmental Protection Agency (USEPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

FIGURES

Legend

- Upgradient Well
- Downgradient Well
- Out of Network Well
- Abandoned Well
- A Area
- Landfill

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- A Area is a former lignite (reclaimed) mine.
- AD-35 was abandoned in November 2018 and a new downgradient well, AD-36, was installed in April 2019.
- Aerial imagery provided by DigitalGlobe and dated 12/1/2018.

1,000 500 0 1,000 Feet

Site Layout

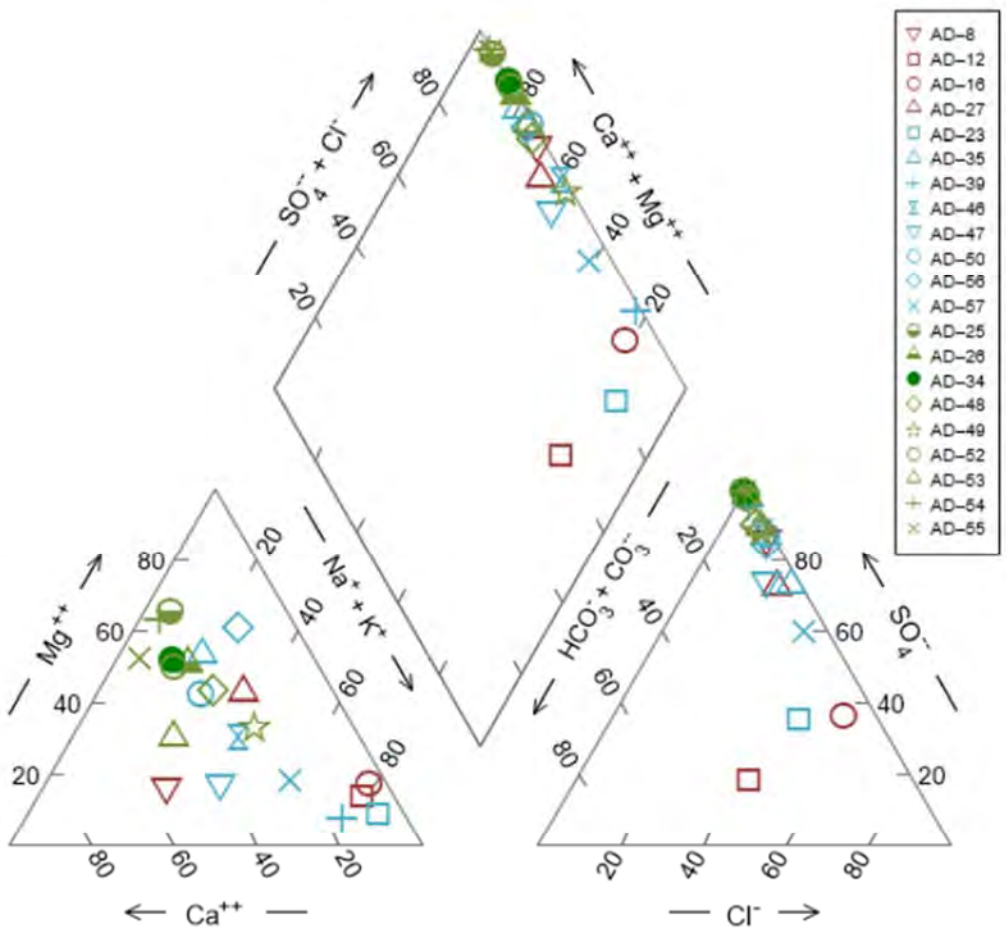
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/06

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Sitelayout_20191224.mxd. ARevezzo. 1/6/2020. Project/Phase/Task.



Notes: Wells in the LF network use February 2019 data, except AD-8 which used August 2018 data due to an apparent outlier. Wells out of the network use August 2019 data.

Red symbology: Upgradient locations
Blue symbology: Downgradient locations screened in natural geology or clean fill.
Green symbology: Downgradient locations screened in mine fill.

Piper Diagram – Landfill Area Wells
Pirkey Landfill

Geosyntec consultants | AMERICAN ELECTRIC POWER | Figure 2

Columbus, Ohio | 19-Sep-2019

internal info: path, date revised, author

Legend

- Wells not screened in mine spoil
- Wells screened in mine spoil
- A Area
- Landfill

Notes
- Monitoring well coordinates, site features, and data provided by AEP.
- Size of point symbol corresponds to sulfate concentration.
- Sulfate concentrations displayed in milligrams per liter (mg/L).
- Sulfate concentrations from the August 2019 sampling event are used, as this is the most complete dataset available.
- Sulfate concentrations for monitoring well AD-35 is representated with data from the August 2018 sampling event; AD-25 is represented with data from the February 2019 sampling event.
- A Area is a former lignite (reclaimed) mine.

900 450 0 900
Feet

Landfill Area Sulfate Values

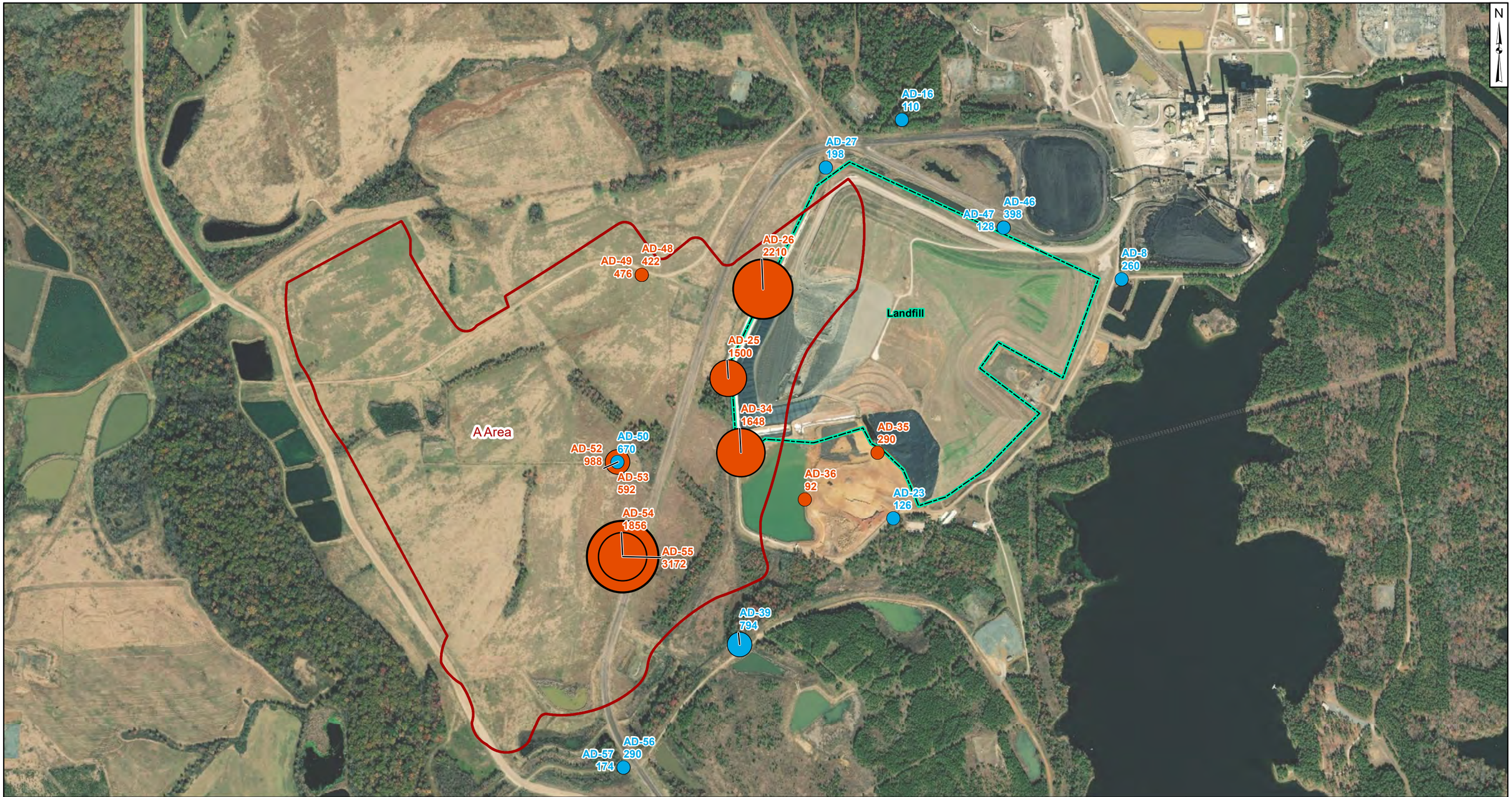
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/06

Figure 3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_PirkeyLF_Sulfate_20191219.mxd. ARevezzo. 1/6/2020.



Legend

- Wells not screened in mine spoil
- Wells screened in mine spoil
- A Area
- Landfill

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- Size of point symbol corresponds to total dissolved solids (TDS) concentration.
- Total Dissolved Solids (TDS) concentrations displayed in milligrams per liter (mg/L).
- TDS concentrations from the August 2019 sampling event are used, as this is the most complete dataset available.
- TDS concentrations for monitoring well AD-35 is representated with data from the August 2018 sampling event; AD-25 is represented with data from the February 2019 sampling event.
- A Area is a former lignite (reclaimed) mine.

900 450 0 900
Feet

Landfill Area Total Dissolved Soilds Values

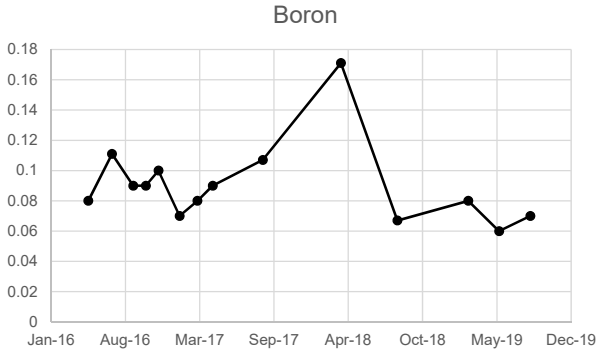
AEP Pirkey Power Plant
Hallsville, Texas

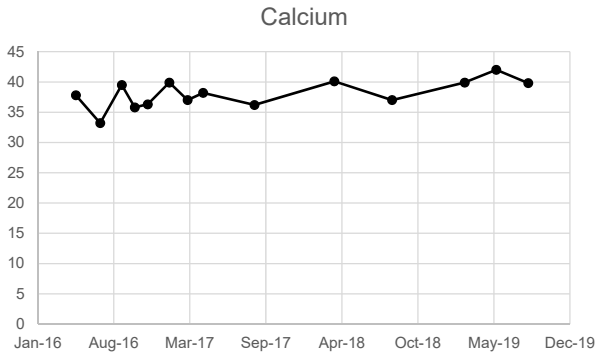
Geosyntec consultants

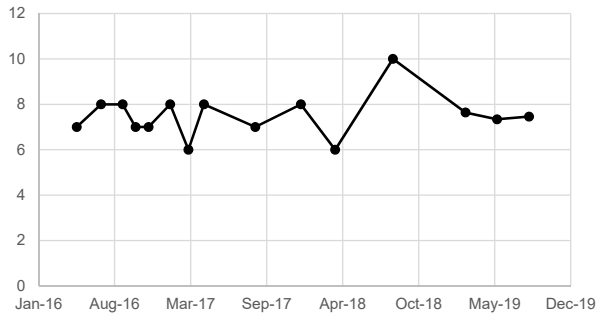
Columbus, Ohio | 2020/01/06

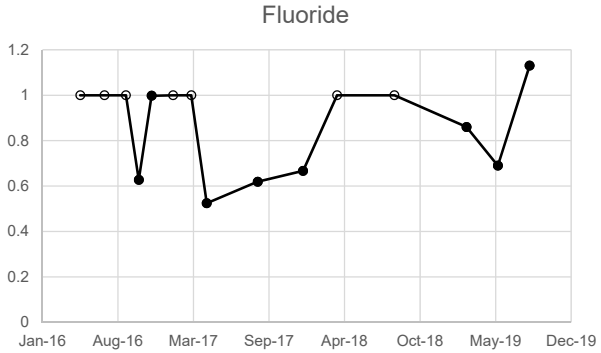
Figure 4

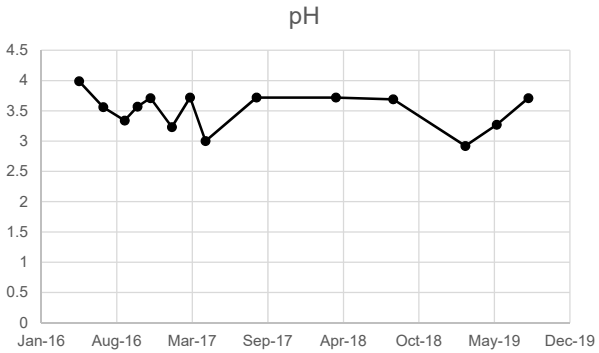
P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_PirkeyLF_TDS_20191219.mxd. ARevezzo. 1/6/2020.

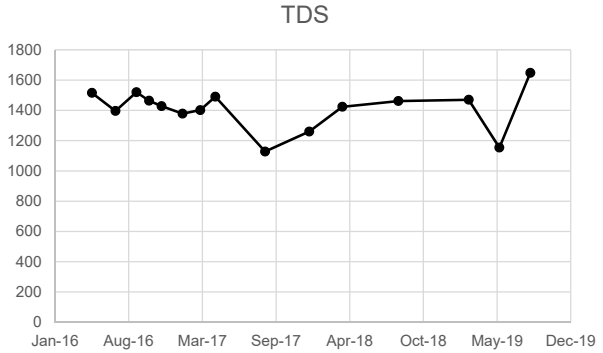


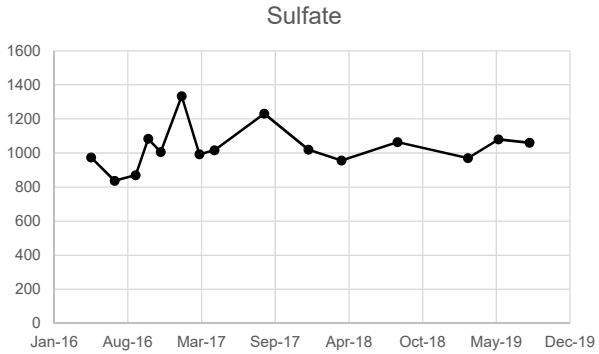












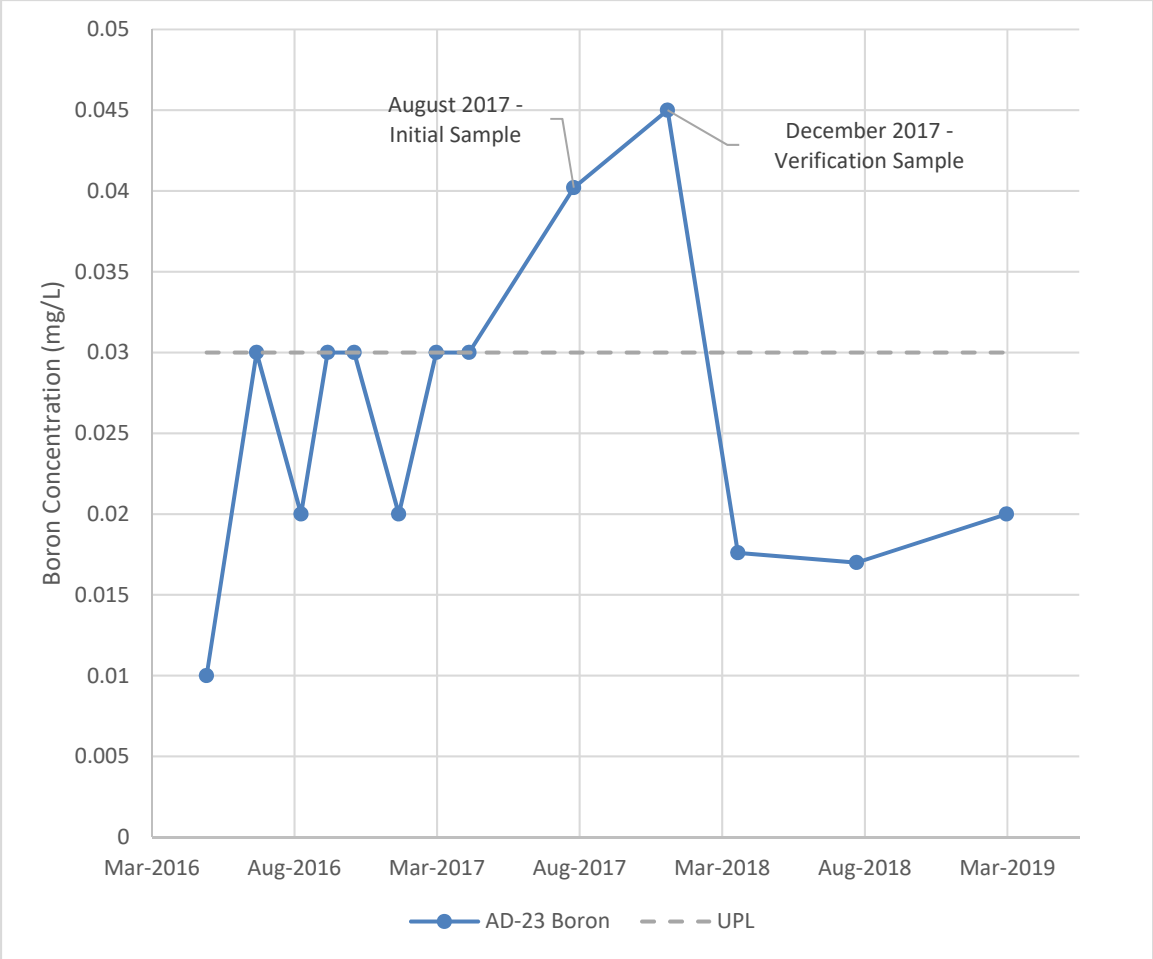
Notes:
- Open circles indicate reporting limit for non-detections
- pH values reported as standard units (SU); all other parameters reported as milligrams per liter (mg/L).

AD-34 Appendix III Time Series Graphs
H.W. Pirkey Power Plant Landfill

Geosyntec consultants

Columbus, OH | 12/20/2019

Figure **5**



Notes:
mg/L: milligrams per liter
UPL: Upper prediction limit

AD-23 Boron Time Series Graph
Pirkey Landfill

Geosyntec consultants

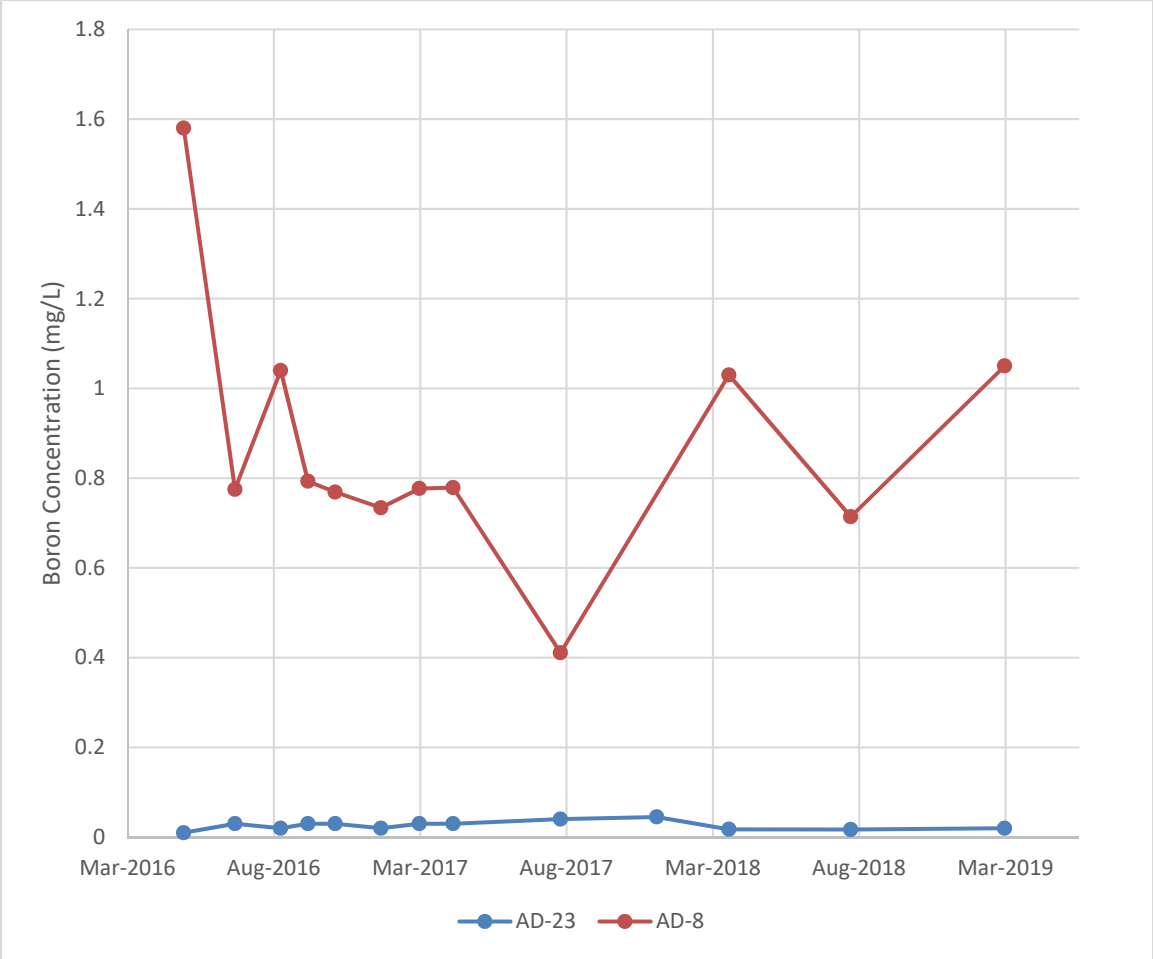
AMERICAN ELECTRIC POWER

Figure **6**

Columbus, Ohio

12-Dec-2019

internal info: path, date revised, author



Notes:
mg/L: milligrams per liter
AD-8 is an upgradient well in the Pirkey LF monitoring network.

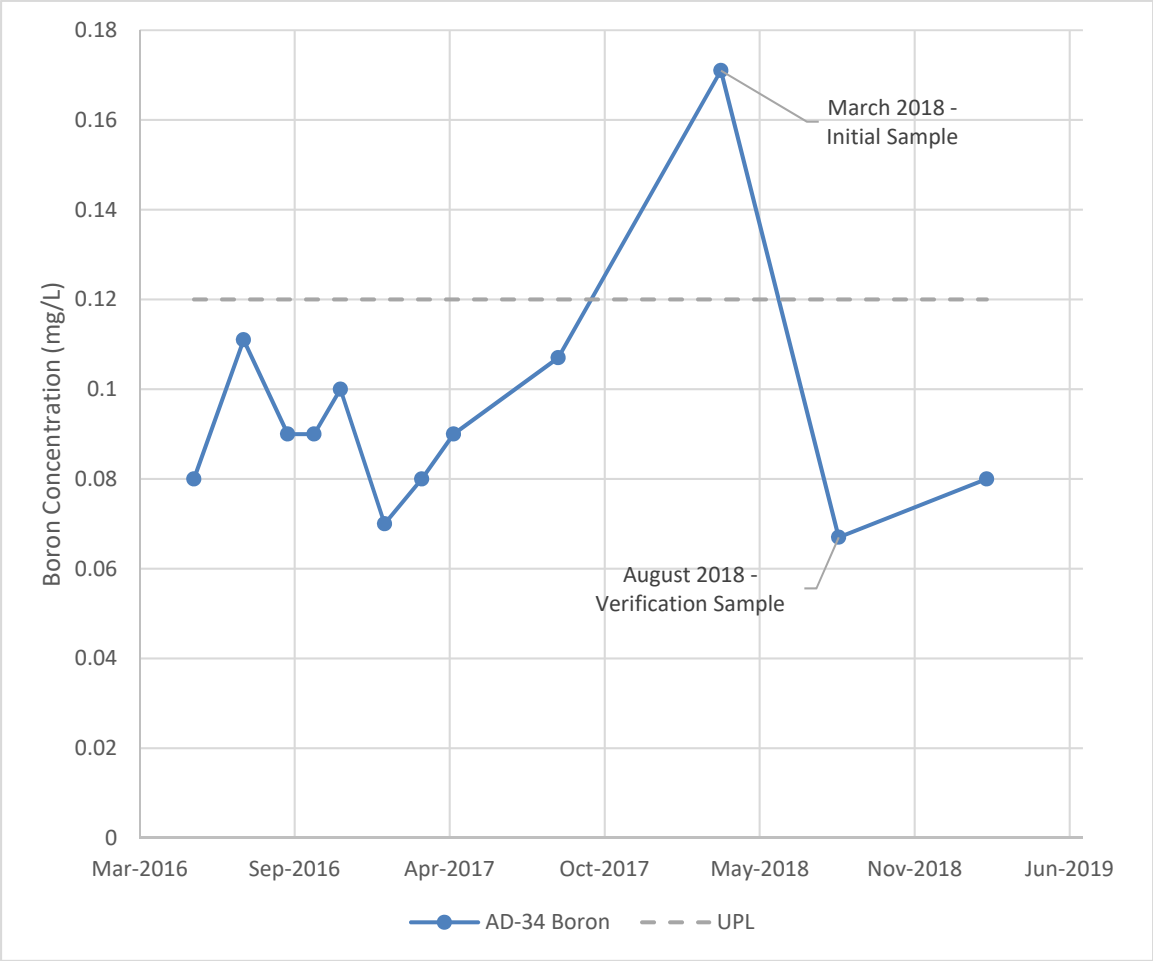
AD-23 and AD-8 Boron Time Series Graphs
Pirkey Landfill

Geosyntec consultants | AMERICAN ELECTRIC POWER

Columbus, Ohio | 12-Dec-2019

Figure **7**

internal info: path, date revised, author



Notes:
mg/L: milligrams per liter
UPL: Upper prediction limit

AD-34 Boron Time Series Graph
Pirkey Landfill

Geosyntec consultants

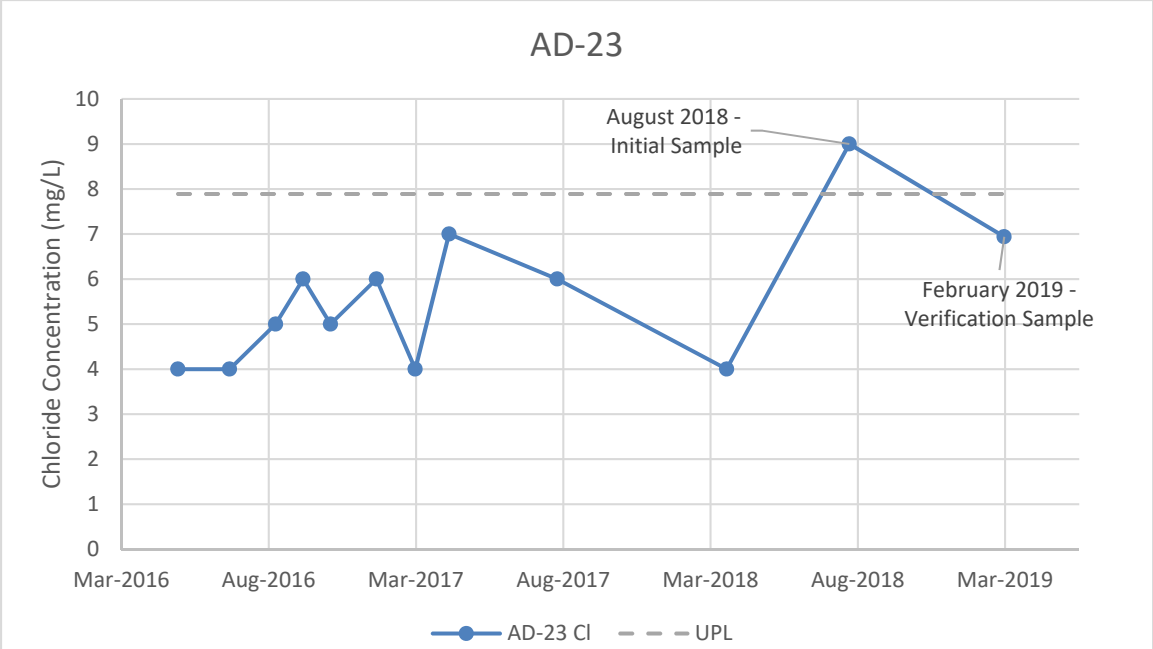
AMERICAN ELECTRIC POWER

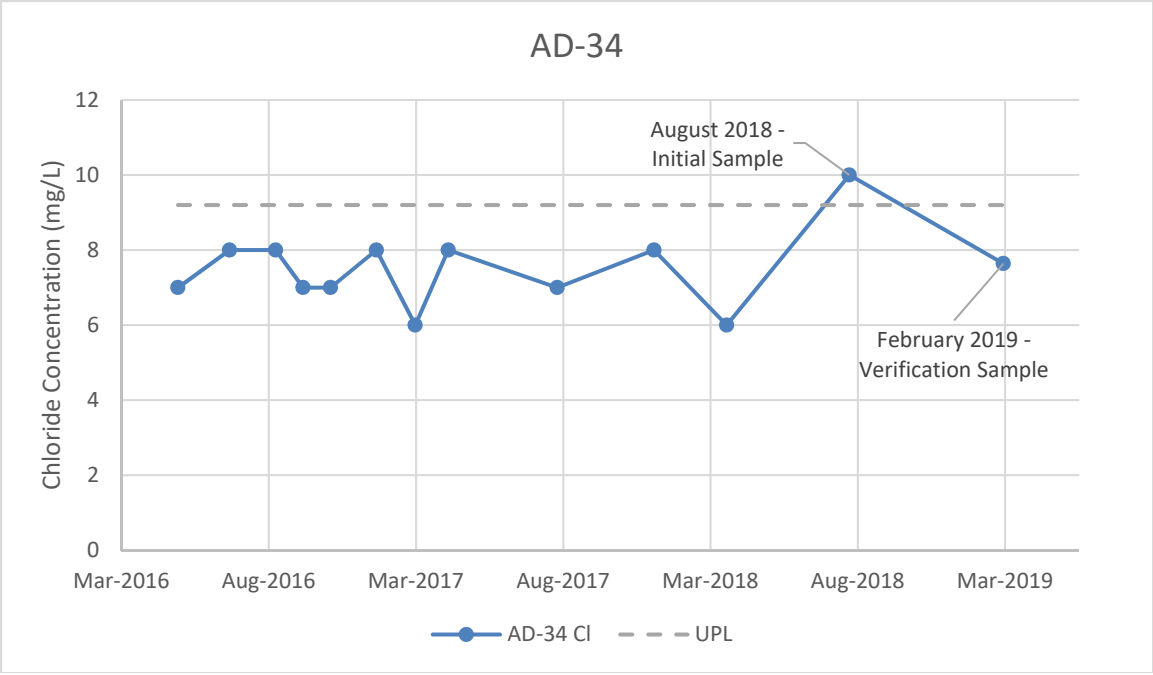
Figure **8**

Columbus, Ohio

12-Dec-2019

internal info: path, date revised, author





Notes:
mg/L: milligrams per liter
UPL: Upper prediction limit

AD-23 and AD-34
Chloride Time Series Graphs
Pirkey Landfill

Geosyntec consultants | AMERICAN ELECTRIC POWER | Figure **9**

Columbus, Ohio | 12-Dec-2019

internal info: path, date revised, author

TABLES

Table 1: Initial Detection Monitoring Data Evaluation
Pirkey Plant - Landfill

Geosyntec Consultants, Inc.

Parameter	Units	Description	AD-23		AD-34		AD-35
			8/23/2017	12/21/2017	8/23/2017	12/21/2017	8/23/2017
Boron	mg/L	Intrawell Background Value (UPL)	0.030		0.120		0.143
		Detection Monitoring Result	**0.0402**	**0.0450**	0.107	--	0.0413
Calcium	mg/L	Intrawell Background Value (UPL)	0.610		42.5		27.7
		Detection Monitoring Result	0.276	0.469	36.2	--	4.33
Chloride	mg/L	Intrawell Background Value (UPL)	7.89		9.2		26.5
		Detection Monitoring Result	6	--	7	8	16
Fluoride	mg/L	Intrawell Background Value (UPL)	1.00		1.00		1.00
		Detection Monitoring Result	0.198	--	0.62	0.67	<0.083
pH	SU	Interwell Background Value (UPL)	5.4				
		Interwell Background Value (LPL)	2.5				
		Detection Monitoring Result	4.1	--	3.7	--	4.9
Sulfate	mg/L	Interwell Background Value (UPL)	207				
		Detection Monitoring Result	11.0	--	**1231**	**1020**	35.0
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	335				
		Detection Monitoring Result	64.0	--	**1128**	**1260**	92

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
<: Non-detect value. Parameters which were not detected are shown as less than the MDL.
Background values are shaded gray.
--: Not Sampled
Based on a 1-of-2 resampling, a statistically significant increase (SSI) is only identified when both samples in the detection monitoring period are above the UPL.

Table 2 - 2016-2017 Background Groundwater Data *Geosyntec Consultants, Inc.*
Pirkey Plant - Landfill

Parameter	Unit	AD-8							
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/11/2017
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Arsenic	mg/L	0.005U	0.00117J	0.005U	0.00147J	0.005U	0.00153J	0.00169J	0.005U
Barium	mg/L	0.038	0.061	0.048	0.061	0.052	0.06	0.052	0.051
Beryllium	mg/L	0.001	0.007	0.002	0.006	0.006	0.006	0.006	0.006
Boron	mg/L	1.58	0.775	1.04	0.793	0.769	0.734	0.777	0.779
Cadmium	mg/L	0.001U	0.00018J	0.001U	0.001U	0.00012J	0.00011J	0.00014J	0.00013J
Calcium	mg/L	109	20.7	50.7	20.8	17.2	18.6	18.1	17.1
Chloride	mg/L	9	13	12	13	13	13	10	12
Chromium	mg/L	0.001	0.001	0.00084J	0.00074J	0.00081J	0.002	0.00063J	0.00089J
Cobalt	mg/L	0.0018J	0.02	0.009	0.018	0.018	0.018	0.018	0.019
Combined Radium	pCi/L	0.9155	6.75	1.658	6.72	6.14	6.29	7.64	5.56
Fluoride	mg/L	1U	2	2	2	3	3	2	3
Lead	mg/L	0.00103J	0.00147J	0.005U	0.00231J	0.00286J	0.003J	0.00327J	0.00244J
Lithium	mg/L	0.001U	0.032	0.018	0.032	0.03	0.032	0.031	0.031
Mercury	mg/L	0.00003	0.00021	0.00005	0.00011	0.00016	0.00016	0.00015	0.00001J
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Selenium	mg/L	0.015	0.005U	0.00385J	0.00251J	0.005U	0.00141J	0.00179J	0.005U
Total Dissolved Solids	mg/L	432	280	285	276	296	280	250	284
Sulfate	mg/L	181	131	121	184	208	228	157	168
Thallium	mg/L	0.0012J	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U
pH	SU	6.1	6.2	5.1	3.7	3.7	3.6	3.7	3.9

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled

Table 2 - 2016-2017 Background Groundwater Data *Geosyntec Consultants, Inc.*
Pirkey Plant - Landfill

Parameter	Unit	AD-12							
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Arsenic	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Barium	mg/L	0.026	0.023	0.03	0.027	0.028	0.023	0.026	0.024
Beryllium	mg/L	0.00022J	0.00019J	0.00023J	0.00015J	0.00015J	0.00013J	0.00015J	0.00016J
Boron	mg/L	0.03	0.03	0.04	0.03	0.04	0.03	0.04	0.05
Cadmium	mg/L	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U
Calcium	mg/L	0.362	0.26	0.343	0.271	0.331	0.315	0.434	0.299
Chloride	mg/L	5	6	6	7	8	7	5	6
Chromium	mg/L	0.00071J	0.00069J	0.00035J	0.00053J	0.00033J	0.00065J	0.00033J	0.00042J
Cobalt	mg/L	0.00158J	0.00129J	0.00167J	0.00157J	0.00147J	0.00109J	0.0013J	0.00133J
Combined Radium	pCi/L	0.2073	2.909	0.881	0.257	0.767	1.536	0.416	0.3895
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	0.2565J
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Lithium	mg/L	0.001U	0.008	0.01	0.012	0.013	0.01	0.009	0.008
Mercury	mg/L	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00001J
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Selenium	mg/L	0.00174J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Total Dissolved Solids	mg/L	94	75	63	92	80	76	50	72
Sulfate	mg/L	4	4	7	8	6	6	4	7
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.00099J	0.002U
pH	SU	4.4	3.1	3.9	3.4	2.6	4.8	3.6	4.7

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled

Table 2 - 2016-2017 Background Groundwater Data
Pirkey Plant - Landfill

Parameter	Unit	AD-16							
		5/10/2016	7/14/2016	9/8/2016	10/13/2016	11/14/2016	1/11/2017	3/1/2017	4/10/2017
Antimony	mg/L	0.005U	0.005U	0.008	0.005U	0.005U	0.005U	0.005U	0.005U
Arsenic	mg/L	0.00183J	0.005U	0.005U	0.00152J	0.005U	0.005U	0.00151J	0.005U
Barium	mg/L	0.061	0.064	0.07	0.056	0.055	0.058	0.076	0.077
Beryllium	mg/L	0.00045J	0.00057J	0.00081J	0.00025J	0.00038J	0.00071J	0.00049J	0.00044J
Boron	mg/L	0.02	0.03	0.03	0.03	0.03	0.02	0.03	0.02
Cadmium	mg/L	0.00008J	0.001U	0.00009J	0.001U	0.001U	0.001U	0.001U	0.001U
Calcium	mg/L	1.21	2	1.83	1.15	1.58	1.76	1.29	1.21
Chloride	mg/L	8	9	9	9	9	10	9	11
Chromium	mg/L	0.001	0.001	0.002	0.001	0.00056J	0.00041J	0.00056J	0.00082J
Cobalt	mg/L	0.00424J	0.006	0.008	0.00334J	0.00434J	0.008	0.005	0.005
Combined Radium	pCi/L	1.294	1.438	1.931	1.843	2.123	2.629	1.417	0.932
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	1U
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Lithium	mg/L	0.006	0.036	0.032	0.033	0.028	0.031	0.021	0.019
Mercury	mg/L	0.00002J	0.00002J	0.00001J	0.00002U	0.00002U	0.00001J	0.00002U	0.00001J
Molybdenum	mg/L	0.005U	0.00112J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Selenium	mg/L	0.00226J	0.005U	0.005U	0.0017J	0.005U	0.005U	0.005U	0.005U
Total Dissolved Solids	mg/L	116	148	133	124	124	112	108	106
Sulfate	mg/L	16	45	33	16	23	43	22	24
Thallium	mg/L	0.00137J	0.002U	0.00175J	0.002U	0.002U	0.002U	0.002U	0.002U
pH	SU	3.9	3.8	3.9	3.9	4.4	3.7	3.2	3.4

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled

Table 2 - 2016-2017 Background Groundwater Data *Geosyntec Consultants, Inc.*
Pirkey Plant - Landfill

Parameter	Unit	AD-23							
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/11/2017
Antimony	mg/L	0.00289J	0.0038J	0.005U	0.0013J	0.005U	0.005U	0.00166J	0.005U
Arsenic	mg/L	0.00165J	0.005U	0.005U	0.007	0.005U	0.00204J	0.005U	0.00397J
Barium	mg/L	0.048	0.048	0.053	0.12	0.05	0.073	0.041	0.086
Beryllium	mg/L	0.00019J	0.00019J	0.0002J	0.00046J	0.00013J	0.00016J	0.00012J	0.00032J
Boron	mg/L	0.01	0.03	0.02	0.03	0.03	0.02	0.03	0.03
Cadmium	mg/L	0.00007J	0.00009J	0.001U	0.00014J	0.001U	0.001U	0.001U	0.00011J
Calcium	mg/L	0.535	0.317	0.26	0.321	0.249	0.319	0.217	0.543
Chloride	mg/L	4	4	5	6	5	6	4	7
Chromium	mg/L	0.002	0.002	0.005	0.041	0.006	0.015	0.0003J	0.022
Cobalt	mg/L	0.0023J	0.00273J	0.00201J	0.00391J	0.00167J	0.00226J	0.00105J	0.00261J
Combined Radium	pCi/L	6.86	5.69	6.68	12.89	7.54	8.06	5.74	10.31
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	0.2688J
Lead	mg/L	0.005U	0.005U	0.00224J	0.031	0.00321J	0.011	0.005U	0.015
Lithium	mg/L	0.00014J	0.006	0.006	1.01*	0.006	0.009	0.005	0.01
Mercury	mg/L	0.00001J	0.00002J	0.00002U	0.0001	0.00002J	0.00009	0.00002U	0.00012
Molybdenum	mg/L	0.005U	0.00135J	0.005U	0.00056J	0.0004J	0.005U	0.005U	0.00032J
Selenium	mg/L	0.00192J	0.002J	0.005U	0.00211J	0.00135J	0.005U	0.00131J	0.005U
Total Dissolved Solids	mg/L	72	59	64	68	100	60	48	76
Sulfate	mg/L	10	11	12	13	14	13	9	11
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U
pH	SU	4.0	2.7	3.5	3.7	3.5	3.7	4.0	4.2

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
*: Value was removed from the dataset as an outlier prior to completion of statistical analyses.

Table 2 - 2016-2017 Background Groundwater Data *Geosyntec Consultants, Inc.*
Pirkey Plant - Landfill

Parameter	Unit	AD-27							
		5/11/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	3/1/2017	4/10/2017
Antimony	mg/L	0.00121J	0.00096J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Arsenic	mg/L	0.00215J	0.00128J	0.005U	0.00214J	0.005U	0.00157J	0.005U	0.005U
Barium	mg/L	0.043	0.045	0.047	0.046	0.041	0.046	0.043	0.045
Beryllium	mg/L	0.005	0.005	0.006	0.005	0.005	0.005	0.005	0.005
Boron	mg/L	0.02	0.03	0.03	0.03	0.03	0.02	0.03	0.03
Cadmium	mg/L	0.00043J	0.00043J	0.0004J	0.00042J	0.00042J	0.0003J	0.00029J	0.00041J
Calcium	mg/L	4.41	4.43	4.17	4.09	4.52	3.74	4.31	4.01
Chloride	mg/L	8	8	8	8	8	9	8	9
Chromium	mg/L	0.00087J	0.002	0.002	0.002	0.002	0.001	0.002	0.00095J
Cobalt	mg/L	0.02	0.021	0.02	0.02	0.022	0.018	0.021	0.021
Combined Radium	pCi/L	2.031	2.406	2.71	4.43	3.69	2.62	3.48	2.58
Fluoride	mg/L	0.6176J	1U	1U	1U	1U	1U	1U	1U
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Lithium	mg/L	0.066	0.097	0.095	0.096	0.095	0.1	0.1	0.104
Mercury	mg/L	0.00002U	0.00002J	0.00002U	0.00002U	0.00002U	0.00001J	0.00002U	0.00002U
Molybdenum	mg/L	0.005U	0.00043J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Selenium	mg/L	0.00111J	0.005U	0.005U	0.00136J	0.005U	0.005U	0.005U	0.005U
Total Dissolved Solids	mg/L	198	192	196	216	216	180	216	180
Sulfate	mg/L	51	54	52	58	92	58	56	54
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U
pH	SU	3.9	2.7	2.9	3.0	3.5	4.1	2.8	3.3

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled

Table 2 - 2016-2017 Background Groundwater Data
Pirkey Plant - Landfill

Parameter	Unit	AD-34							
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/10/2017
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Arsenic	mg/L	0.012	0.025	0.009	0.01	0.007	0.006	0.007	0.0045J
Barium	mg/L	0.072	0.177	0.031	0.039	0.023	0.029	0.011	0.023
Beryllium	mg/L	0.003	0.004	0.003	0.003	0.002	0.002	0.002	0.002
Boron	mg/L	0.08	0.111	0.09	0.09	0.1	0.07	0.08	0.09
Cadmium	mg/L	0.006	0.006	0.008	0.005	0.008	0.007	0.006	0.011
Calcium	mg/L	37.8	33.2	39.5	35.8	36.3	39.9	37	38.2
Chloride	mg/L	7	8	8	7	7	8	6	8
Chromium	mg/L	0.034	0.081	0.012	0.015	0.006	0.008	0.001U	0.007
Cobalt	mg/L	0.301	0.296	0.306	0.297	0.292	0.284	0.294	0.299
Combined Radium	pCi/L	9.64	7.75	7.91	10.12	13.21	11.9	9.87	2.407
Fluoride	mg/L	1U	1U	1U	0.6272J	0.9978J	1U	1U	0.5241J
Lead	mg/L	0.012	0.039	0.00102J	0.0037J	0.005U	0.005U	0.005U	0.005U
Lithium	mg/L	0.176	0.183	0.158	0.174	0.154	0.164	0.158	0.167
Mercury	mg/L	0.0001	0.00031	0.00006	0.00004	0.00002	0.00003	0.00002U	0.00002J
Molybdenum	mg/L	0.00069J	0.00211J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Selenium	mg/L	0.005U	0.007	0.005U	0.005U	0.00451J	0.005U	0.005U	0.005U
Total Dissolved Solids	mg/L	1516	1396	1520	1464	1428	1378	1402	1490
Sulfate	mg/L	974	837	870	1084	1006	1334	993	1016
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U
pH	SU	4.0	3.6	3.3	3.6	3.7	3.2	3.7	3.0

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled

Table 2 - 2016-2017 Background Groundwater Data
Pirkey Plant - Landfill

Geosyntec Consultants, Inc.

Parameter	Unit	AD-35							
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/11/2017
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Arsenic	mg/L	0.011	0.009	0.00113J	0.00407J	0.012	0.00215J	0.00404J	0.0014J
Barium	mg/L	0.124	0.185	0.116	0.11	0.143	0.115	0.094	0.092
Beryllium	mg/L	0.00033J	0.00039J	0.00019J	0.00014J	0.0003J	0.00009J	0.00009J	0.00007J
Boron	mg/L	0.109	0.07	0.04	0.05	0.06	0.06	0.123	0.07
Cadmium	mg/L	0.00011J	0.001U	0.001U	0.001U	0.00024J	0.00009J	0.001U	0.00033J
Calcium	mg/L	17.4	5.35	3.42	2.43	2	10.4	22.5	10.8
Chloride	mg/L	17	18	14	14	14	18	19	25
Chromium	mg/L	0.021	0.019	0.005	0.006	0.03	0.005	0.003	0.001
Cobalt	mg/L	0.01	0.006	0.00344J	0.00299J	0.007	0.00406J	0.00475J	0.006
Combined Radium	pCi/L	2.465	4.21	2.065	6.01	4.83	3.65	2.02	2.707
Fluoride	mg/L	1U	1U	1U	0.3552J	1U	1U	1U	1U
Lead	mg/L	0.007	0.00437J	0.005U	0.00153J	0.007	0.005U	0.00124J	0.005U
Lithium	mg/L	0.001U	0.013	0.011	0.012	0.019	0.01	0.008	0.007
Mercury	mg/L	0.00006	0.00011	0.00002U	0.00001J	0.00007	0.00002J	0.00002J	0.00002U
Molybdenum	mg/L	0.00044J	0.005U	0.005U	0.005U	0.00058J	0.005U	0.005U	0.005U
Selenium	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Total Dissolved Solids	mg/L	162	114	104	116	142	128	140	160
Sulfate	mg/L	50	28	21	23	29	62	84	75
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U
pH	SU	4.7	4.6	4.0	3.6	4.3	4.7	3.5	4.8

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Component was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Component was detected in concentrations below the reporting limit
-: Not sampled

Table 3: Detection Monitoring Data Evaluation - Updated Background Prediction Limits
Pirkey Plant - Landfill

Geosyntec Consultants, Inc.

Parameter	Units	Description	AD-23						AD-34				
			8/23/2017	12/21/2017	3/21/2018	8/20/2018	2/28/2019	5/23/2019	8/23/2017	12/21/2017	3/21/2018	8/20/2018	2/28/2019
Boron	mg/L	Intrawell Background Value (UPL)	0.030						0.120				
		Detection Monitoring Result	**0.0402**	**0.0450**	0.0176	0.0170	0.0200	--	0.107	--	**0.171**	0.0670	0.080
Calcium	mg/L	Intrawell Background Value (UPL)	0.654						42.5				
		Detection Monitoring Result	0.276	0.469	0.227	0.247	0.300	--	36.2	--	40.1	37.0	39.9
Chloride	mg/L	Intrawell Background Value (UPL)	7.89						9.2				
		Detection Monitoring Result	6	--	4	**9**	6.94	--	7	8	6	**10**	7.64
Fluoride	mg/L	Intrawell Background Value (UPL)	1.00						1.00				
		Detection Monitoring Result	0.198	--	<0.083	<0.083	0.040	--	0.619	0.67	<0.083	<0.083	0.86
pH	SU	Intrawell Background Value (UPL)	4.8						4.3				
		Intrawell Background Value (LPL)	2.5						2.7				
		Detection Monitoring Result	4.1	--	3.9	3.8	**5.1**	4.8	3.7	--	3.7	3.7	2.9
Sulfate	mg/L	Intrawell Background Value (UPL)	15.8						1388				
		Detection Monitoring Result	11	--	10	11	7.2	--	1231	1020	956	1060	970
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	106						1587				
		Detection Monitoring Result	64.0	--	72.0	92.0	70.0	--	1128	1260	1420	1460	1470

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
<: Non-detect value. Parameters which were not detecteda re shown as less than the method detection limit (MDL).
Background values are shaded gray.
--: Not Sampled
Based on a 1-of-2 resampling, a statistically significant increase (SSI) is only identified when both samples in the detection monitoring period are above the UPL.
Based on a revised understanding of the site, the Appendix III prediction limits were recalculated for intrawell tests using the background dataset.

ATTACHMENT A
Revised Statistical Output

GROUNDWATER STATS
CONSULTING

January 8, 2020

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis of the groundwater data for American Electric Power Company's Pirkey Landfill. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, is listed below. Note that downgradient well AD-35 was originally in the well network but has been abandoned and replaced with a new well. No data are currently available from the new well but will be included in future analyses.

- **Upgradient wells:** AD-8, AD-12, AD-16 and AD-27; and
- **Downgradient wells:** AD-23 and AD-34

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS;
- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (see attached). Values previously flagged during the screening as outliers may be seen in a lighter font and disconnected symbol on the time series graphs. A summary of flagged values follows this letter (see attached).

Evaluation of Appendix III Parameters

Intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, calcium, chloride, fluoride, pH, sulfate and TDS. The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Intrawell prediction limits utilize the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the background data set will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. The summary table of those results follows this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable. Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site which is an

indication of natural variability in groundwater unrelated to practices at the site. When changing concentrations are noted upgradient of the facility, it is an indication that groundwater quality is changing naturally and unrelated to the facility.

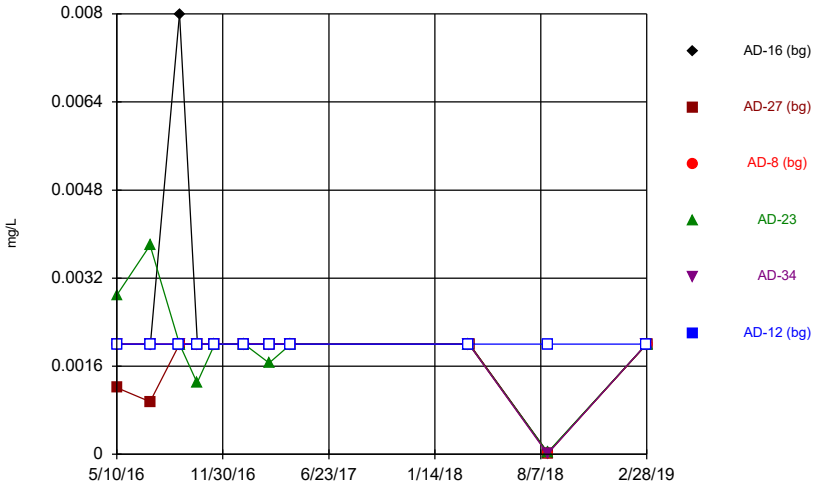
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Landfill. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

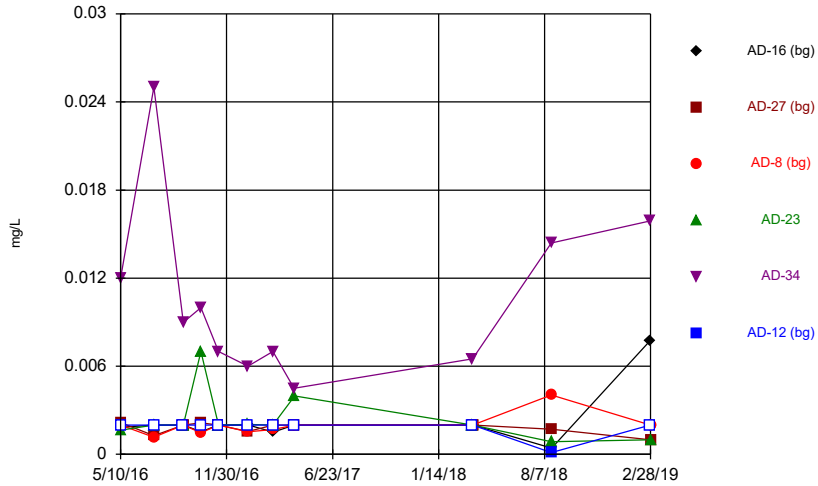
Time Series



Constituent: Antimony, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

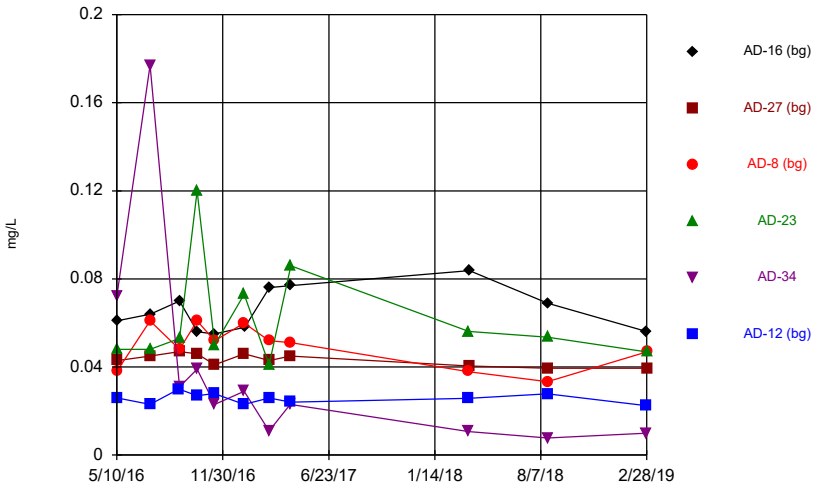
Time Series



Constituent: Arsenic, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

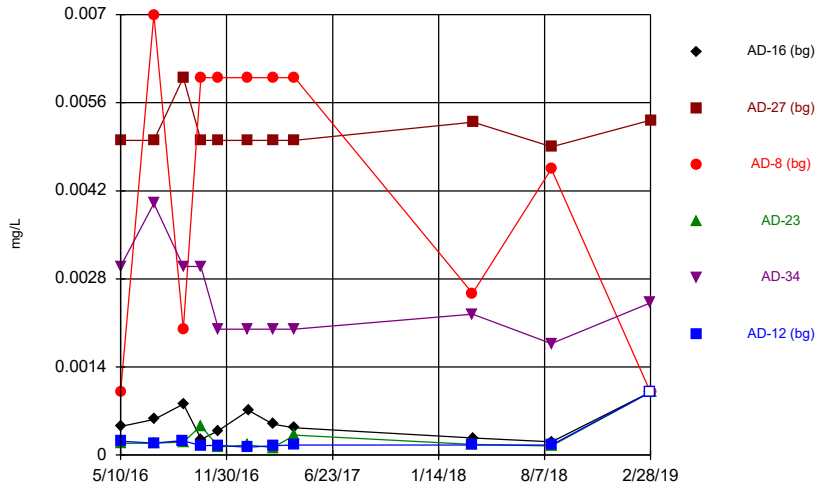
Time Series



Constituent: Barium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

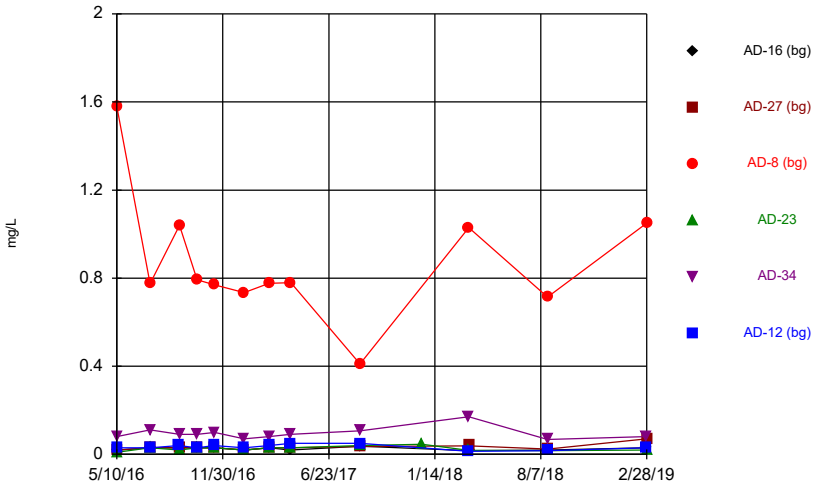
Time Series



Constituent: Beryllium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

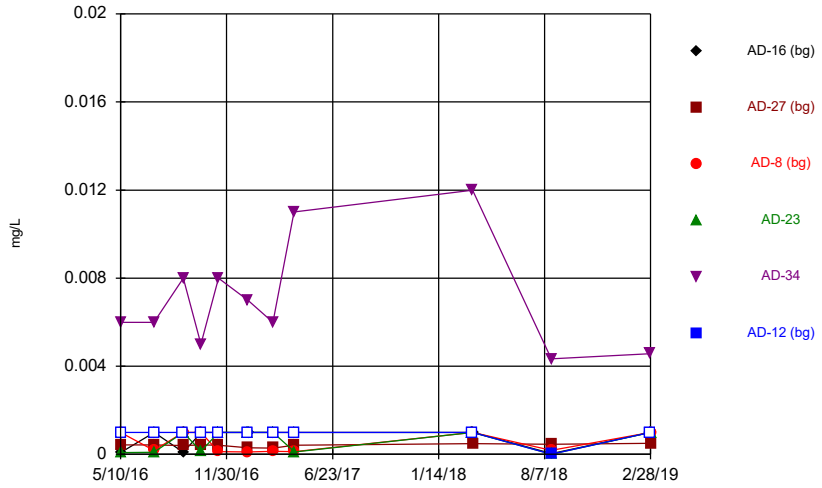
Time Series



Constituent: Boron, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

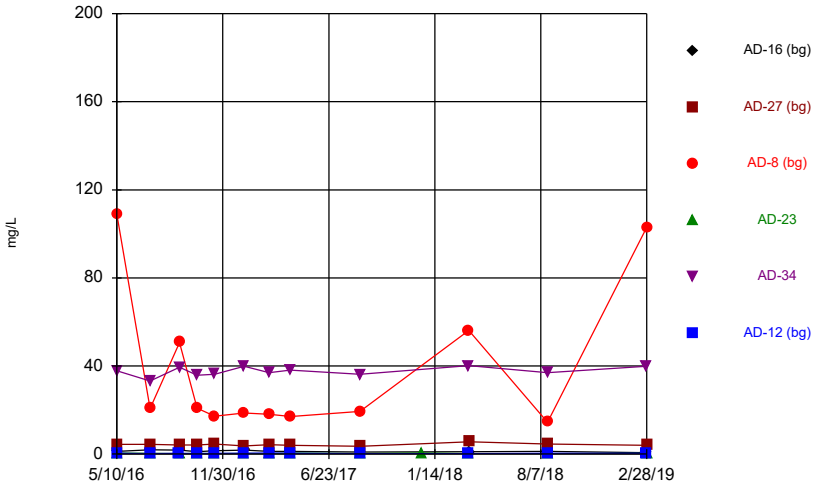
Time Series



Constituent: Cadmium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

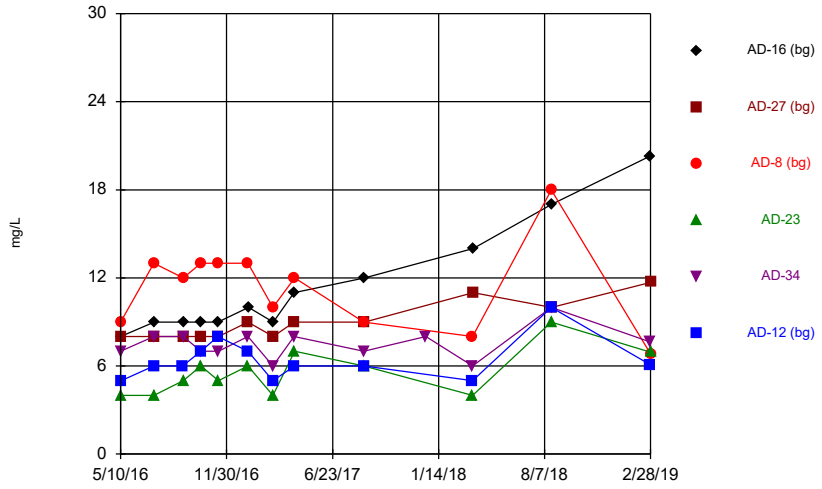
Time Series



Constituent: Calcium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

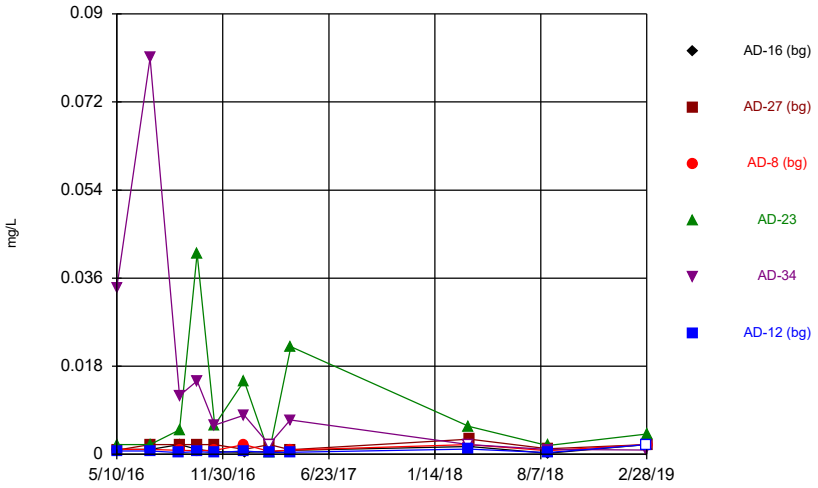
Time Series



Constituent: Chloride, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

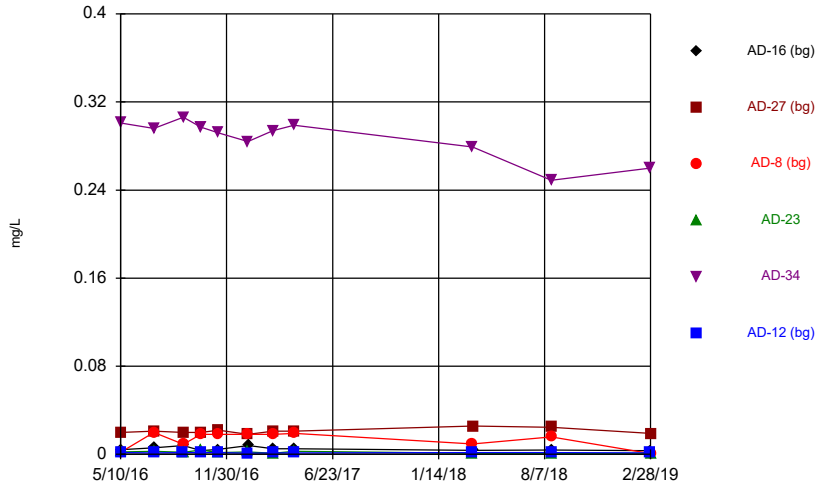
Time Series



Constituent: Chromium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

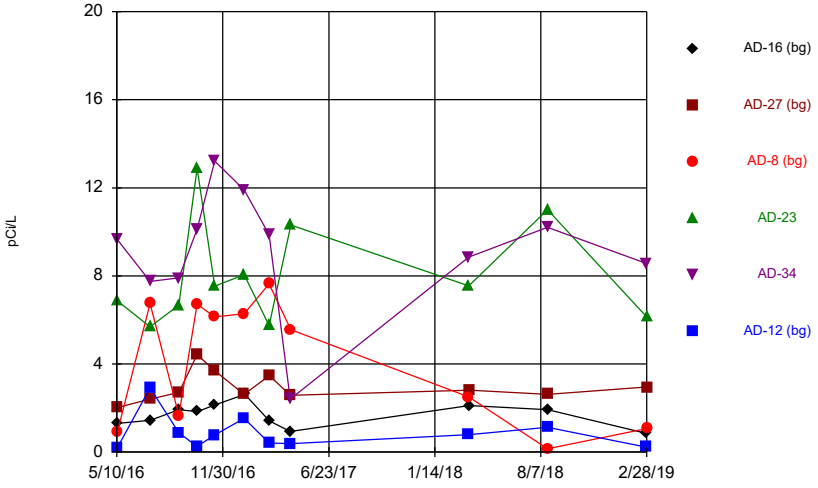
Time Series



Constituent: Cobalt, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

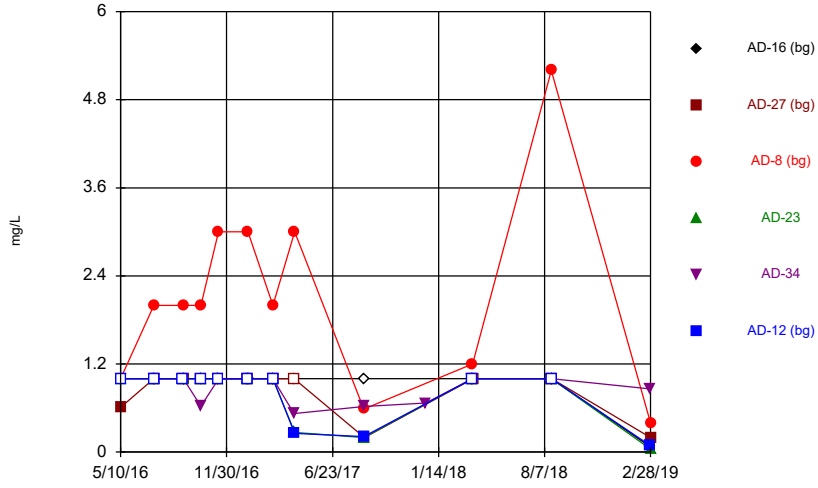
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

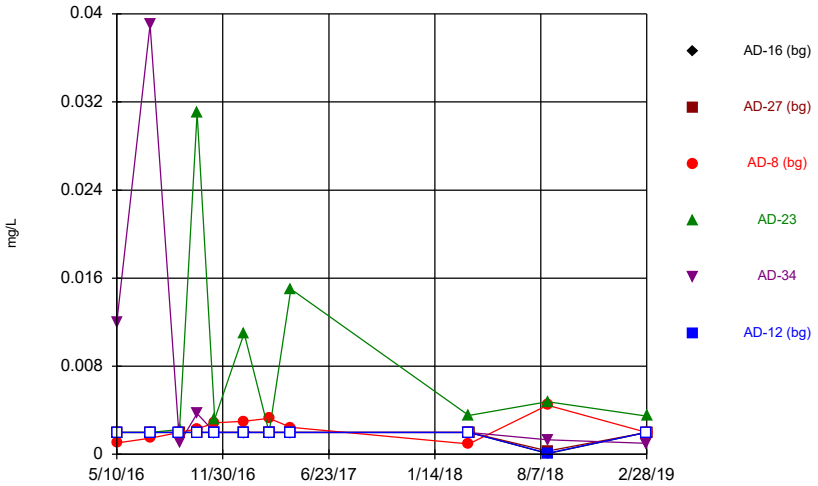
Time Series



Constituent: Fluoride, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

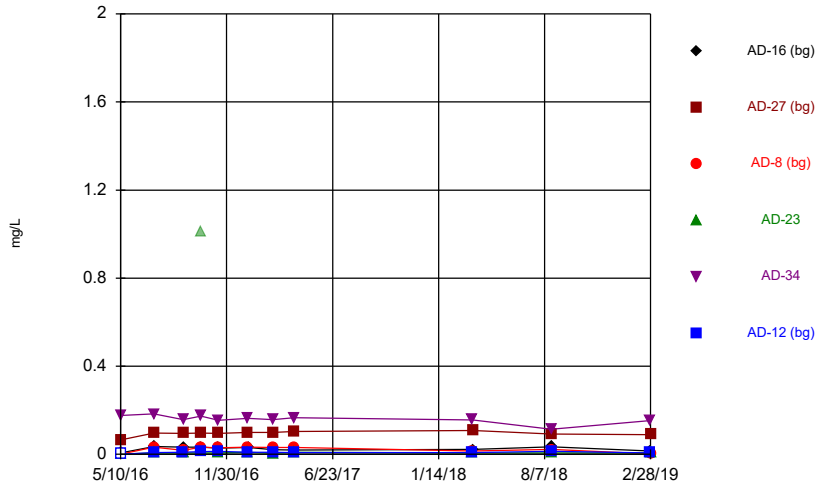
Time Series



Constituent: Lead, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

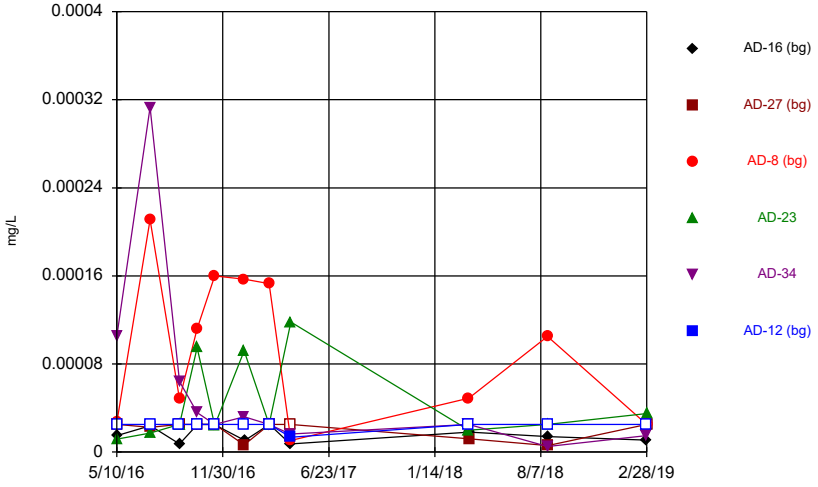
Time Series



Constituent: Lithium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

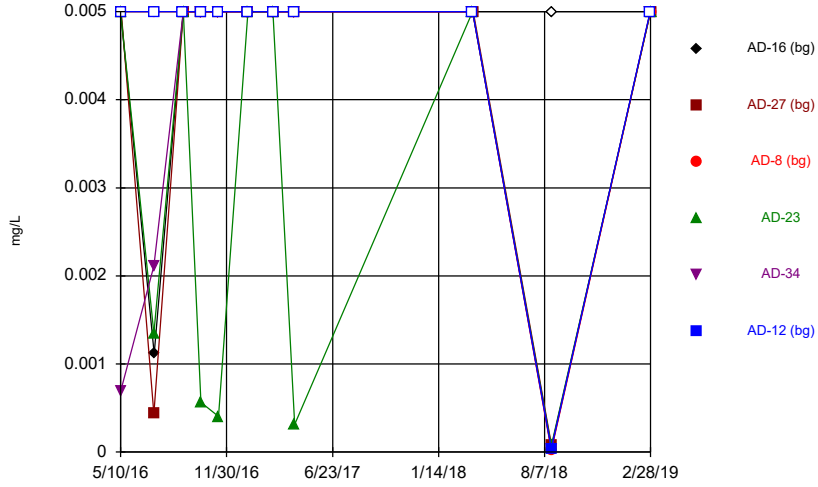
Time Series



Constituent: Mercury, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

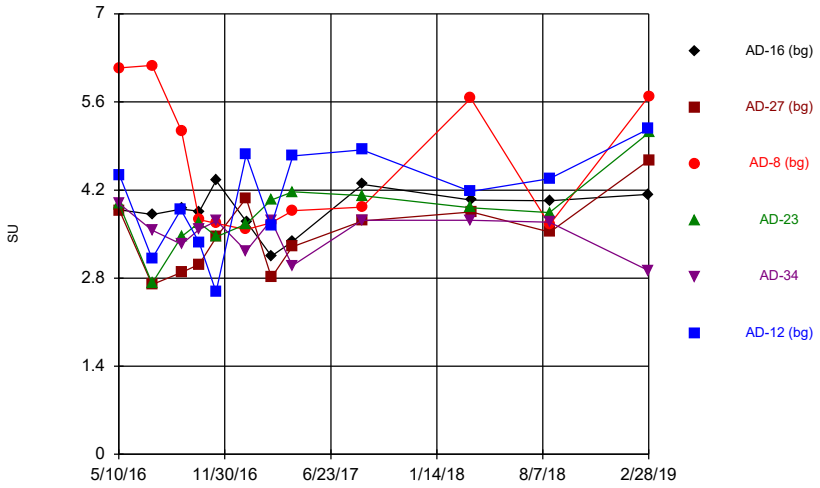
Time Series



Constituent: Molybdenum, total Analysis Run 9/5/2019 1:37 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

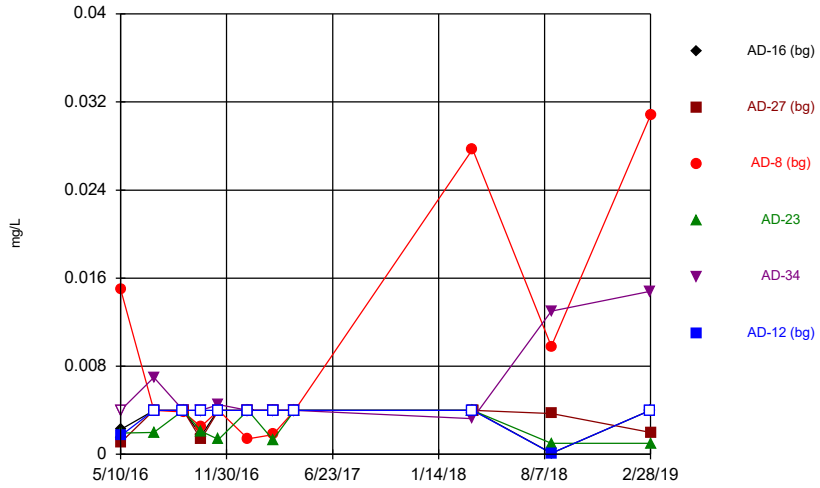
Time Series



Constituent: pH, field Analysis Run 9/5/2019 1:37 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

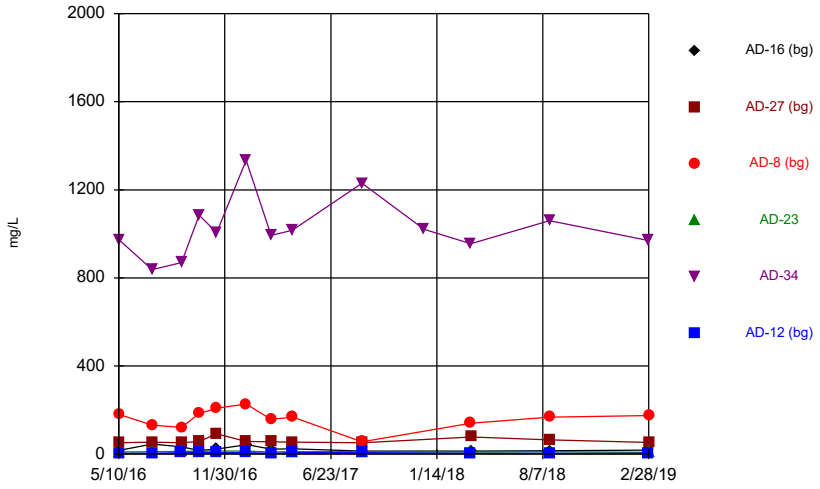
Time Series



Constituent: Selenium, total Analysis Run 9/5/2019 1:37 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

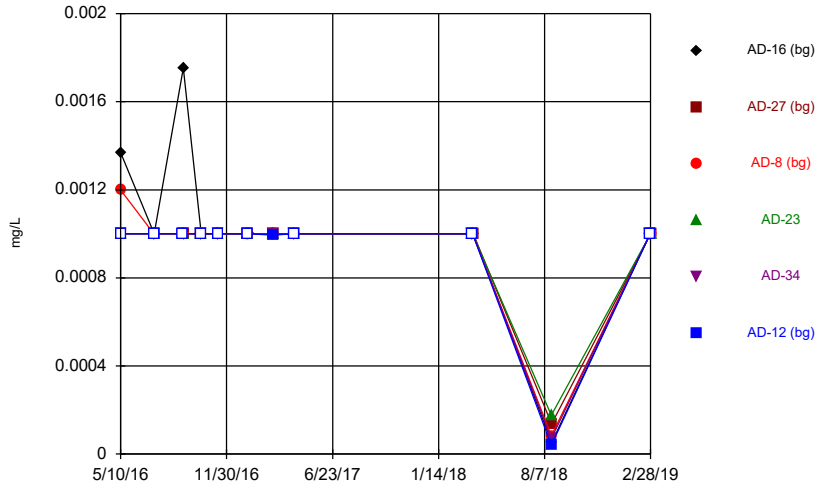
Time Series



Constituent: Sulfate, total Analysis Run 9/5/2019 1:37 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

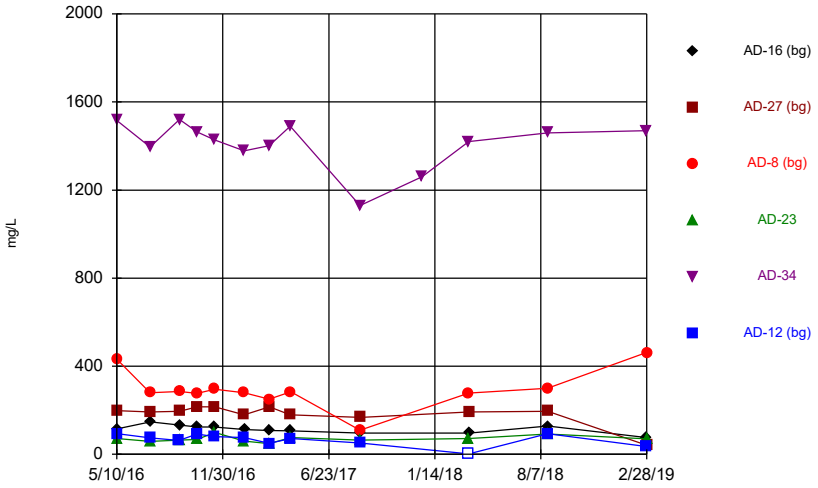
Time Series



Constituent: Thallium, total Analysis Run 9/5/2019 1:37 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:37 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Outlier Summary

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 9/5/2019, 1:41 PM

	AD-23 Lithium, total (mg/L)
10/12/2016	1.01 (o)

Intrawell Prediction Limit Summary - All Results

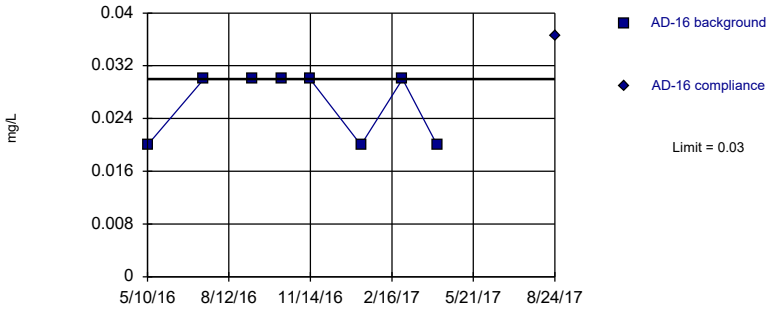
Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 11/26/2019, 8:05 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-16**	**0.03**	**n/a**	**8/24/2017**	**0.0365**	**Yes**	**8**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.02144**	**NP Intra (normality) 1 of 2**
Boron, total (mg/L)	**AD-27**	**0.03**	**n/a**	**8/24/2017**	**0.0358**	**Yes**	**8**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.02144**	**NP Intra (normality) 1 of 2**
Boron, total (mg/L)	AD-8	1.58	n/a	8/23/2017	0.411	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Boron, total (mg/L)	**AD-23**	**0.03**	**n/a**	**8/23/2017**	**0.0402**	**Yes**	**8**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.02144**	**NP Intra (normality) 1 of 2**
Boron, total (mg/L)	AD-34	0.1201	n/a	8/23/2017	0.107	No	8	0.08888	0.01271	0	None	No	0.002505	Param Intra 1 of 2
Boron, total (mg/L)	AD-35	0.1433	n/a	8/23/2017	0.0413	No	8	0.07275	0.02871	0	None	No	0.002505	Param Intra 1 of 2
Boron, total (mg/L)	AD-12	0.05454	n/a	8/23/2017	0.0495	No	8	0.03625	0.00744	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-16	2.318	n/a	8/24/2017	0.945	No	8	1.504	0.3311	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-27	4.848	n/a	8/24/2017	3.58	No	8	4.21	0.2595	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-8	109	n/a	8/23/2017	19.4	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Calcium, total (mg/L)	AD-23	0.6535	n/a	8/23/2017	0.276	No	8	0.3451	0.1255	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-34	42.53	n/a	8/23/2017	36.2	No	8	37.21	2.163	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-35	27.73	n/a	8/23/2017	4.33	No	8	9.288	7.502	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-12	0.4631	n/a	8/23/2017	0.245	No	8	0.3269	0.05542	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	**AD-16**	**11.43**	**n/a**	**8/24/2017**	**12**	**Yes**	**8**	**9.25**	**0.8864**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Chloride, total (mg/L)	AD-27	9	n/a	8/24/2017	9	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Chloride, total (mg/L)	AD-8	15.69	n/a	8/23/2017	9	No	8	11.88	1.553	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-23	7.893	n/a	8/23/2017	6	No	8	5.125	1.126	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-34	9.204	n/a	8/23/2017	7	No	8	7.375	0.744	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-35	26.47	n/a	8/23/2017	16	No	8	17.38	3.701	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-12	8.794	n/a	8/23/2017	6	No	8	6.25	1.035	0	None	No	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-16	1	n/a	8/24/2017	1ND	No	8	n/a	n/a	100	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-27	1	n/a	8/24/2017	0.197	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-8	3.988	n/a	8/23/2017	0.587	No	8	2.25	0.7071	12.5	None	No	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-23	1	n/a	8/23/2017	0.198	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-34	1	n/a	8/23/2017	0.619	No	8	n/a	n/a	62.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-35	1	n/a	8/23/2017	1ND	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-12	1	n/a	8/23/2017	0.213	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
pH, field (SU)	AD-16	4.644	2.864	8/24/2017	4.29	No	8	3.754	0.3622	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-27	4.51	2.022	8/24/2017	3.71	No	8	3.266	0.506	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-8	7.306	1.689	8/23/2017	3.93	No	8	4.498	1.143	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-23	4.776	2.519	8/23/2017	4.11	No	8	3.648	0.4592	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-34	4.285	2.745	8/23/2017	3.72	No	8	3.515	0.3135	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-35	5.552	3.02	8/23/2017	4.86	No	8	4.286	0.515	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-12	5.764	1.866	8/23/2017	4.84	No	8	3.815	0.7928	0	None	No	0.001253	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-16	55.68	n/a	8/24/2017	14	No	8	27.75	11.36	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-27	92	n/a	8/24/2017	52	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Sulfate, total (mg/L)	AD-8	261.3	n/a	8/23/2017	56	No	8	172.3	36.21	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-23	15.77	n/a	8/23/2017	11	No	8	11.63	1.685	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-34	1388	n/a	8/23/2017	1230	No	8	1014	151.9	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-35	107.6	n/a	8/23/2017	35	No	8	46.5	24.85	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-12	9.636	n/a	8/23/2017	6	No	8	5.75	1.581	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-16	156	n/a	8/24/2017	96	No	8	121.4	14.09	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-27	237	n/a	8/24/2017	168	No	8	199.3	15.34	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-8	432	n/a	8/23/2017	110	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-23	106.3	n/a	8/23/2017	64	No	8	68.38	15.42	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-34	1587	n/a	8/23/2017	1130	No	8	1449	55.98	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-35	185.9	n/a	8/23/2017	92	No	8	133.3	21.43	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	110.7	n/a	8/23/2017	52	No	8	75.25	14.41	0	None	No	0.002505	Param Intra 1 of 2

Exceeds Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

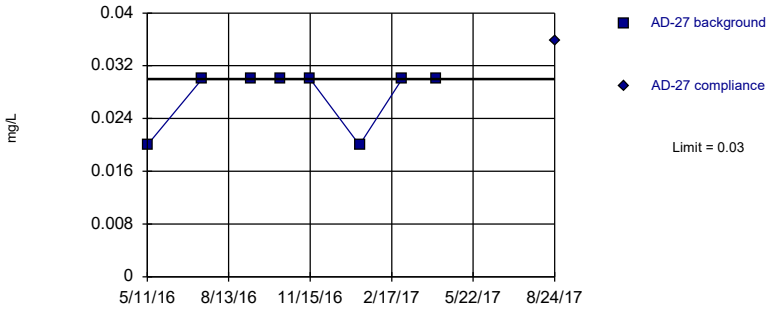
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

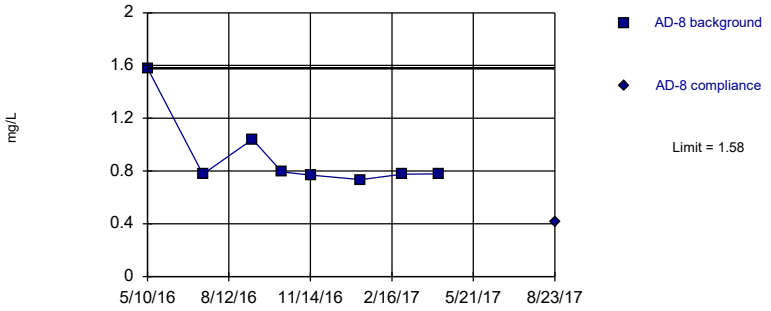
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

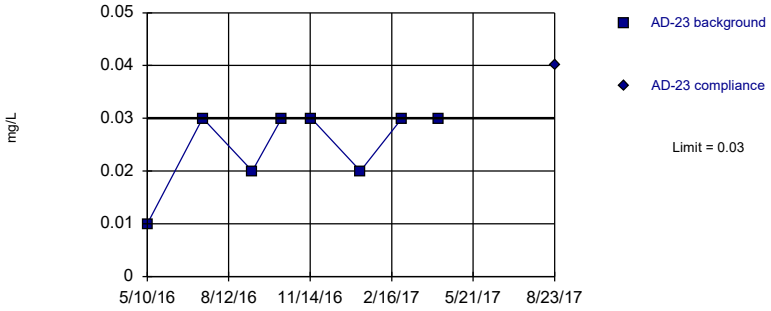
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

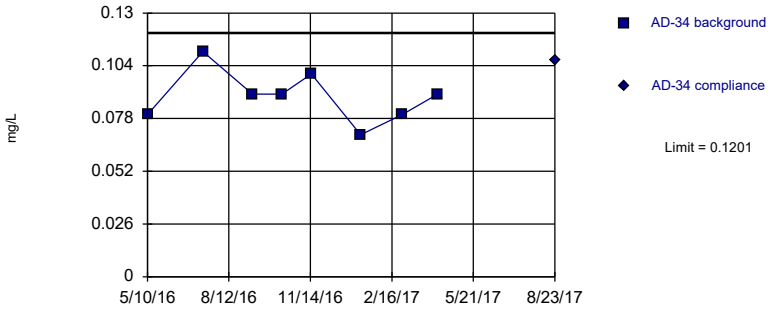
Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.08888, Std. Dev.=0.01271, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9562, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

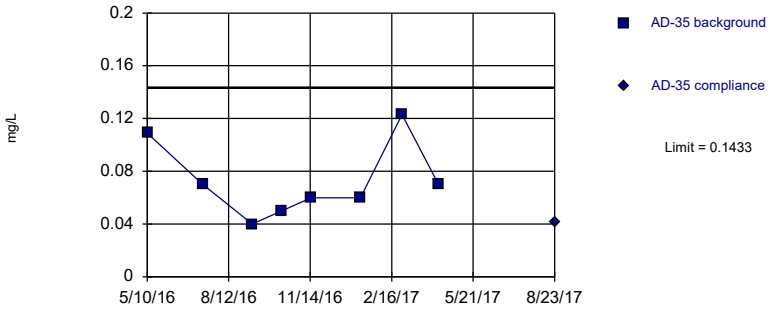
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.07275, Std. Dev.=0.02871, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8787, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

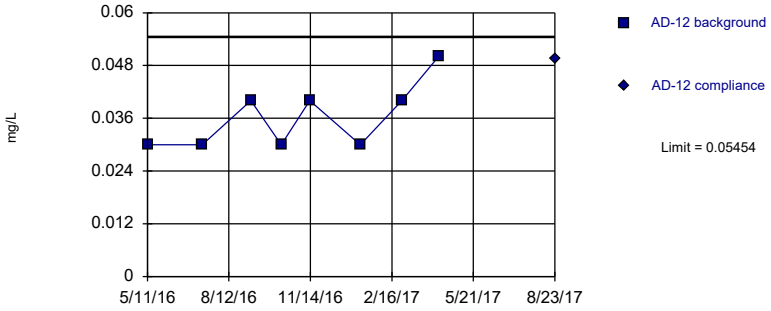
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.03625, Std. Dev.=0.00744, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7968, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

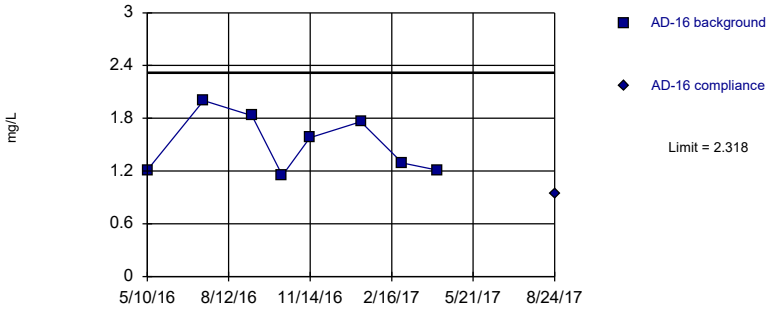
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1.504, Std. Dev.=0.3311, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8818, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

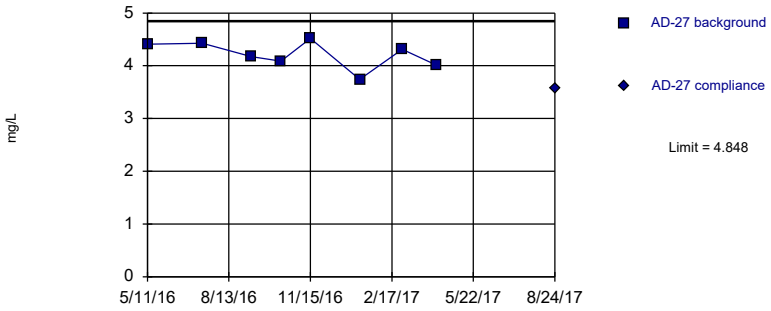
Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.21, Std. Dev.=0.2595, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9482, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

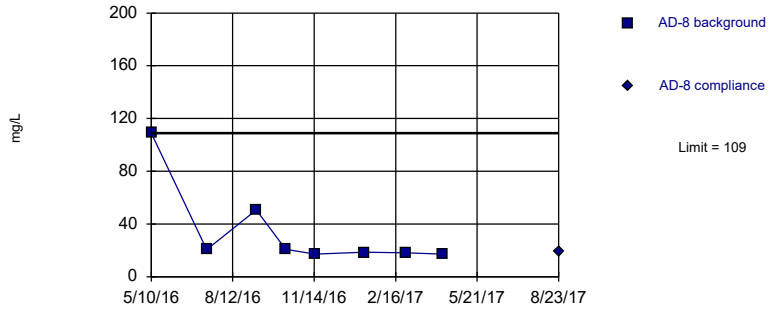
Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

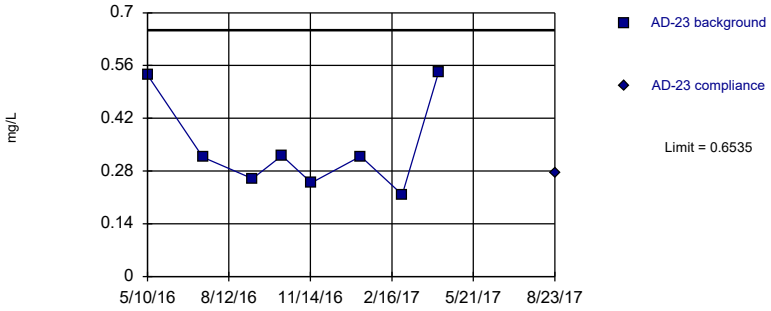
Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.3451, Std. Dev.=0.1255, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.809, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

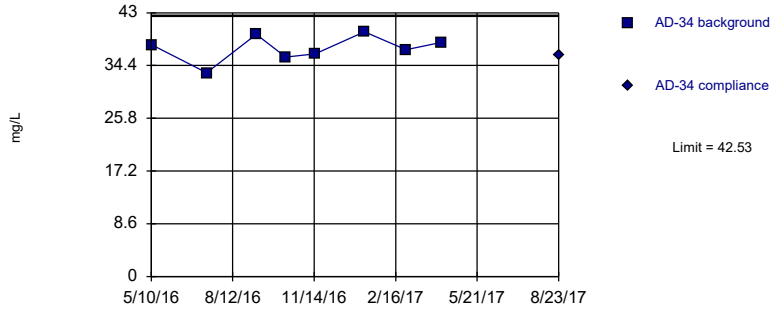
Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



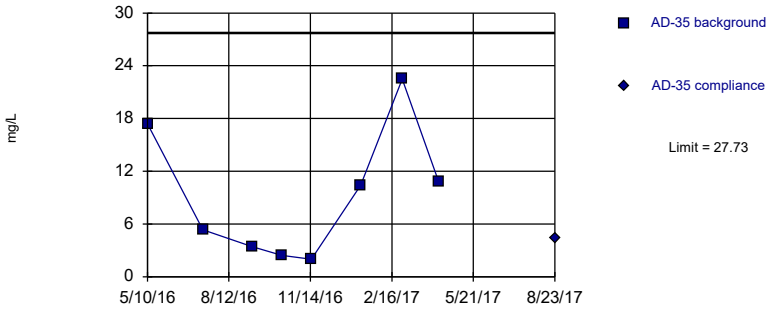
Background Data Summary: Mean=37.21, Std. Dev.=2.163, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9581, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=9.288, Std. Dev.=7.502, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8888, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

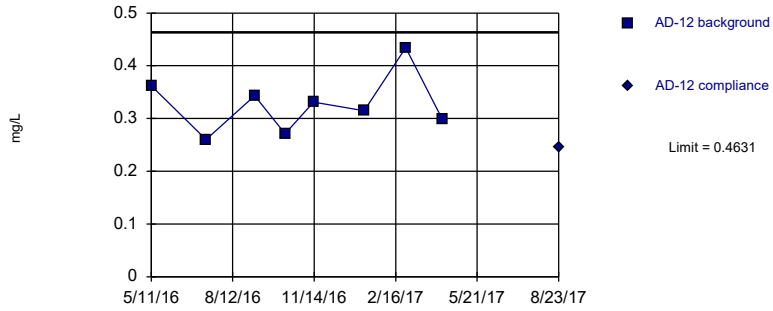
Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.3269, Std. Dev.=0.05542, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9467, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

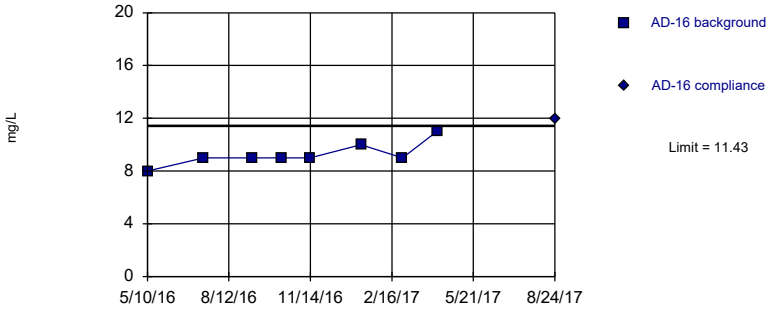
Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=9.25, Std. Dev.=0.8864, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8264, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

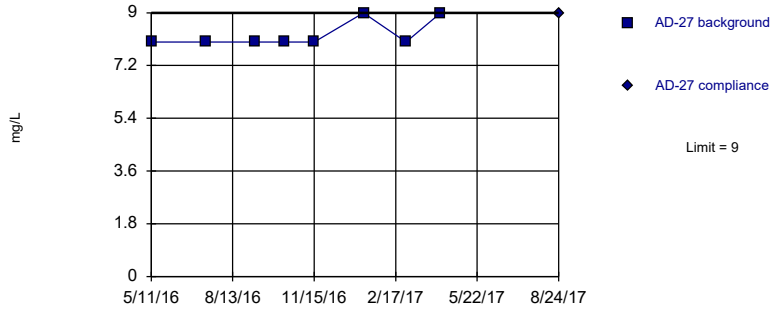
Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

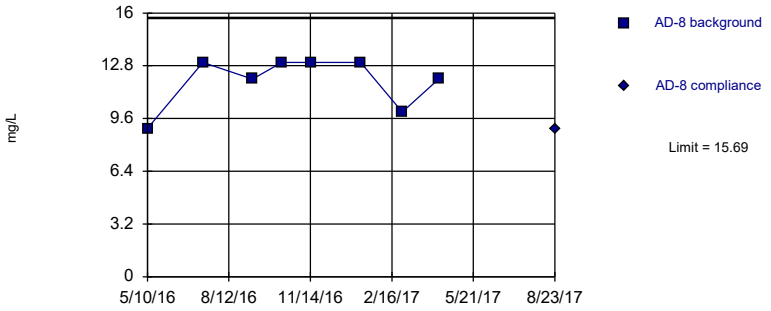
Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=11.88, Std. Dev.=1.553, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7682, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

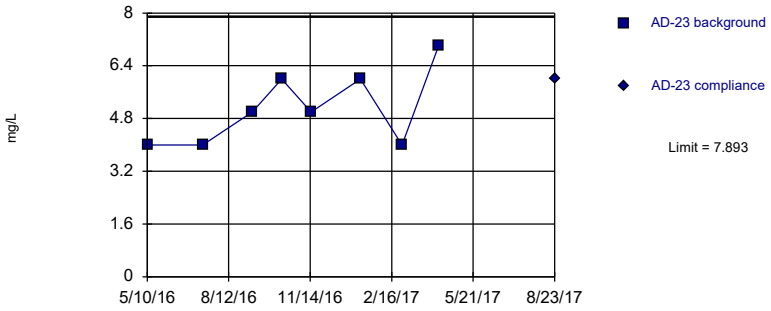
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.125, Std. Dev.=1.126, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8815, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

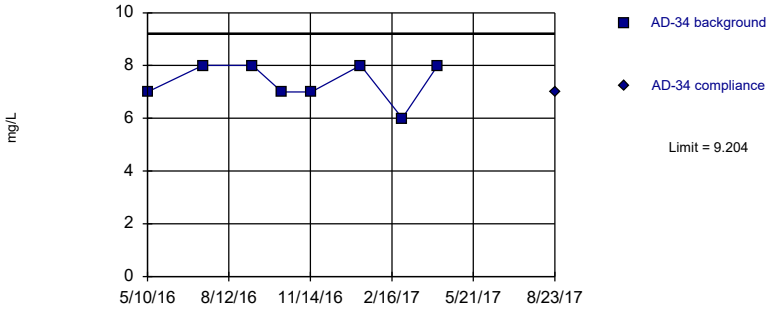
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=7.375, Std. Dev.=0.744, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7968, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

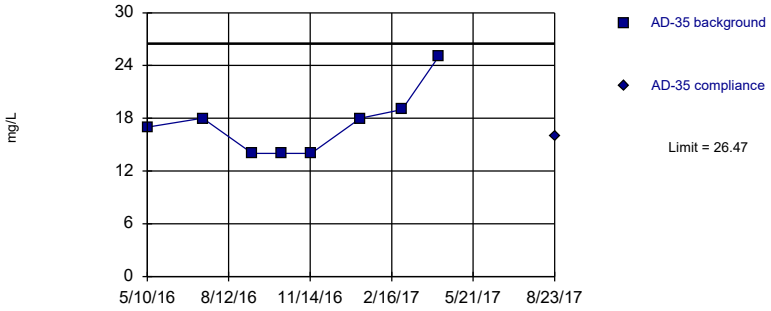
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=17.38, Std. Dev.=3.701, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8434, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

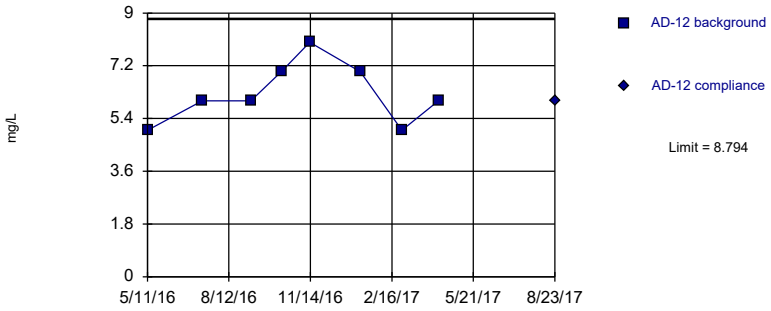
Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=6.25, Std. Dev.=1.035, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9171, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

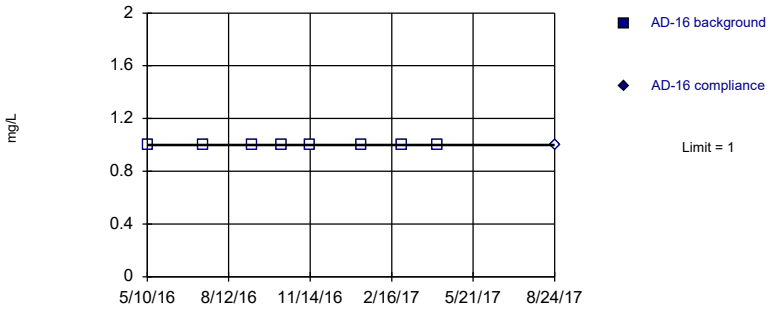
Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 8) were censored; limit is most recent reporting limit. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

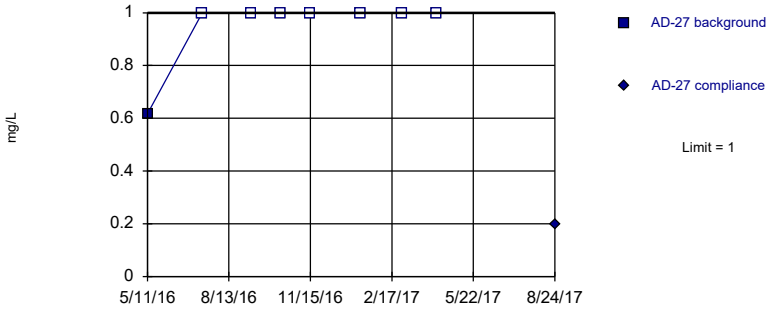
Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

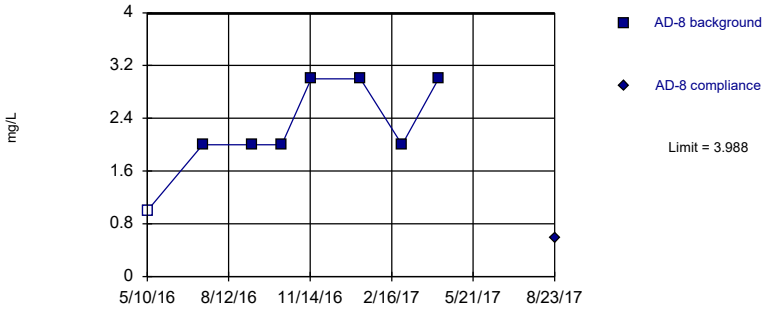
Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=2.25, Std. Dev.=0.7071, n=8, 12.5% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8268, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

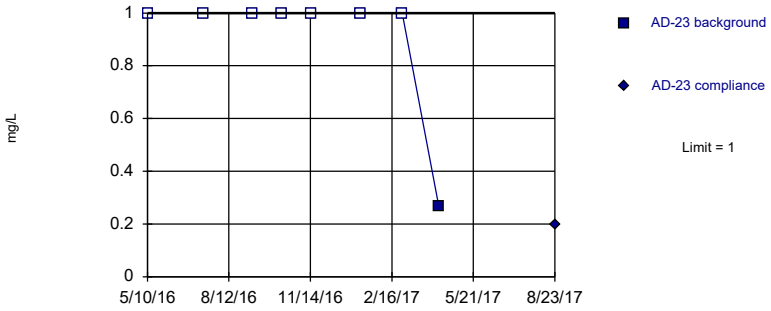
Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

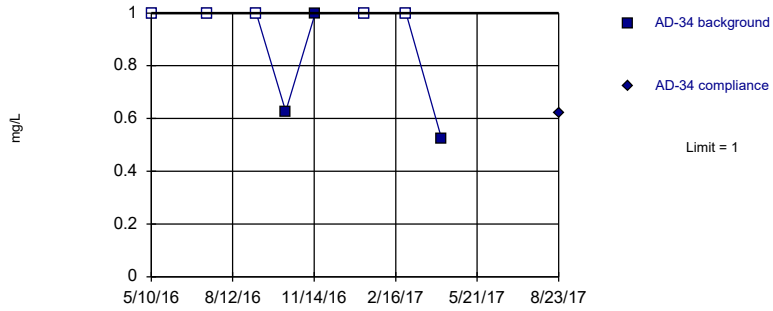
Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 62.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

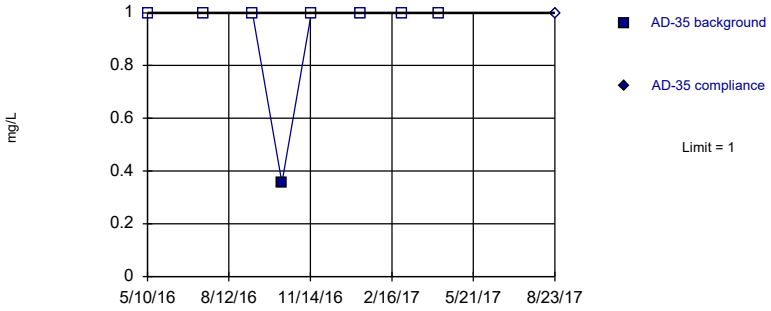
Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

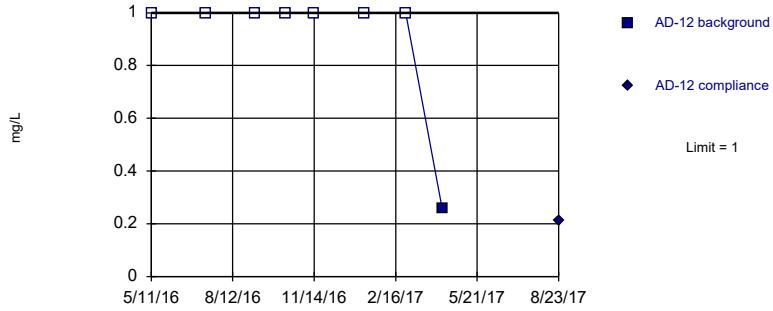
Constituent: Fluoride, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



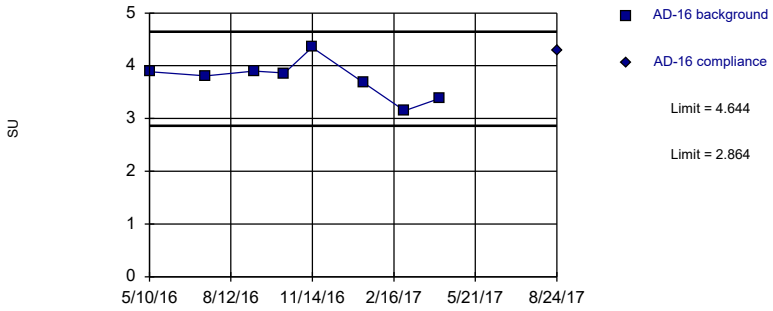
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.754, Std. Dev.=0.3622, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9388, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

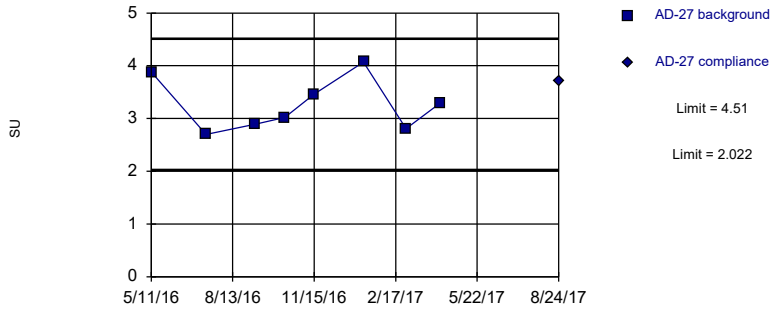
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.266, Std. Dev.=0.506, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.918, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

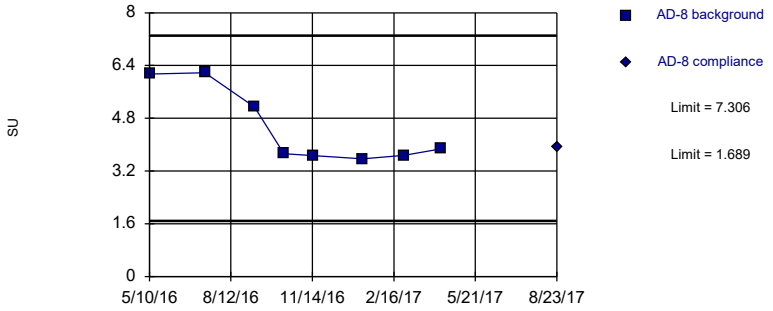
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.498, Std. Dev.=1.143, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7532, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

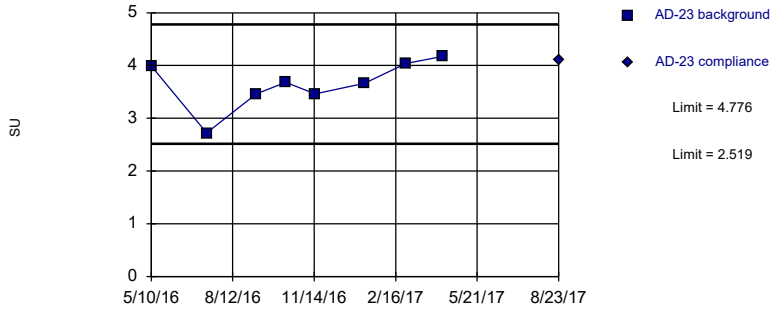
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.648, Std. Dev.=0.4592, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.903, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

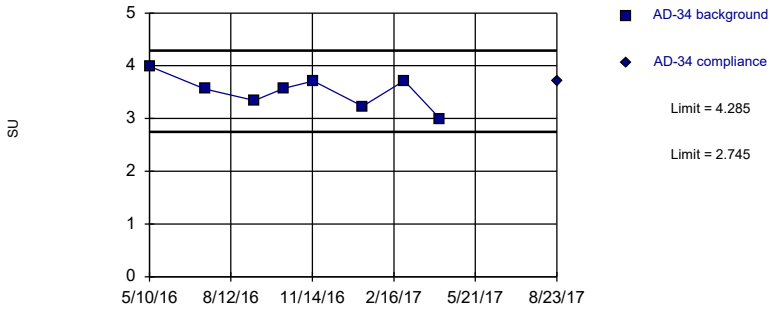
Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.515, Std. Dev.=0.3135, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9758, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

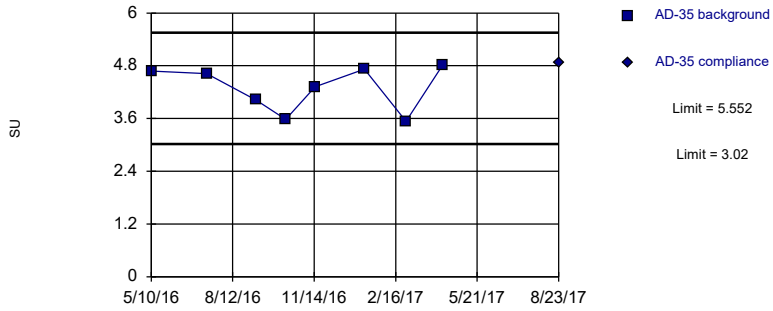
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.286, Std. Dev.=0.515, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8567, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

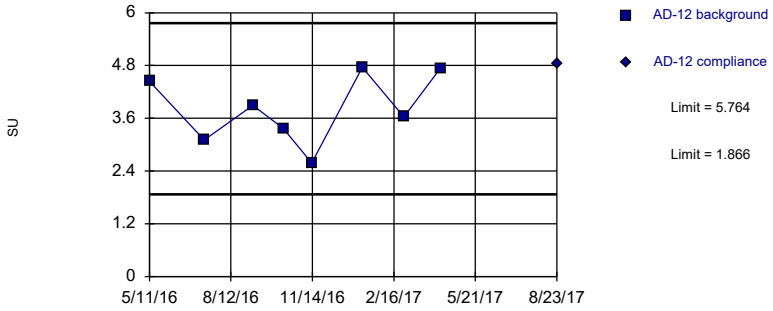
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.815, Std. Dev.=0.7928, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

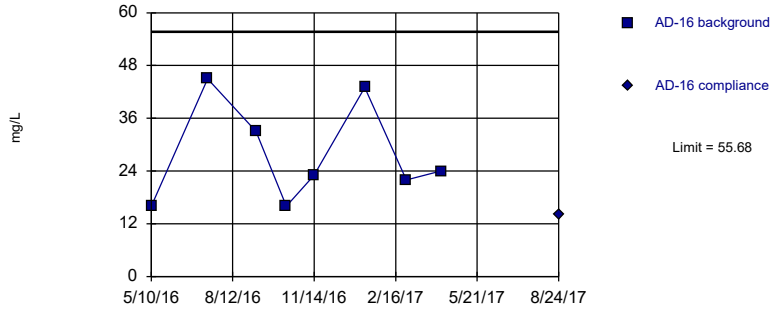
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=27.75, Std. Dev.=11.36, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8719, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

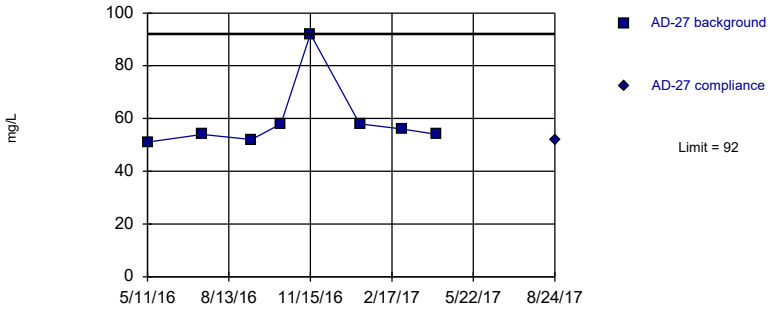
Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

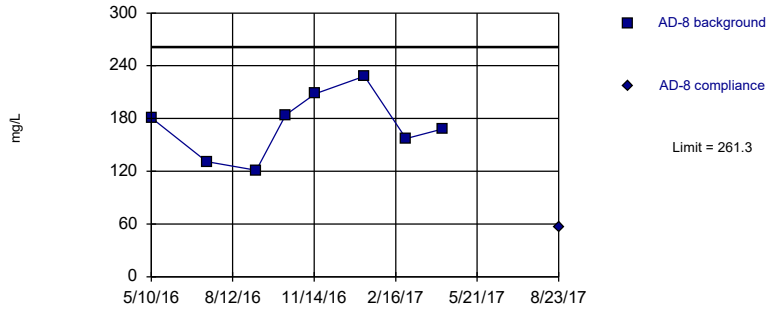
Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=172.3, Std. Dev.=36.21, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.974, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

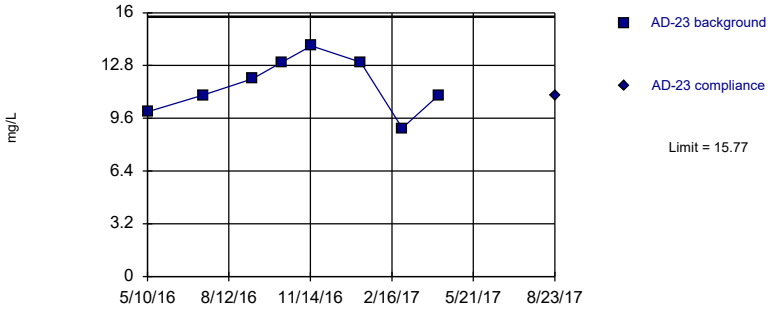
Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=11.63, Std. Dev.=1.685, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9652, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

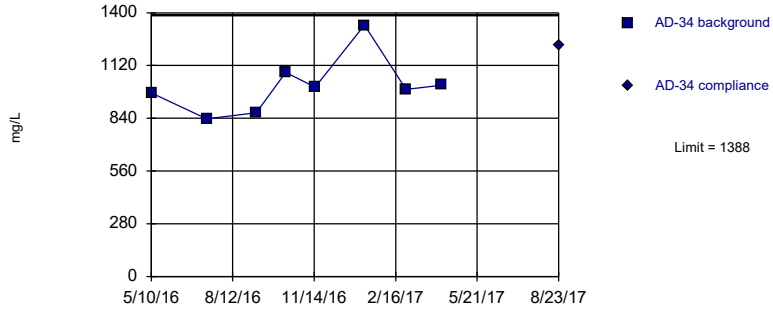
Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



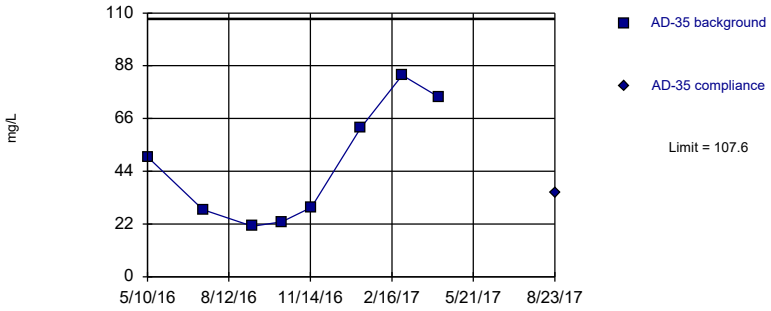
Background Data Summary: Mean=1014, Std. Dev.=151.9, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8781, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=46.5, Std. Dev.=24.85, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8804, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

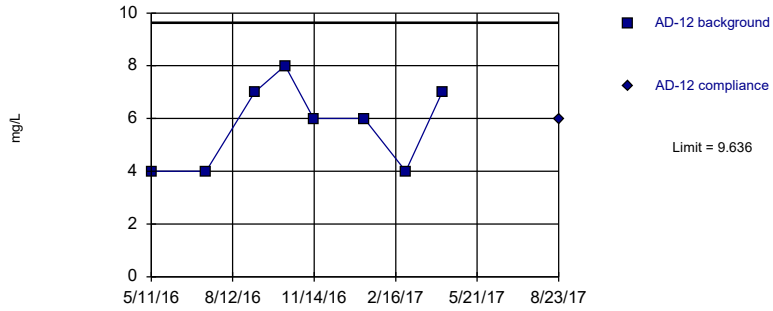
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.75, Std. Dev.=1.581, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.866, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

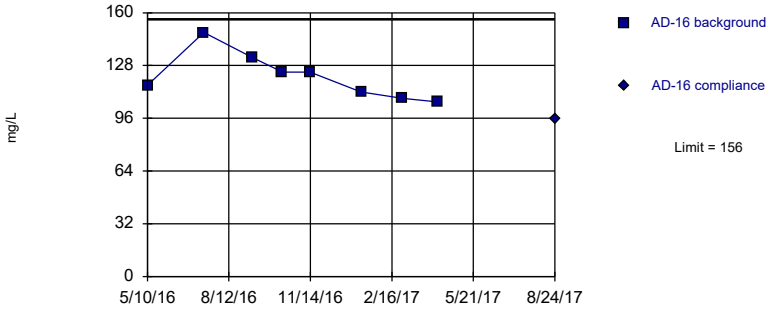
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=121.4, Std. Dev.=14.09, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9257, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

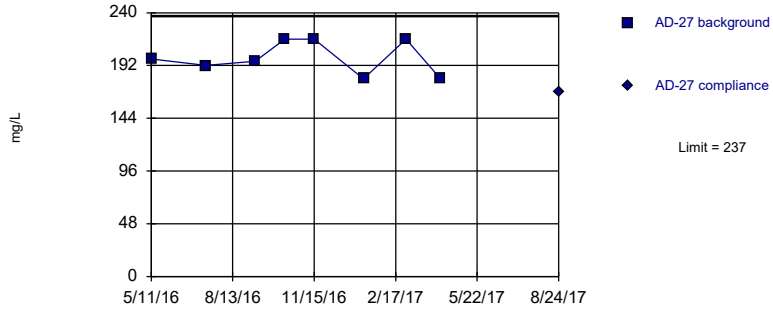
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=199.3, Std. Dev.=15.34, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8523, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

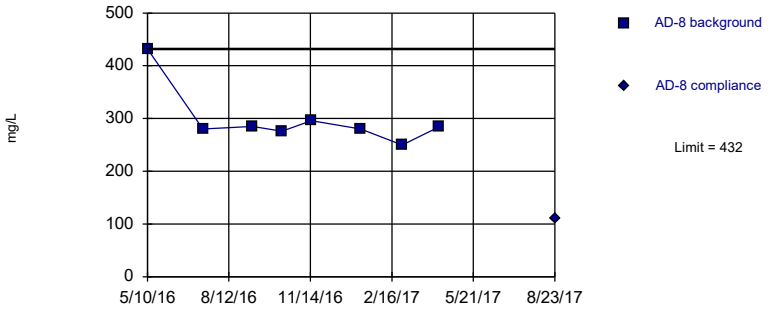
Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

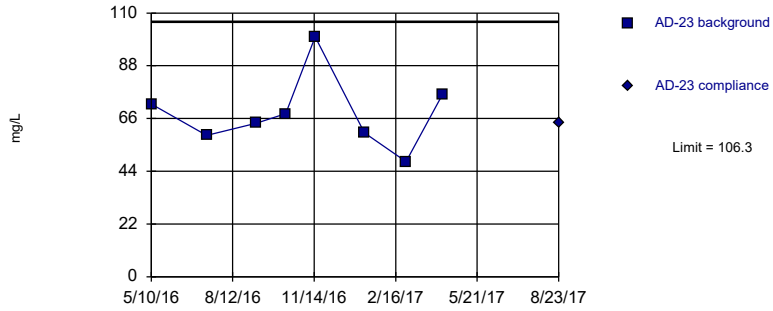
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=68.38, Std. Dev.=15.42, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9219, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

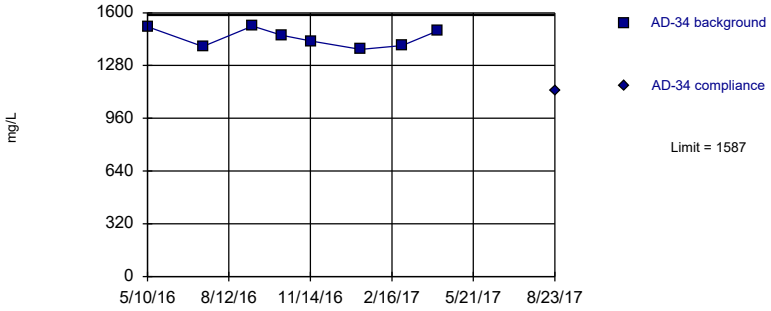
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1449, Std. Dev.=55.98, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9097, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

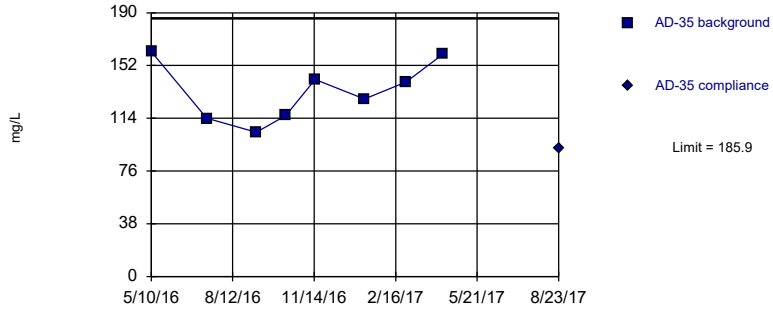
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=133.3, Std. Dev.=21.43, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.936, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

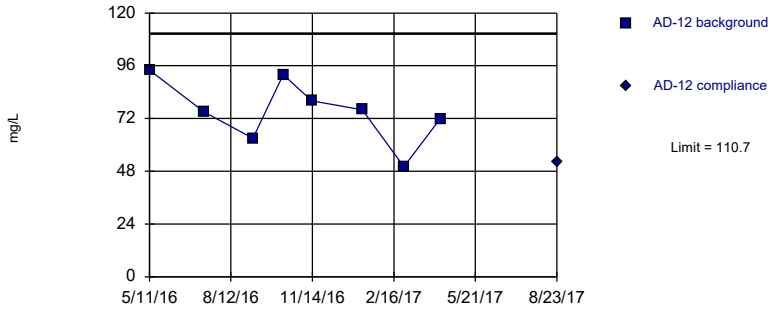
Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=75.25, Std. Dev.=14.41, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9549, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Trend Test Summary Table - Signfiicant Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 9/5/2019, 1:43 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Chloride, total (mg/L)	**AD-16 (bg)**	**3.476**	**54**	**38**	**Yes**	**12**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride, total (mg/L)	**AD-27 (bg)**	**1.144**	**44**	**38**	**Yes**	**12**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Total Dissolved Solids [TDS] (mg/L)	**AD-16 (bg)**	**-20.86**	**-40**	**-38**	**Yes**	**12**	**0**	**n/a**	**n/a**	**0.01**	**NP**

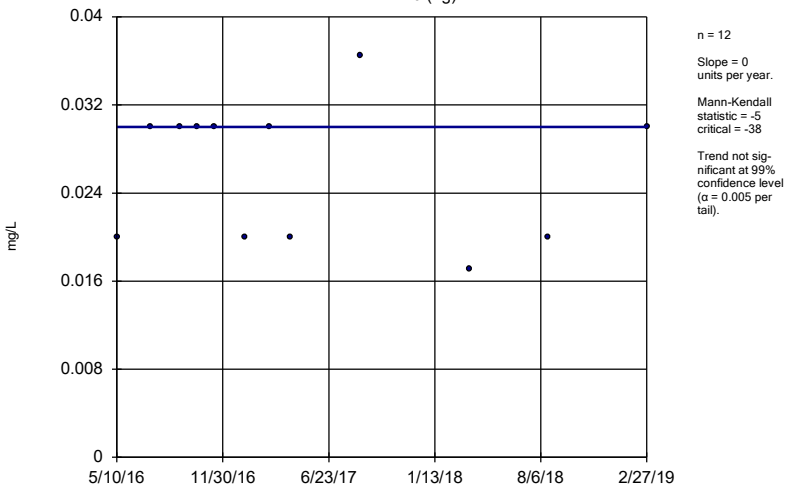
Trend Test Summary Table - All Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 9/5/2019, 1:43 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-16 (bg)	0	-5	-38	No	12	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-27 (bg)	0.005714	26	38	No	12	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-8 (bg)	-0.03662	-12	-38	No	12	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0	-1	-38	No	12	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	**AD-16 (bg)**	**3.476**	**54**	**38**	**Yes**	**12**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride, total (mg/L)	**AD-27 (bg)**	**1.144**	**44**	**38**	**Yes**	**12**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride, total (mg/L)	AD-8 (bg)	-1.386	-16	-38	No	12	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.01522	10	38	No	12	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-16 (bg)	0	-11	-38	No	12	91.67	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-27 (bg)	0	-6	-38	No	12	75	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-8 (bg)	0	1	38	No	12	8.333	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-12 (bg)	0	-22	-38	No	12	75	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-16 (bg)	-3.711	-23	-38	No	12	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-27 (bg)	1.909	11	38	No	12	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-8 (bg)	-1.069	-1	-38	No	12	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-34	31.48	14	43	No	13	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.565	-18	-38	No	12	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	**AD-16 (bg)**	**-20.86**	**-40**	**-38**	**Yes**	**12**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Total Dissolved Solids [TDS] (mg/L)	AD-27 (bg)	-16.41	-22	-38	No	12	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-8 (bg)	-0.5925	-1	-38	No	12	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-34	-23.3	-12	-43	No	13	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-20.7	-27	-38	No	12	8.333	n/a	n/a	0.01	NP

Sen's Slope Estimator

AD-16 (bg)



n = 12

Slope = 0 units per year.

Mann-Kendall statistic = -5 critical = -38

Trend not significant at 99% confidence level (α = 0.005 per tail).

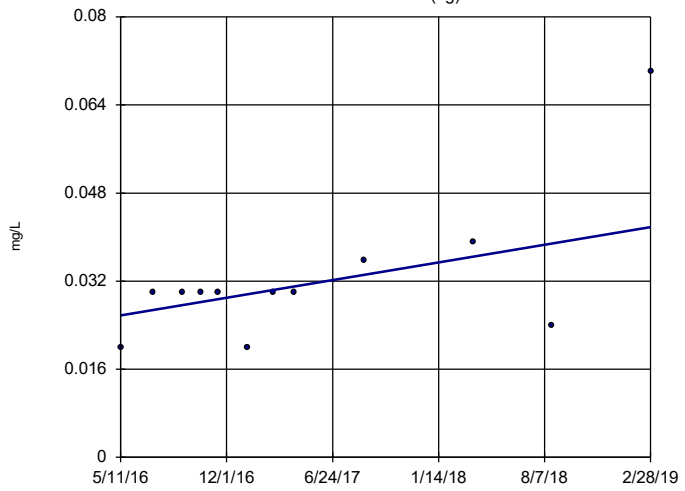
Constituent: Boron, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 12

Slope = 0.005714 units per year.

Mann-Kendall statistic = 26 critical = 38

Trend not significant at 99% confidence level (α = 0.005 per tail).

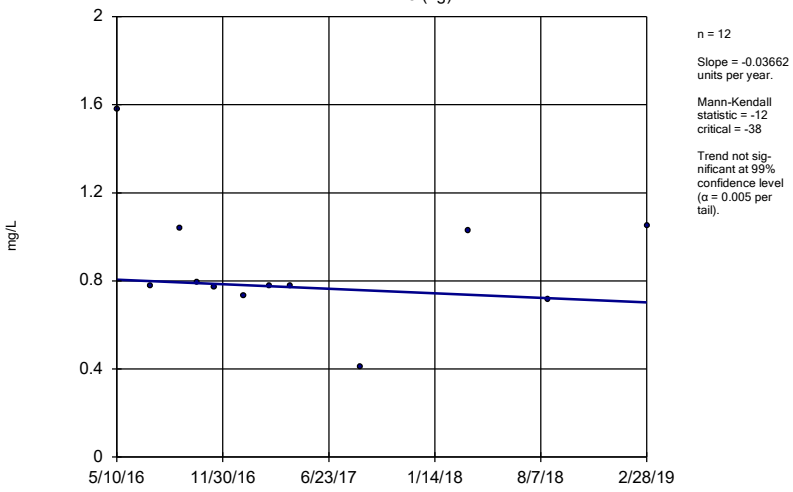
Constituent: Boron, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 12

Slope = -0.03662 units per year.

Mann-Kendall statistic = -12 critical = -38

Trend not significant at 99% confidence level (α = 0.005 per tail).

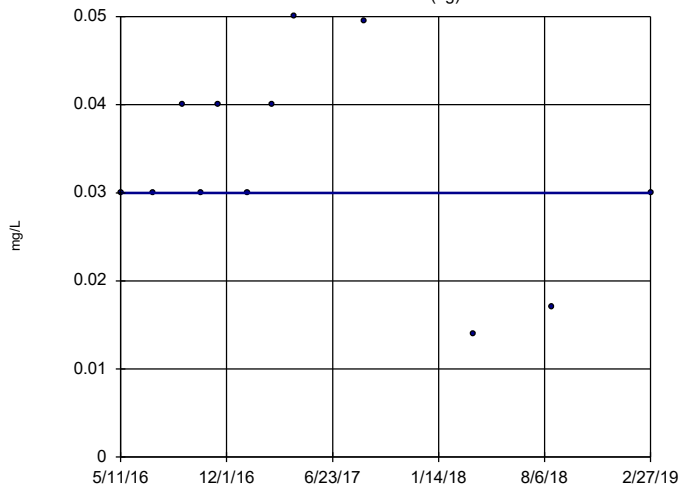
Constituent: Boron, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 12

Slope = 0 units per year.

Mann-Kendall statistic = -1 critical = -38

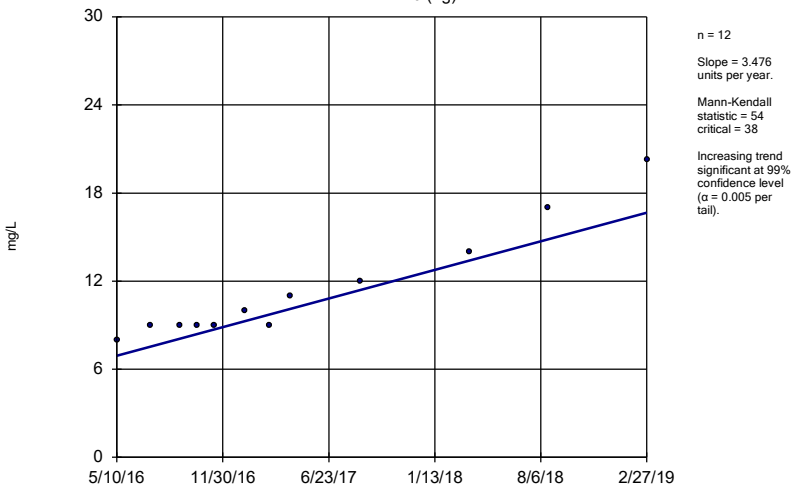
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-16 (bg)



n = 12

Slope = 3.476 units per year.

Mann-Kendall statistic = 54 critical = 38

Increasing trend significant at 99% confidence level (α = 0.005 per tail).

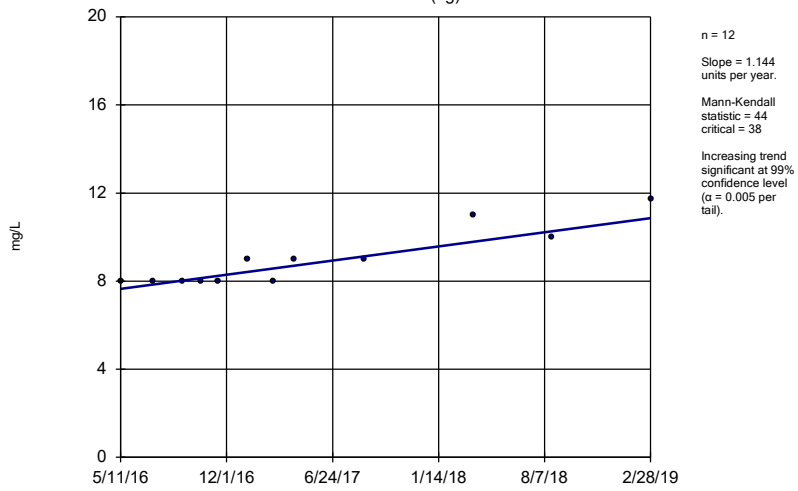
Constituent: Chloride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 12

Slope = 1.144 units per year.

Mann-Kendall statistic = 44 critical = 38

Increasing trend significant at 99% confidence level (α = 0.005 per tail).

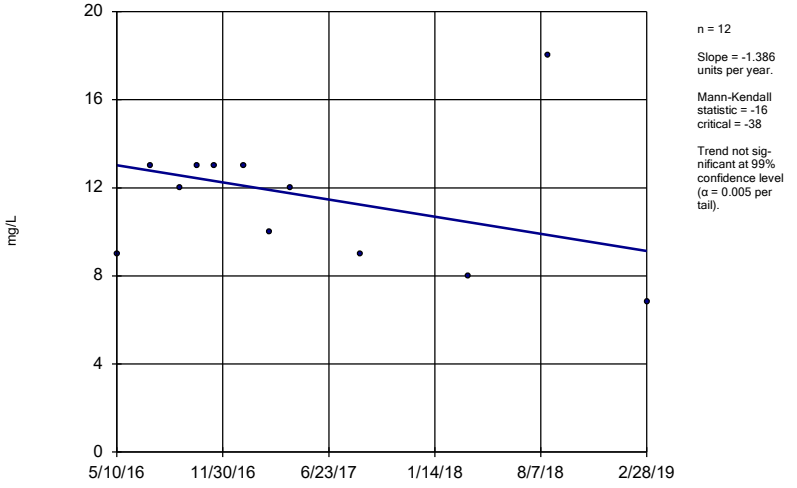
Constituent: Chloride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 12

Slope = -1.386 units per year.

Mann-Kendall statistic = -16 critical = -38

Trend not sig-nificant at 99% confidence level (α = 0.005 per tail).

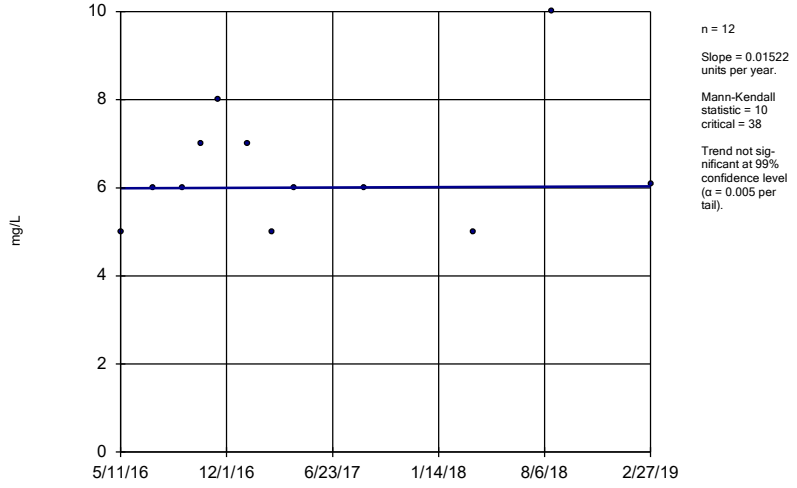
Constituent: Chloride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 12

Slope = 0.01522 units per year.

Mann-Kendall statistic = 10 critical = 38

Trend not sig-nificant at 99% confidence level (α = 0.005 per tail).

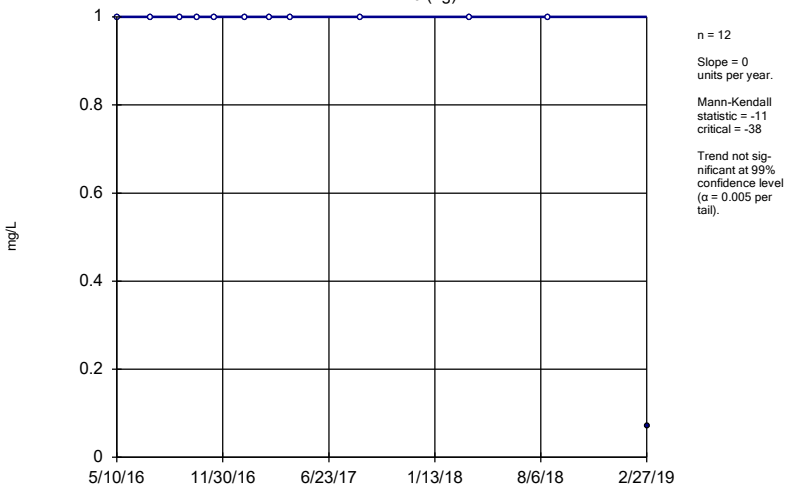
Constituent: Chloride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-16 (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = -11
critical = -38

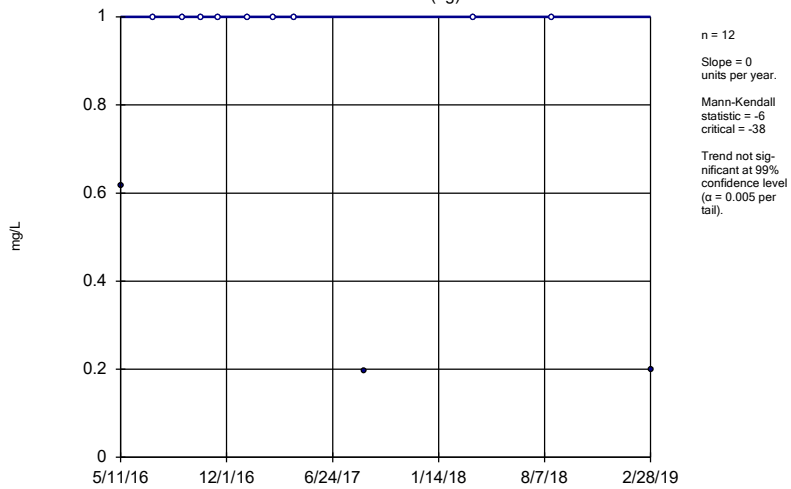
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Fluoride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-27 (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = -6
critical = -38

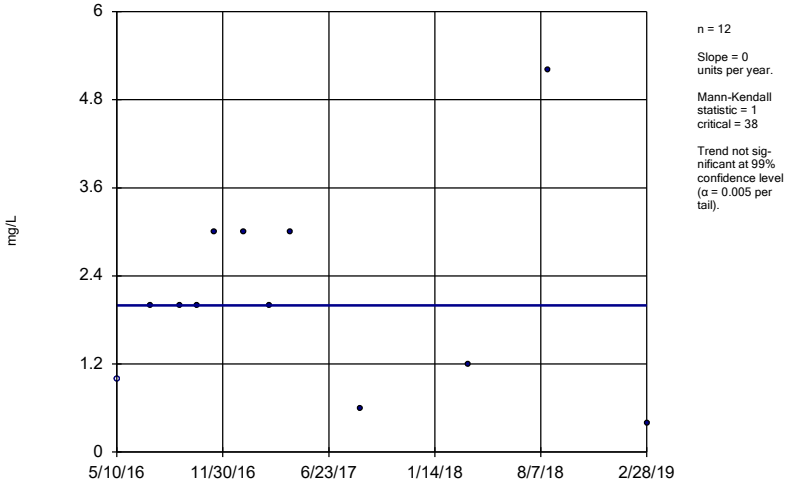
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Fluoride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-8 (bg)



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = 1
critical = 38

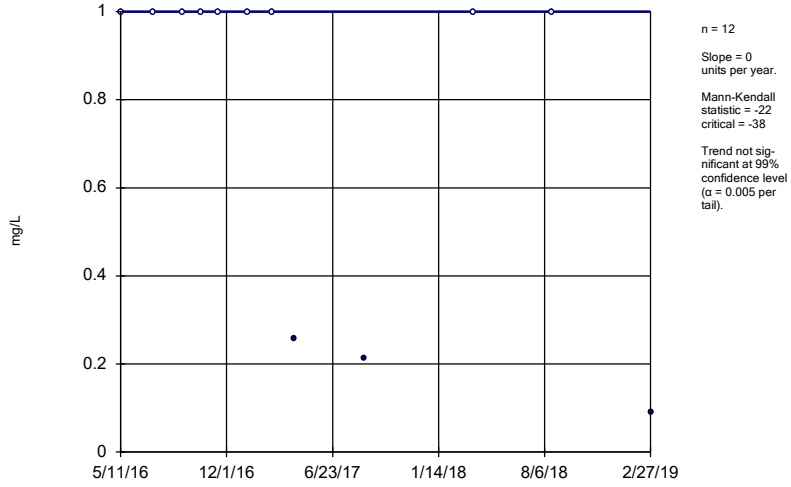
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Fluoride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 12

Slope = 0
units per year.

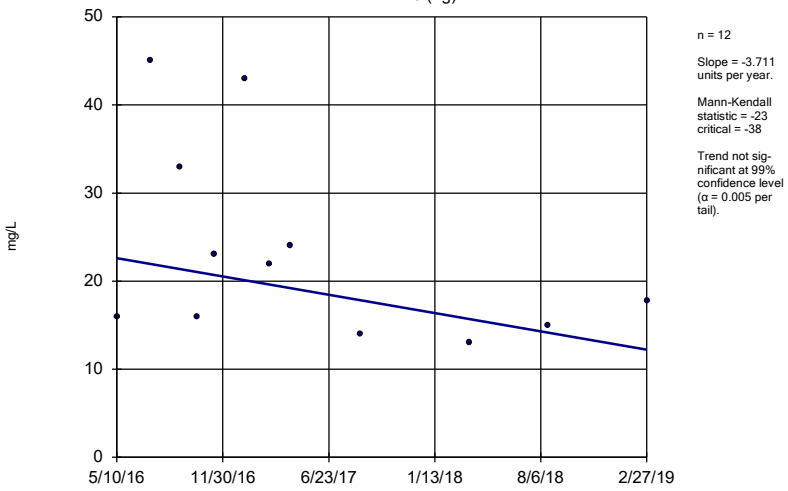
Mann-Kendall
statistic = -22
critical = -38

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Fluoride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-16 (bg)



n = 12

Slope = -3.711 units per year.

Mann-Kendall statistic = -23
critical = -38

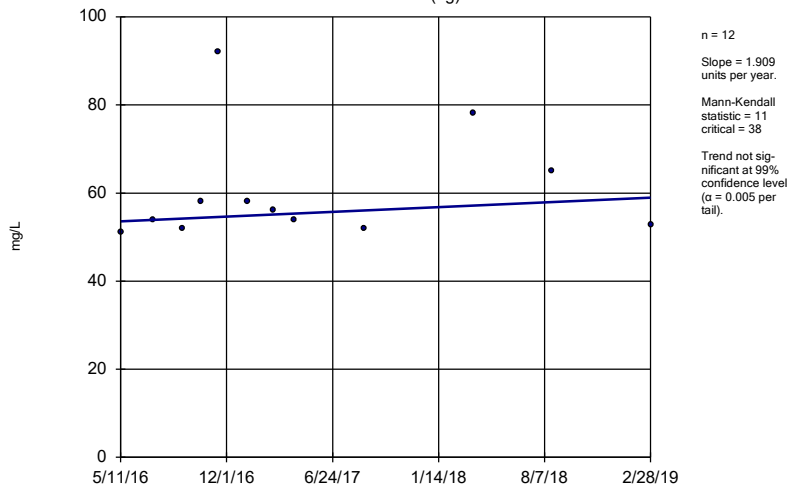
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 12

Slope = 1.909 units per year.

Mann-Kendall statistic = 11
critical = 38

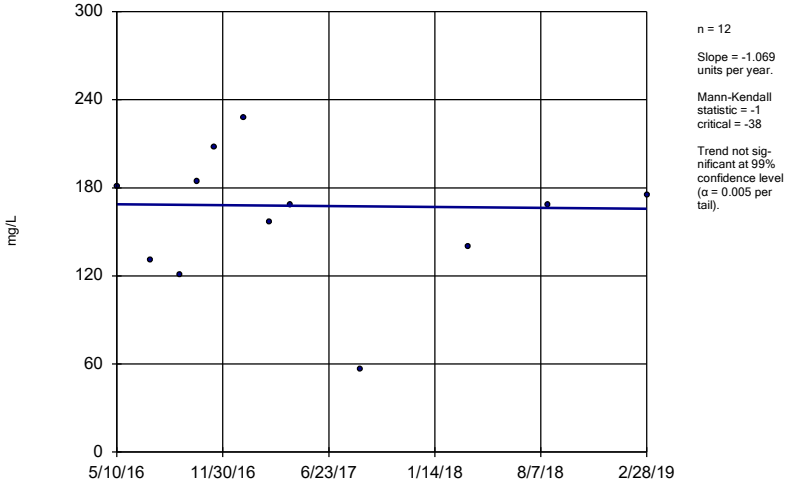
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 12

Slope = -1.069 units per year.

Mann-Kendall statistic = -1
critical = -38

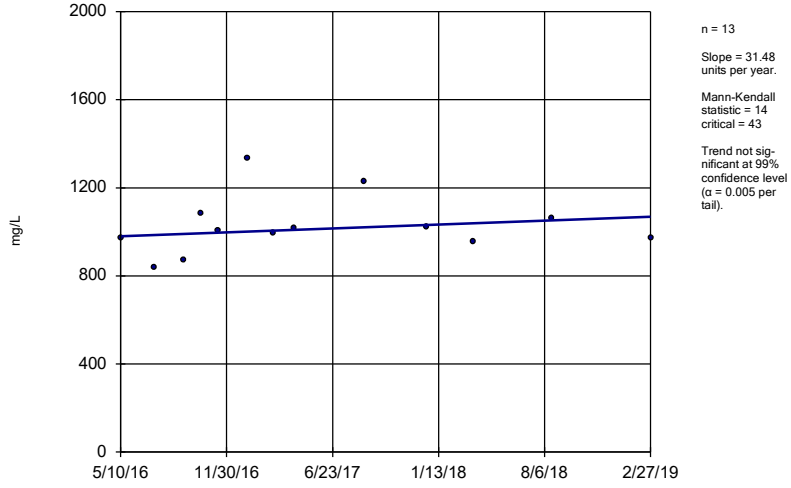
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-34



n = 13

Slope = 31.48 units per year.

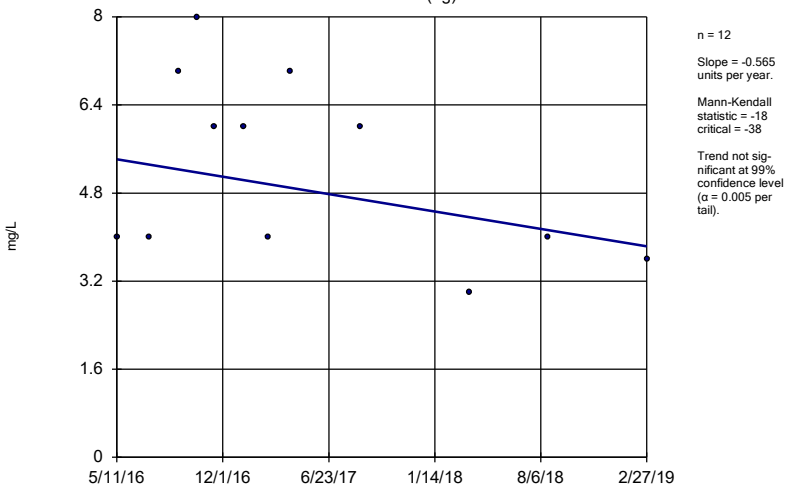
Mann-Kendall statistic = 14
critical = 43

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-12 (bg)



n = 12

Slope = -0.565 units per year.

Mann-Kendall statistic = -18
critical = -38

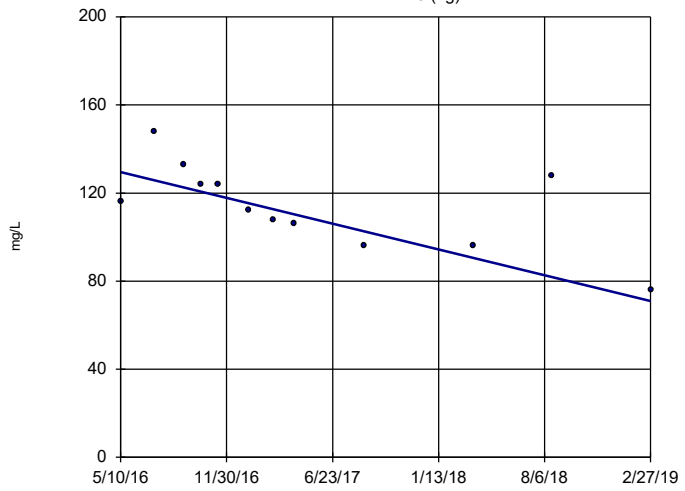
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-16 (bg)



n = 12

Slope = -20.86 units per year.

Mann-Kendall statistic = -40
critical = -38

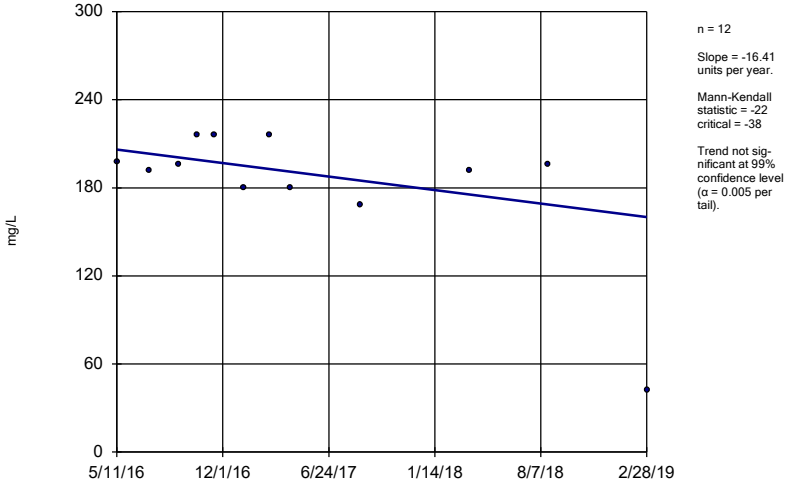
Decreasing trend significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 12

Slope = -16.41 units per year.

Mann-Kendall statistic = -22
critical = -38

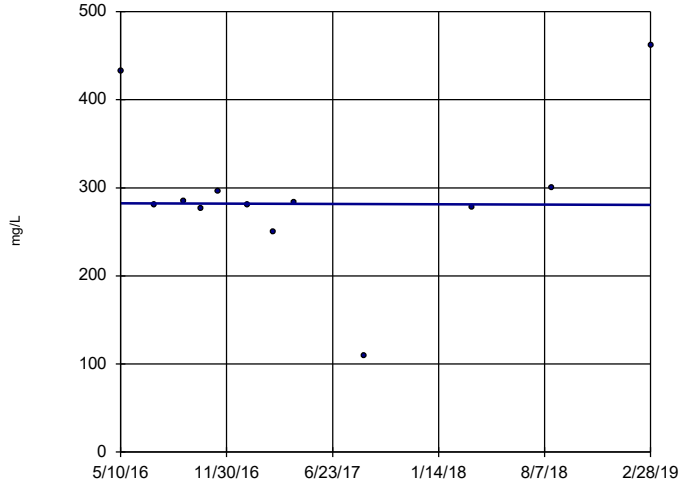
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 12

Slope = -0.5925 units per year.

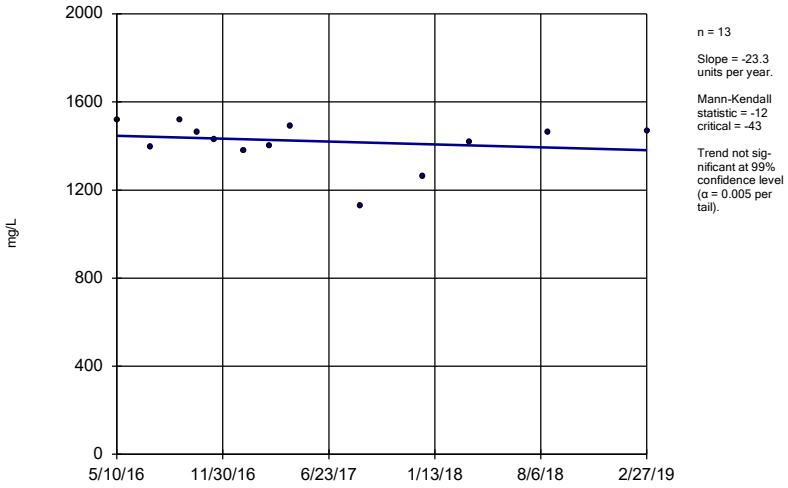
Mann-Kendall statistic = -1
critical = -38

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-34



n = 13

Slope = -23.3 units per year.

Mann-Kendall statistic = -12 critical = -43

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests

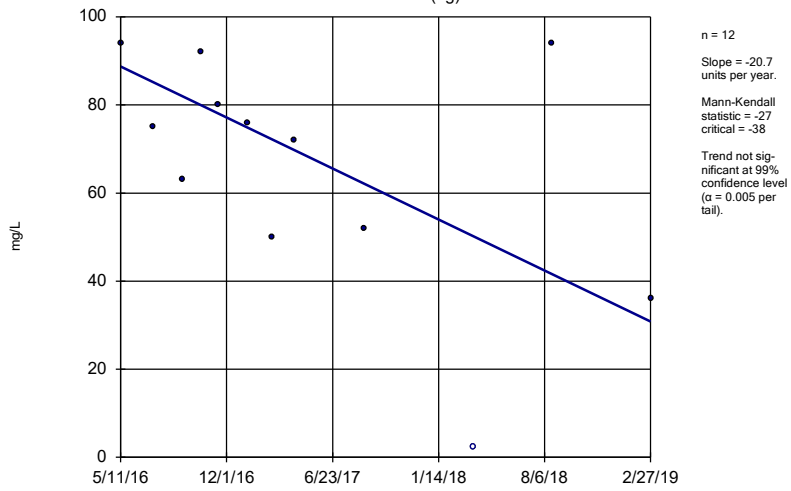
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 12

Slope = -20.7 units per year.

Mann-Kendall statistic = -27 critical = -38

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

ATTACHMENT B
Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey LF CCR management area and that the requirements of 40 CFR 257.94(e)(2) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
2039 Centre Point Blvd., Suite 103
Tallahassee, FL 32308

Texas Registered Engineering Firm
No. F-1182

79864	Texas	1/7/2020
License Number	Licensing State	Date

APPENDIX IV

Notices of groundwater monitoring program transitions are included in this appendix.

APPENDIX V

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #511623

Owner:	**American Electric Power Company**	Owner Well #:	**AD-36**
Address:	**502 N. Allen Street Shreveport, LA 71101**	Grid #:	**35-37-4**
		Latitude:	**32° 27' 05.39" N**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Longitude:	**094° 29' 50.99" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **4/24/2019** Drilling End Date: **4/24/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**15**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
Filter Pack Intervals:	**4**	**15**	**Sand**	**20/40**

Annular Seal Data: **No Data**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C & S Lease Service**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **David Diduch** Apprentice Number: **60297**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**9**	**Sandy clay with gravel, mainly fill**
9	**11**	**Clayey sand, mainly Iron ore**
11	**14**	**Sandy clay**
14	**15**	**clayey sand with iron ore**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**5**	**15**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506035

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.08" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 58.82" W**
Well County:	**Harrison**	Elevation:	**No Data**
			****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #185184**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/19/2019** Drilling End Date: **2/20/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**31**	**38**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

	Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Plug Information:	**SAND**	**50**	**60**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**clay brown**
1	**5**	**silty sand**
5	**9.5**	**clay**
9.5	**11**	**sand**
11	**32**	**clay**
32	**39**	**sand and clay**
39	**55**	**sand**
55	**60**	**fine sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**40**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**40**	**50**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS PLUGGING REPORT for Tracking #185184

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.08" N**
		Longitude:	**094° 29' 58.82" W**
	LOCATED ON OWNERS PROPERTY	Elevation:	**No Data**
Well County:	**Harrison**		

Well Type: **Monitor**

Drilling Information

Company: **Plains Environmental Services** Date Drilled: **2/20/2019**

Driller: **Jesse Kalvig** License Number: **5025**

Well Report Tracking #506035

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Plugging Information

Date Plugged: **2/21/2019** Plugger: **Jesse Kalvig**

Plug Method: **Pour in 3/8 bentonite chips when standing water in well is less than 100 feet depth, cement top 2 feet**

Casing Left in Well:

DIa (in.)	*Top (ft.)*	*Bottom (ft.)*
2	**15**	**50**

Plug(s) Placed in Well:

Top (ft.)	*Bottom (ft.)*	*Description (number of sacks & material)*
1	**40**	**Bentonite 10 Bags/Sacks**

Certification Data: The driller certified that the driller plugged this well (or the well was plugged under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the reports(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

STATE OF TEXAS WELL REPORT for Tracking #506039

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD37**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Latitude:	**32° 27' 56.32" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 41.78" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**17**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**10**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**8.5**	**CLAYS WITH SOME SAND**
8.5	**10.5**	**SAND**
10.5	**13**	**CLAY SOME SAND**
13	**15**	**SAND WITH SOME CLAYS**
15	**17**	**CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**12**	**17**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506038

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD38**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 46.12" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 43.34" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/21/2019** Drilling End Date: **2/21/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**CLAY RED**
5	**7**	**CLAY GRAY/RED**
7	**11.5**	**SAND/CLAY**
11.5	**17.5**	**SAND SOME CLAYS**
17.5	**18**	**CLAY SLITS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506037

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD39**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.05" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 58.84" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/20/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**12**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**5**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**CLAY**
1	**5**	**CLAY/SAND**
5	**9.5**	**CLAY**
9.5	**12**	**SAND/CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**7**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**7**	**12**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508688

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**AD-40 (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/10/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**40**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
27	**40**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**13**	**Cement**
13	**27**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**40**	**red and grey sand with occasional clay intervals**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**30**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**30**	**40**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508686

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB(MW)-01A**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/9/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**100**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
86	**100**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**86**	**Bentonite 17 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**85**	**red and grey sand with occasional clay intervals**
85	**88**	**grey clay**
88	**100**	**grey sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**90**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**90**	**100**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508703

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**22**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**22**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**3**	**Cement**
3	**8**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**22**	**red and grey sand w/occ. lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**12**	**22**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508695

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**80**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
56	**80**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**56**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**36**	**red and grey sand w/occ. lignite layers**
36	**41**	**red and tan clay**
41	**69**	**red and grey sand with occasional clay iand lignite layers**
69	**80**	**grey sandy clay with lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**59**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**59**	**69**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508712

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/24/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**25**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
12	**25**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**12**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**25**	**brown sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**15**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**15**	**25**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508708

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
45	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**45**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**28**	**brown sand**
28	**41**	**brown and grey silty clay**
41	**70**	**grey sand with occasional lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506040

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6S**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 30.34" N**
		Longitude:	**094° 29' 27.76" W**
	LOCAATED ON OWNERS PROPERTY	Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**18**	**SANDS AND CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506041

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6D**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 30.28" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 27.75" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**65**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**53**	**Bentonite 19 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**24**	**SANDS AND CLAYS**
24	**29**	**CLAYS**
29	**42.5**	**SANDS AND CLAYS**
42.5	**48.5**	**SANDS WITH SOME CLAY**
48.5	**56**	**CLAYS WITH SOME SAND**
56	**65**	**SILY SANDS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508722

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/3/2019** Drilling End Date: **3/3/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**45**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
32	**45**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**32**	**Bentonite 6 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**45**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**35**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**35**	**45**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508720

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
57	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**57**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**70**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**60**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**60**	**70**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508724

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**35**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**35**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**23**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**35**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**25**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**25**	**35**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508729

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 medium (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**65**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
52	**65**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**53**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**65**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508777

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/26/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**93**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
77	**93**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**77**	**Bentonite 15 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**90**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**
90	**93**	**gray clay (old pit base?)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**80**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**80**	**90**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508781

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/5/2019** Drilling End Date: **3/5/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**30**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
17	**30**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**17**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**30**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**20**	**30**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508779

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/4/2019** Drilling End Date: **3/4/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**60**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
48	**60**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**48**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**60**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508718

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/8/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**15**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**15**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement**
1	**3**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**5**	**15**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508717

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/7/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**43**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
30	**43**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**30**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**
18	**43**	**red and grey sand w/occ. clay layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**33**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**33**	**43**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540